$17.00

Major Horticultural & Household Insects of Oklahoma

Circular E-918

Oklahoma Cooperative Extension Service
Division of Agricultural Sciences and Natural Resources
Oklahoma State University

Common Horticultural and Household Insects of Oklahoma

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INTRODUCTION

This handbook was developed as a reference on the common insects and mites that damage vegetables, fruits, pecans, ornamental trees and shrubs, and turf in Oklahoma. It also covers some common household pests and a few miscellaneous "critters," but does not include every "bug" found in the state. The handbook is intended to serve as a resource for county Extension educators, master gardeners, and horticulture students with respect to identifying common arthropod pests as well as providing information on life cycles, host plants, damage, and management.

In this age of environmental awareness, the concept of routine, preventative treatments for pests is simply not acceptable. Insecticides and miticides should be used only when specific pests appear or where there is a historical basis for anticipating a pest. Every effort should be made to prevent an outbreak of insect/mite infestations through non-chemical means. When chemical control is justified, the least toxic, most effective, and pest-specific product(s) should be used.

The philosophy of Integrated Pest Management (IPM) encourages the use of suppression tactics that are: (1) most effective, (2) least expensive, and (3) least detrimental to the environment. Such tactics include monitoring pests (scouting) and their damage and using cultural, biological, and chemical control techniques. Over-reliance on chemical control can lead to artificial selection of pests that are resistant to the chemicals used, which will in turn unnecessarily increase costs and contaminate the environment.

We intentionally excluded specific chemical control recommendations in this publication. Chemical control suggestions are readily available in OSU Extension Fact Sheets, Circulars, Current Reports, and in the *OSU Extension Agentsí Handbook of Insect, Plant Disease and Weed Control* (publication E-832), which are updated frequently and, thus, are a more reliable source for information about insecticides.

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VEGETABLE INSECTS

ASPARAGUS APHID

Brachycorynella asparagi **(Mordvilko)**

Whitney Cranshaw, Colorado State University, www.insectimages.org

Description

This small, slender aphid measures $^{1}/_{32}$ to $^{1}/_{16}$ inch in length. The body is green to grayish green and is more or less covered with a gray, powdery material. The cornicles are very small and difficult to see without considerable magnification. Winged forms are darker, almost black.

Life Cycle

The biology of this introduced aphid has not been studied in Oklahoma, but the following account is considered likely for the state. Overwintering eggs are laid on the foliage during the fall and spend the winter on plants or on the soil. Wingless females hatch in the spring and feed and reproduce on newly emerged asparagus plants. Several generations of both winged and wingless aphids are produced during the spring, summer, and early fall. As plants begin to yellow in the fall, winged males are produced and mate with females, who begin laying overwintering eggs.

Hosts

Asparagus is the only known food plant of this aphid.

Damage

Asparagus aphids feed in the axils of the modified leaves and under bracts. Heavily infested seedlings may form rosettes or shrivel and die. Similar infestations on older plants may cause severe dwarfing. Symptoms of aphid attack include a shortening of the internodes between the whorls of needles, which produces a characteristic tufted appearance marked by a blue-gray color. During the fern stage of growth, buds may be prematurely released from the crown. This can result in plant death if all viable buds are exhausted at the time of fern cutting. Feeding occurs only on the ferns, and aphid colonies have not been found on the marketable spears. In some areas of the U. S., this pest has been described as the most damaging species that feeds on asparagus.

Inspection and Control

First, determine if the aphid has been found in your area. It was not found in Oklahoma until 1981 and is still limited in distribution within the state. At least two other species of aphids have been found on asparagus in Oklahoma. The asparagus aphid can be identified by its apparent lack of cornicles; other species on asparagus will have well-defined cornicles. If asparagus aphid is found, check the number of aphids and the amount of damage present. This aphid is often controlled by predators, parasites, and diseases, and there is no benefit to treating damage if aphids are no longer present. Because the asparagus aphid is a fern feeder, growers should pay close attention to protecting the fern both early in the season for young asparagus and late June or July for mature stands. Chemical controls can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

ASPARAGUS BEETLE

Crioceris asparagi **(Linnaeus)**

Description

The adult beetle is smooth, shiny, slightly elongated, and measures slightly more than $^1/_4$ inch in length. It has a metallic blue head and blue-black wing covers, each with three yellowish, squared spots and a red outer margin. The thorax is reddish with two small blue spots. The eggs are elongate, dark brown, and attached at one end to the host plant. Larvae are plump, humpbacked, wrinkled, and sluggish. They are dark gray with black heads. This pest has a limited distribution in Oklahoma.

Life Cycle

Asparagus beetles overwinter as adults in sheltered sites, particularly under bark or in stems of old plants. Beetles emerge in early spring and begin to feed. Egg laying begins in mid or late spring. Eggs hatch in three to eight days and larvae feed for approximately two weeks. Pupation lasts five to ten days and occurs in silken cocoons spun in chambers beneath the soil. This three- to four-week life cycle is typical in the summer, but a single generation can take as long as eight weeks in early spring or late fall. There are probably four or five generations per year in Oklahoma.

Hosts

Asparagus is the only known food plant of this beetle.

Damage

Asparagus beetles may begin feeding as soon as asparagus shoots appear in the spring. Adults eat shoots and leaves, but are particularly damaging when they gnaw the tips of buds, causing them to scar and turn brown. Similar damage is inflicted by larvae, who also secrete a black fluid that stains the plants. Eggs are glued to the plants and are difficult to remove from harvested spears.

Inspection and Control

Inspection should begin as soon as new shoots begin to emerge in early spring. Scout for damage, eggs, and adult beetles. Later in the season, the most noticeable symptom is loss of leaves on the ferns. In small plantings, the larvae can be knocked from the plants onto the soil. They will not usually be able to climb the plants and will die on the hot soil. Many beneficial insects reduce numbers of asparagus beetles through predation and parasitism of eggs and larvae. These "natural enemies" include lady beetles and other predaceous beetles, predaceous stink bugs, and certain parasitic wasps.

In general, if beetles are present in early spring when spears can be damaged, insecticides should be applied to protect the marketed product. Later in the year, some damage to the ferns can be tolerated, especially when they are actively growing. However, an appropriate insecticide should be used if significant damage appears imminent. Chemical controls can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

BEAN LEAF BEETLE

Cerotoma trifurcata **(Forster)**

Description

Adult bean leaf beetles measure about $^1/_5$ to $^1/_4$ inch in length and are yellow, orange, or red with a black head and black spots down the center of the back. Normally, there are six black spots which may run together so that it appears only three spots are present, or they may be completely absent. The triangular black mark at the base of the wing covers is always present. The yellow forms can be mistaken for a small, spotted cucumber beetle.

Life Cycle

Adults overwinter in leaf litter or other vegetation, primarily in wooded areas. They become active in early spring and move to the earliest host plants available. They feed for several days and then mate. Each female lays 175 to 250 eggs in clusters of 12 to 24 in the soil at the base of plants. Eggs hatch in one to three weeks, depending on the temperature. Larvae feed on the base of the stem or roots for three to six weeks. Mature larvae form earthen cells, in which they pupate. There are two or three overlapping generations, and adults are present almost continuously from early spring to late fall.

Hosts

The adults feed primarily on legumes. The most common hosts are snap beans, soybeans, and alfalfa in Oklahoma.

Damage

Beetles feed on the underside of bean leaves, and damage will appear as small, round holes. Damage often occurs as host plants are emerging, and stand reduction can occur if beetles are present in large enough numbers. Large populations are capable of causing extensive defoliation to older stands.

Inspection and Control

Bean leaf beetles drop to the ground when plants are disturbed. Therefore, check for beetles by placing a drop cloth beneath the plant, brushing the plants with your hand, and counting the number of beetles that drop onto the cloth. Control should not be based solely on foliar damage, but on the combination of damage, plant maturity, and number of beetles present. Early in the season, control measures should be based on limiting stand loss to 5 or 10 percent, depending on the quality of the initial stand. Chemical controls can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

BEET LEAFHOPPER

Circulifer tenellus **(Baker)**

A.C. Magyarosy, , www.insectimages.org

Description

The adult is a small, wedge-shaped insect measuring approximately $^{1}/_{8}$ inch in length, and is pale green to yellow with darker blotches. Adults have long, slender rear legs and will jump or fly away when disturbed. Adults move into fields in early spring and feed on plants, often moving when suitable hosts are not located.

Life cycle

Adults move into fields in early spring and lay eggs on suitable hosts. Eggs hatch and nymphs develop to adults in two to three months. There may be multiple generations in Oklahoma.

Hosts

Adults may land and probe-feed on many different plants, but generally prefer to lay eggs on beets, tomatoes, and various weeds.

Damage

Adults and nymphs have piercing-sucking mouthparts, which they use to remove plant nutrients from leaves and stems of host plants. When adults and nymphs are abundant, feeding can result in shriveled and burned leaves, which is generally referred to as 'hopper burn.' However, the primary damage caused by the leafhopper is from a pathogen transmitted by adults – curly top virus – which is spread from plant to plant. This virus causes tomato and potato plant leaves to turn yellow and curl, and often turns leaf veins and stems a purplish hue. Infected plants cease growing and remain stunted, and stems become stiff. Generally, fruits ripen prematurely and are deformed.

Inspection and Control

Plants should be visually inspected for presence of adult leafhoppers. An insect net can be swept through vegetation surrounding the garden or field to monitor adult movement into the area. However, there are currently no effective management strategies that can be used to prevent the adult leafhoppers from probing and feeding on plants prior to transmission of the virus. Infected plants should be removed, and growers may be able to plant a sequential and second planting for later fruit production.

CABBAGE LOOPER

Trichoplusia ni **(Hubner)**

David Cappaert, Michigan State University, www.insectimages.org

Keith Naylor, www.insectimages.org

Description

Cabbage looper moths have a wingspan of 1 $^{1}/_{2}$ inches. The forewings are gray brown with a silvery spot resembling the letter "V" or number "8" near the center. The hindwings are pale, but become darker near the outer margin. Eggs are round, greenish white, and slightly smaller than a pinhead. Newly hatched larvae are green. As they mature, they develop white stripes, two on top and two on each side. They have only three pairs of prolegs, two pairs on the abdomen and one pair at the anal end. Larvae move in a characteristic "looping" motion. They reach about 1 $^{1}/_{5}$ inches in length at maturity. The pupal stage is encased in a loosely woven, white cocoon on the host plant.

Life Cycle

This species overwinters as pupae in the soil or in cocoons on host plants. Adults emerge in mid spring and females soon begin laying eggs. Larvae are present by April or May. Moths are active at night and each female may lay 275 to 350 eggs singly on the upper surface of leaves. Larvae feed for two to four weeks before pupating. The pupal stage lasts for two weeks. With warm temperatures, development of all cabbage looper stages—from egg to adult—takes about 18 to 25 days. Looper activity (egg laying and larval feeding) will decrease as cool weather (50° F or less) becomes common. Three to five generations occur per year and activity typically continues through most of October.

Hosts

Cole crops such as cabbage, collards, broccoli, cauliflower, and turnips are commonly infested. Cabbage loopers also feed on other vegetables such as lettuce, spinach, celery, parsley, beets, peas, potatoes, and tomatoes. Other hosts include alfalfa, soybeans, and cotton.

Damage

Young larvae scarify the leaves and older larvae chew irregular-shaped holes of various sizes. Young plants can be killed by loopers if they destroy the growing point, or they can cause branching by feeding on the growing point. Problems in cabbage include loopers feeding on the head, and the presence of larvae and frass (excrement) down in the head at harvest time. If not controlled, larvae are often found in broccoli heads at harvest. The larvae are not easily washed out and will go to market with the broccoli. Damage to leafy vegetables is obvious from looper feeding (i.e., large, patchy areas consumed). Tomatoes are damaged by larvae feeding on the leaves, thus exposing fruit to the sun and resulting in sun scald.

Inspection and Control

Cabbage loopers are mostly leaf feeders and are usually found on the undersides of leaves. However, larger larvae may be found deep in the heads of plants such as cabbage or broccoli. Control should be aimed at the younger larvae as older ones are more difficult to kill. To achieve best control, consider the crop and how it is to be marketed. For instance, damage to frame leaves of cabbage is not going to have an impact on the cabbage head that is eaten or sold. Also, minor damage to broccoli leaves before heading will not affect yield, whereas damage to the head will reduce yield.

The decision to apply insecticides should be based primarily on the presence of larvae. Research and large-scale field trials have shown that the action threshold (i.e., time to treat) for caterpillars on cole crops is 0.3 larvae per plant (one larva per three plants). This threshold can be used for all crops as long as fields are scouted at least twice weekly and the field is sampled sufficiently to gain a representative index of larval activity. Usually 25 to 40 samples are adequate for a field measuring less than 40 acres. Although attention

should be paid to field edges and "problem" areas, treatment decisions should be made based on randomly selected plants from all sections of the field. Prior to cupping in cabbage, more larvae can be tolerated than after cupping (usually up to 0.5 larvae per plant, or one larvae per two plants). Also, control of larvae before thinning direct-seeded crops is not critical unless the plant stand is significantly threatened.

The bacterial insecticide, *Bacillus thuringiensis* var. *kurstaki* (e.g., Dipel, Foray), is very effective on loopers. Chemical controls can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact sheet EPP-7313.

Notes

COLORADO POTATO BEETLE

Leptinotarsa decemlineata **(Say)**

David Cappaert, Michigan State University, www.insectimages.org

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Description

Adults measure about $^{3}/_{8}$ inch long by $^{1}/_{4}$ inch wide, and are oval and very convex. They are yellowish-brown beetles with five black stripes on each wing cover and small black spots on the thorax. Eggs are elongate, yellow or orange, and occur in clusters, laid on end and grouped into rows. Newly hatched larvae are cherry red with black heads and legs, and are humpbacked and soft bodied. As they grow, they turn brick red or orange and develop two rows of black spots along each side of the body. They reach a length of about $^{3}/_{8}$ inch when mature.

Life Cycle

Adults overwinter in the soil. They emerge in spring and feed for a short period before mating and laying eggs. Females deposit 300 to 500 eggs in clusters of 20 or more on the undersides of leaves over a period of four to five weeks. Larvae hatch in four to nine days and feed for three weeks, often in groups. Mature larvae drop to the ground and pupate in the soil. A new generation of adult beetles emerges five to ten days later. There can be two or three generations per year in Oklahoma.

Hosts

Colorado potato beetles infest a wide variety of cultivated and wild solanaceous plants, including potato, eggplant, tomato, pepper, tobacco, ground cherry, buffalo burr, and horse nettle.

Damage

Both adults and larvae feed on the leaves and terminal growth of their host plants. The loss of foliage hinders development of tubers or fruit, thereby reducing yield. In cases of severe infestation, entire plants may be killed. Overwintered adults can be numerous enough to cause extensive damage to young plants, and larvae are capable of severely defoliating older plants. Potato beetles generally feed from the outside of the leaf in towards the mid-vein.

Inspection and Control

Adults are easily found as they spend much of their time on the upper and/or outer portion of the plant. Also, plant tops can be brushed and the adults will drop to the ground where they can be caught in a drop cloth and counted. Eggs are usually found on the undersides of leaves on the lower portion of the plants. Larvae will spend a small amount of time near the egg mass from which they hatched, and then tend to move up the plant. Often small larvae will be seen in the terminal feeding on tender young leaves. Chemical control targets the first generation to prevent more severe damage that would result from subsequent generations if they became more numerous. Foliar insecticides should not be applied until the first eggs are hatching, unless the overwintered adults are very numerous. The bacterial insecticide, *Bacillus thuringiensis* var. *tenebrionis*, is effective on larvae, but will not kill adults. Hand picking is effective in small plantings. Chemical controls can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

CORN EARWORM / TOMATO FRUITWORM

Helicoverpa zea **(Boddie)**

Bruce Marlin, Red Planet, Inc., www.cirrusimage.com

R.L. Croissant, www.insectimages.org

Description

The adult moth is usually light yellow-olive with a single dark spot near the center of each forewing, but some adults have vague, darker markings on the wings. The wingspan is about 1 $^{1}/_{2}$ inches. Eggs are almost spherical with a flattened base and are white or cream colored. Larvae vary in color, ranging from shades of pink, yellow, green, brown, and black. Coloration depends to some extent on the host plant. Larvae usually have darker or lighter stripes running lengthwise on the body, and can be positively identified by the presence of short, sharp microspines between the body hairs. However, magnification of 7x to 10x is necessary to see these spines.

Life Cycle

Earworms overwinter as pupae in the top 1 to 2 inches of soil. Adults begin to emerge in early spring. Moths also migrate north from Texas, augmenting the population that overwinters in Oklahoma. Eggs are laid on the buds or fruits of host plants. Before entering the soil to pupate, larvae feed for a period of slightly longer than three weeks. They prefer buds or fruits, but will also feed on the leaves of many different plants. First-generation larvae are found mostly in alfalfa and seldom cause problems in vegetables. Second-generation larvae commonly damage corn, beginning in mid May. Damage to tomatoes is seldom seen before June but may continue into early October. There are at least four generations per year.

Hosts

Corn and tomatoes are the most commonly damaged vegetables, but earworms will also feed on several other vegetables, many field crops, some ornamentals, and a wide variety of wild plants. The name of the caterpillar is often based on its host plant, e.g., corn earworm, tomato fruitworm, cotton bollworm, soybean podworm, or sorghum headworm.

Damage

Damage to corn occurs when larvae feed in the terminals of young plants and in the ears (on the kernels) of older plants. Tomatoes, and occasionally peppers, are damaged mostly by larvae boring into the fruit. Larvae will feed on the leaves and pods of beans and cowpeas and on the pods of okra.

Inspection and Control

Earworms have a number of parasites, predators, and diseases. These natural enemies help reduce numbers, but often do not keep populations from causing serious damage. Egg surveys can be used to time insecticide applications because newly laid eggs hatch in three to five days. Chemical control should be directed at small larvae as larger larvae often feed in protected locations and are much more difficult to kill even if contacted by the material.

Mineral oil has been applied to corn silks to control earworms, but one has to be aware of possible adverse side effects. It must be applied during early silk development to be effective, which often interferes with kernel development. Chemical controls in corn must be applied at two- to three-day intervals to be effective. In the home garden, it is often simpler to cut out damage at harvest and not attempt to control this pest. Tomatoes and other vegetables should be treated when damage begins to appear. Susceptible crops should be inspected regularly for damage. The bacterial insecticide, *Bacillus thuringiensis* var. *kurstaki*, can be used to control this pest. Suggested chemicals can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

CUTWORMS

Family Noctuidae

University of Georgia Archive, University of Georgia, www.insectimages.org

University of Georgia Archive, University of Georgia, www.insectimages.org

Ian Kimber, www.insectimages.org

Tony Davison, www.insectimages.org

Description

Adult cutworms are medium-sized moths with a wingspan of 1 to 2 inches. Most species are brown or gray with various darker or lighter markings on the forewings. The larvae are black, gray, or brown caterpillars that measure about 1 $^{1}/_{2}$ inches in length at maturity. Some species have darker or lighter spots or stripes on the body. At least 7 species are known to damage vegetables in Oklahoma. The variegated cutworm, *Peridroma saucia* (Hubner); and claybacked cutworm, *Agrotis gladiaria* Morrison are the most common. The army cutworm, *Euxoa auxiliaris* (Grote); and black cutworm, *Agrotis ipsilon* (Hufnagel); cause problems in some years and the bronzed cutworm, *Nephelodes minians* Guenee; dusky cutworm, *Agrotis venerabilis* Walker; and dingy cutworms, *Feltia* spp. are occasionally found.

Lacy L. Hyche, Auburn University, www.insectimages.org

Life Cycle

Cutworms overwinter as larvae or pupae, depending on the species, and damage to vegetables can occur from late February to early June. Army cutworms overwinter as larvae, feed early in the spring, and have one generation per year. Damage in March is most likely to be caused by this species. Claybacked and dusky cutworms also overwinter as larvae and have one generation per year, but the larvae develop later in the spring. Variegated and black cutworms overwinter as pupae and have several generations per year. Local populations of some species are augmented by migration of moths. Black cutworms migrate north in the spring and army cutworms migrate from the mountains in Colorado in the fall.

Hosts

Cutworms are general feeders and attack a wide range of plants. Some common vegetable hosts include asparagus, beans, cabbage and other

crucifers, carrot, corn, lettuce, onion, peas, pepper, potato, rhubarb, and tomato.

Damage

Cutworm problems are sporadic but can occasionally be severe. The dark-colored moths are active at night and lay eggs on leaves or stems close to the soil surface soon after plants emerge. After hatching, young larvae may feed on leaf surfaces for a short time, but older larvae tunnel into the soil and emerge at night to feed. Cutworm larvae may be distinguished from certain other larvae by their habit of curling into a C-shape when disturbed. Damage by cutworms is characterized by plant stems being cut partially or completely at the soil surface. Plants begin to wilt and usually die.

Inspection and Control

After plant emergence, check for wilted plants with completely or partially severed stems. Once damaged plants are found, look for cutworms by digging around the base of the plants and sifting the soil for caterpillars. Cutworms are not normally found on the soil surface during the day, so it is best to scout for them at dawn or at night using a flashlight. Damaged plants often occur in a sequence of four or five within a row.

Cutworms often recur in the same fields and in the same parts of fields from year to year. Areas that have had a dense stand of weeds often have high populations. Insecticidal baits are more effective when other food is limited, so check for cutworms and apply bait to the field before the crop emerges, especially where cutworms have caused previous damage.

Cultural controls can help prevent cutworm damage. Remove weedy field margins and disc fields at least ten days before planting to destroy larvae, food sources, and egg-laying sites. In small gardens, barriers placed around plants can prevent serious cutworm damage. Individual plant stems can be encircled with cardboard or metal collars pressed 1 inch into the soil. Barriers, however, are not practical for large plantings. It is seldom warranted to treat for cutworms before thinning unless the plant stand is otherwise poor. If an insecticide is used, effectiveness is increased by applying a band at the base of the plants, preferably at or shortly before dusk. For specific chemicals, see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

Notes

DIAMONDBACK MOTH

Plutella xylostella **(Linnaeus)**

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Nathan Herrick, USDA Agricultural Research Service

Description

This small, gray-brown moth has narrow forewings, conspicuously fringed hindwings, and a wingspan of about $^{3}/_{4}$ inch. When at rest, the wings come together to form a line of white or pale yellow diamonds down the middle of the back. The minute, round eggs are pale yellow. Larvae are pale green and slightly tapered at each end. They have black heads and scattered black hairs on the body. The prolegs on the last abdominal segment are spread apart, forming a characteristic "V" shape. Larvae are slightly longer than $^{1}/_{4}$ inch at maturity and wriggle rapidly if disturbed. The yellow pupae are enclosed in loosely spun, gauzelike cocoons.

Life Cycle

Diamondback moths overwinter as adults among field debris of cruciferous crops. Active adults may be seen during warm periods any time in the winter. In spring, eggs are laid singly or in groups of two or three on foliage. Larvae hatch a few days later, usually by early April in Oklahoma. Larvae feed for about ten days during warm weather or for as much as a month during cool seasons. They first feed as leafminers but soon emerge and infest the undersides of leaves. When mature, larvae spin loose cocoons which remain attached to the lower leaf surface. After a two-week pupal period, a new generation of moths emerges. Activity can continue through winter in southern Oklahoma. There may be five or more generations per year in Oklahoma.

Hosts

The diamondback moth is a pest of practically all crucifers, including cabbage, broccoli, cauliflower, collards, kale, brussels sprouts, kohlrabi, turnip, radish, mustard, and watercress.

Damage

Larvae feed on all plant parts, but prefer the undersides of older leaves, crevices between loose leaves, and young buds. They chew small holes in leaves and buds or feed superficially, leaving slight perforations instead of distinct holes entirely through the leaf. When populations remain low, these small caterpillars cause little damage; however, in large numbers, they may be injurious to young plants. Heavy feeding on buds may cause the marketable portion of the plant to fail to develop properly.

Inspection and Control

An important form of cultural control for this pest is to reduce source populations through destruction of crop residue and weeds that serve as alternate hosts. Because diamondback moth pupae survive in the soil and crop residue left behind after harvest, it is important to destroy "harborage" by shredding, discing, and plowing. Resistant varieties of cabbage, mustard, turnip, kale, and radish will also reduce infestations.

The decision to apply insecticides should be based primarily on the presence of larvae. Research and large-scale field trials have shown that the action threshold for caterpillars on cabbage is 0.3 larvae per plant (one larva per three plants). This threshold can be used for all cruciferous crops as long as fields are scouted at least twice weekly and the field is sampled sufficiently to gain a representative index of larval activity. Usually 25 to 40 samples are adequate for a field measuring less than 40 acres. Although attention should be paid to field edges and "problem" areas, treatment decisions should be made based on randomly selected plants from all sections of the field. Prior to cupping in cabbage, more larvae can be tolerated than after cupping (usually up to 0.5 larvae per plant, or one larvae per two plants). Also, control of larvae before thinning direct-seeded crops is not critical unless the plant stand is significantly threatened.

Recently, the diamondback moth has become more difficult to control with insecticides and high levels of resistance have been observed in several production areas. It is strongly advised to use a *Bacillus thuringiensis* var. *kurstaki* product in each of the insecticide sprays as a basis for a control program. Other chemicals can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

EGGPLANT LACE BUG

Gargaphia solani **Heidemann**

Debbie Roos, North Carolina State University

Description

The prothorax (area behind the head) of this gray or light brown bug has a hood-like projection, which extends out over the body and comes to a point over the wings. The bug also has a small hood-like projection over the head and two lacy, lateral projections. It has a dark head, pale yellow legs, and two pairs of lace-like wings, which are black at the base. The body appears flattened and measures about $^{3}/_{32}$ inch in length. Nymphs lack the lacy wings and thoracic projections, but have spines on the body. Nymphs are yellow with a dark spot at the tip of the abdomen. The small, dark-colored eggs are laid on end in loose, circular clusters.

Life Cycle

Eggplant lace bugs overwinter as adults within shriveled leaves or among other plant debris. They emerge and begin laying eggs in early spring. Each female spends four to five days depositing 100 to 200 eggs in a roughly circular mass on the underside of a leaf and guards her eggs against predators. When eggs hatch about six days later, the female continues to guard her offspring. Nymphs feed and move as a colony, guided by the adult female. They develop into new adults in about ten days, but several days may elapse before adults of the new generation mate and deposit more eggs. There are probably six or eight generations per year in Oklahoma.

Hosts

This species feeds mostly on solanaceous plants, especially eggplant and horse nettle. It has also been reported on potato, tomato, jimsonweed, sunflower, sage, and cotton.

Damage

The first noticeable symptoms of lace bug damage on leaves are circular, discolored areas about the size of a quarter. The remains of an egg mass and a group of nymphs typically are found on the underside of each discolored spot. Lace bugs gradually move outward until the whole leaf yellows and dries. Feeding in groups, they move from leaf to leaf and eventually to new plants. A severe lace bug infestation may kill whole plants or weaken them to the point that fruit fails to develop.

Inspection and Control

Removal of nearby wild hosts, especially horse nettle, may help keep numbers of lace bugs low. Check the undersides of leaves of any plants that develop discolored spots. If lace bugs do become a problem, effective insecticides are available. Chemical controls can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

FLEA BEETLES

Family Chrysomelidae

Description

Flea beetles are small, oval insects that vary from $^1/_6$ to $^1/_5$ inch in length. Most are blue-black, brown, or yellow-brown and some have red or yellow markings. The hind legs are distinctly enlarged, thickened, and packed with muscle, enabling these beetles to jump readily when disturbed. Larvae are small, white, and elongated and have three pairs of thoracic legs and brown or red heads. They range from $^1/_8$ to $^1/_3$ inch in length and are found in the soil.

Life Cycle

Life cycles of flea beetles vary with species. Generally, they overwinter as adults in dead leaves, grass, or debris. They resume activity in the spring and feed on weed hosts until cultivated plants are available. Eggs, deposited in the soil near the bases of host plants, may require a week or more to hatch. Larvae feed on or in roots, tubers, or lower stems for two to four weeks before pupating. After a pupal period of seven to ten days, a new generation of beetles emerges. Some species have only one generation per year while others may have three or four generations per year.

Hosts

Nearly all kinds of plants are attacked by flea beetles. Some species are rather host specific but others will attack a wide variety of plants. The vegetables most commonly damaged in Oklahoma are radishes, corn, eggplant, and potatoes.

Damage

Adults chew small, round holes in the leaves of plants. Most serious early in the growing season, this injury eventually kills infested leaves. In addition, some species can transmit plant diseases. Root-feeding larvae cause little significant injury to most host plants, except for potato. Larvae tunnel superficially on the surface of tubers, leaving scars and increasing susceptibility to disease organisms.

Inspection and Control

Cultural methods are primary sources of defense against flea beetle infestations. First, it is important to keep fields free of weeds. Destruction of plant residues, especially piles of cull potatoes and trash where adults overwinter, prevents the buildup of flea beetle populations. Second, late planting dates favor growth of the host plant over establishment of flea beetles. Lastly, covering beds of seedlings with a gauze-like material prevents beetle entry into the crop.

A number of insecticides are available to control adult flea beetles. Plants should be treated when adults and damage appear. Treatment can be repeated as needed. Specific chemicals can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

Appreciation is expressed to Mechelle Hampton who, as a student in the Horticultural Insects Course in 1991, developed much of the material included here.

GARDEN FLEAHOPPER

Halticus bractatus **(Say)**

Description

There are three forms of garden fleahopper adults: slender, long-winged females, oval, short-winged females, and slender, long-winged males. All forms are black and have long legs and antennae. They measure less than $^{1}/_{8}$ inch in length. They usually move by jumping but are also capable of flying. Nymphs range in color from pale yellow to dark green. Nearly mature nymphs have a distinctive black spot on each side of the first segment behind the head. They are active insects that readily jump when disturbed.

Life Cycle

Overwintering appears to occur primarily as eggs, which are inserted into plant tissue during August and September. However, late-maturing adults are reported to go into hibernation, and some of these may survive the winter and lay eggs in the spring. Nymphs emerge in the spring and feed on the underside of leaves. They mature in about two to five weeks, depending on the temperature.

Adults live one to three months. During her lifetime, each female can lay about 100 eggs. Eggs are deposited into punctures made by the mouthparts, mostly in leaves or leaf petioles. About 12 to 20 days later, eggs hatch and the life cycle is repeated. There are probably five generations per year in Oklahoma.

Hosts

Garden fleahoppers feed on a wide range of garden, ornamental, and forage plants as well as many weeds and grasses. Vegetable crops that may be damaged include beans, beets, cabbage, celery, corn, cowpeas, cucumbers, eggplant, lettuce, peas, peppers, potatoes, pumpkins, squash, sweet potatoes, and tomatoes.

Damage

This insect causes "stippling," or the appearance of pale spots on leaves due to sucking plant sap. These spots gradually merge to produce extensive discoloration. Heavily infested foliage dies and drops from the plant.

Inspection and Control

Damage somewhat resembles that caused by spider mites, but there is no webbing on the leaves. Look for small white spots plus the presence of small, dark-colored, jumping insects. Garden fleahoppers prefer cool, moist weather. In summer, they usually confine themselves to shady sites or plants with dense foliage.

Remove and destroy infested material during winter to eliminate overwintering eggs. Removal of nearby weedy hosts during the growing season may help to reduce localized infestations. Where possible, prevent the growth of dense foliage or thin plants to maintain good air circulation.

Insecticides should be applied when damage first becomes evident, often in late summer or fall. Direct sprays or dusts to the underside of leaves. Chemicals used to control aphids and leafhoppers will also control garden fleahoppers. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

Appreciation is expressed to Mechelle Hampton who, as a student in the Horticultural Insects Course in 1991, developed much of the material included here.

GREEN PEACH APHID

Myzus persicae **(Sulzer)**

Scott Bauer, USDA Agricultural Research Service, www.insectimages.org

Whitney Cranshaw, Colorado State University, www.insectimages.org

Description

This soft bodied, pear-shaped insect is usually wingless and measures about $^{1}/_{16}$ inch in length. The wingless female is pale yellow-green. The winged migrant form has a yellow-green abdomen with a dark dorsal blotch. Both forms have a pair of tailpipe-like appendages known as cornicles. Nymphs are smaller than adults, but similar in shape. They are pale yellow-green with three dark lines on the abdomen. All stages can be recognized by the shape of the frontal tubercles (on the front of the head at the antennal bases). In dorsal view, these tubercles are strongly developed (gibbose) and converge anteriorly (toward the front).

Life Cycle

Adults overwinter on greens and wild hosts such as spinach, collards, turnip, wild mustard, and dock. Winged forms migrate to other hosts in late spring. During these migratory flights, aphids may spread viral diseases from infected volunteer plants and weeds to healthy crop plants. Movement between host plants continues through summer and fall. Successive generations of females, mainly wingless, are produced throughout the year. Winged migrants develop whenever overcrowding occurs or food becomes scarce. Outdoor infestations are most common during spring and fall and decline during the hottest months of summer. This aphid is also a very common pest in greenhouses, where it breeds continuously. Many generations are produced each year.

Hosts

The green peach aphid infests a wide range of plants, especially under greenhouse conditions. Some important hosts include cabbage and related cole crops, dandelion, endive, mustard greens, parsley, turnip, tomato, tobacco, potato, spinach, pepper, beet, celery, lettuce, and chard.

Damage

Green peach aphids extract sap from plants and excrete a sweet, sticky substance known as honeydew. Black sooty mold grows on honeydew and, though not directly harming the plants, may block out sufficient light to reduce yield. Weakened plants become susceptible to other insects and diseases and may be inoculated with viruses carried by the aphids. Viruses transmitted by green peach aphid include potato leaf roll, potato virus Y, beet mosaic, beet yellows, and lettuce mosaic.

Inspection and Control

Insect predators, fungal diseases, high temperatures, damp weather, and hard rains help reduce aphid populations. Cultural practices are helpful in avoiding aphid infestations. Winter host plants (spinach, collards, mustard, dock, turnip) in the vicinity of seed beds should be destroyed before plants begin to come up. Wild mustard serves as a host for green peach aphid and may speed the colonization of aphids into greens; therefore, aphid problems may be reduced by destruction of these weeds before planting and maintenance of field margins. The purchase of certified seed from areas free of virus is also a good preventative measure. Newly purchased transplants should be inspected for aphids as the plants may come from infested greenhouses.

Control can be achieved with insecticides, provided care is taken to ensure good coverage. Poor coverage is especially likely to occur in greens crops. Economic thresholds for aphids are not well defined for Oklahoma production. Control procedures are usually warranted shortly after aphids initially colonize, and the proportion of infested leaves should be kept below 5 percent, if possible. Fields should be monitored twice per week to gain representative samples of each area of a field; this will enable quick detection of aphid immigrations. For specific chemical control recommendations, see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

HARLEQUIN BUG

Murgantia histrionica **(Hahn)**

Tom Royer, Oklahoma State University

Whitney Cranshaw, Colorado State University, www.insectimages.org

Description

This black, shield-shaped stink bug is brightly colored with orange, red, and yellow markings and measures about $^{3}/_{8}$ inch in length. Eggs are barrel shaped, less than $^{1}/_{16}$ inch long, and laid in clusters. Each egg is light gray to pale yellow with two black bands, one at the top and the other near the bottom, and a black spot is located just above the lower band. Immature bugs are similar to the adult in coloration, except they are smaller and lack wings.

Life Cycle

Harlequin bugs overwinter as adults among plant debris. Adults emerge in early spring and about two weeks after resuming activity, females begin depositing eggs on the underside of leaves. Eggs are laid in double-row clusters of ten to thirteen until each female has deposited about 155 eggs. In early spring, eggs hatch in about twenty days, whereas hatching occurs in as few as four or five days in warmer weather. Nymphs feed for six to eight weeks before becoming adults. There are three or four generations per year.

Hosts

These bugs attack nearly all crucifers, including common weeds of the mustard family such as wild mustard, shepherd's purse, and peppergrass. If infestations are heavy and food becomes scarce, they will also feed on squash, corn, beans, asparagus, okra, tomato, and many other plants.

Damage

Adults and nymphs pierce stalks, leaves, and veins with their needle-like mouthparts and extract plant juices. Stems and leaves injured in this manner develop irregular, cloudy spots around the puncture wound. Young plants are likely to wilt, turn brown, and eventually die, while older plants become stunted.

Inspection and Control

Overwintering adults can be reduced by plowing under plant debris after the onset of cold weather. Other overwintering sites can be limited by destruction of weeds (especially those in the mustard family) within fields and along fence rows.

No economic thresholds are established for this pest, but control is usually warranted shortly after bugs are found in the field. Repeated insecticide applications may be needed, especially in young plantings. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

IMPORTED CABBAGEWORM

Pieris rapae **(Linnaeus)**

Whitney Cranshaw, Colorado State University, www.insectimages.org

David Cappaert, Michigan State University, www.insectimages.org

Description

The adult is a white butterfly with a black area near the tip of each forewing and a black spot on the front edge of each hindwing. The female has two other black spots on each forewing, whereas the male only has one. Eggs are pale yellow, bullet shaped, ribbed lengthwise and crosswise, and laid on end on the leaf surface. Larvae are green with a faint yellow stripe down the back and a row of faint yellow spots on each side. They have a velvety appearance because of numerous short hairs on the body. Five pairs of prolegs are present on the abdomen and larvae measure about $1\ ^{1}/_{4}$ inches in length at maturity. Pupae are sharply angled, colored green, gray, or brown, and attached to the lower leaf surface by a silken loop.

Life Cycle

Imported cabbageworm overwinters as a pupa attached to host plant debris. Butterflies emerge in early spring. Each female will deposit several hundred eggs, one at a time, on the leaves of host plants. Eggs hatch in four to eight days and larvae feed for ten to fourteen days before pupating. Pupae may be found on the host plant or on nearby objects. The pupal stage lasts seven to twelve days. There are four generations per year in Oklahoma and activity will continue until October or November.

Hosts

Imported cabbageworm prefers cabbage, broccoli, and cauliflower, but will feed on turnip, collards, kale, radish, mustard, horseradish, and lettuce. The first generation may develop on wild hosts of the family Cruciferae if cultivated hosts are not available.

Damage

Damage appears as irregularly shaped holes of various sizes and the presence of masses of wet, green-brown excrement deep among the leaves. Younger larvae feed on the outer leaves and older larvae feed on the more succulent, inner leaves. Unlike cabbage loopers, imported cabbageworms tend to bore into the center of the head (in cabbage), thereby doing more damage to the edible portion of the plant. If large numbers of larvae occur on small plants, they may kill or severely stunt plants, or prevent head formation in cabbage and cauliflower. Infestations beginning near harvest may be ignored if control has previously been achieved, as the outer leaves of most brassicas are not harvested and do not need to be free of damage.

Inspection and Control

An important cultural control for this pest is to reduce source populations through destruction of crop residue and weeds that serve as alternate hosts. It is important to destroy residue after harvest by shredding, discing, and plowing because pupae of imported cabbageworm survive in the soil and debris left behind after a cole crop is harvested.

The decision to apply insecticides should be based primarily on the presence of larvae. Research and large-scale field trials have shown that the action threshold for caterpillars on cabbage is 0.3 larvae per plant (one larva per three plants). This threshold can be used for all species as long as fields are scouted at least twice weekly and the field is sampled sufficiently to gain a representative index of larval activity. Usually 25 to 40 samples are adequate for a field measuring less than 40 acres. Although attention should be paid to field edges and "problem" areas, treatment decisions should be made based on randomly selected plants from all sections of the field. Prior to cupping in cabbage, more larvae can be tolerated than after cupping (usually up to 0.5 larvae per plant,or one larvae per two plants). Also, control of larvae before thinning direct-seeded crops is not critical unless the plant stand is significantly threatened.

The use of *Bacillus thuringiensis* var. *kurstaki* as a basis for caterpillar control programs will enhance levels of biological control achieved by a variety of parasites and predators. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

LESSER CORNSTALK BORER

Elasmopalpus lignosellus **(Zeller)**

David Riley, University of Georgia, www.insectimages.org

Richard Sprenkel, University of Florida, www.insectimages.org

Description

The male moth has brown-yellow forewings with gray margins and several dark spots. Forewings of the female are nearly black. Wingspan is about 1 inch. Larvae are slender, blue-green, brown-striped caterpillars measuring about $^{3}/_{4}$ inch in length when mature. Larvae become very active and thrash about violently when disturbed.

Life Cycle

This insect can overwinter as larvae or pupae, but they usually spend most of the winter as larvae and pupate in late winter or early spring. Moths emerge in early spring and lay eggs on or near host leaves or stems. Eggs hatch in two to seven days. Larvae may first feed on leaves or roots or tunnel up the main stem of a plant. Later they construct underground silken tubes or burrows from which they bore into plants near the soil line. Larvae become full grown in two to three weeks, leave their burrows, and spin silken cocoons under debris on the surface of the ground. Moths emerge two to three weeks following pupation within these cocoons. There appear to be at least four generations per year in Oklahoma.

Hosts

The lesser cornstalk borer is known to feed on corn, beans, cowpeas, crabgrass, johnsongrass, peas, peanuts, sorghum, soybeans, and wheat.

Damage

Injury occurs when a larva bores into the stalk of a host plant, thereby disrupting the growing point. Damage can be slight or it can kill the plant. Infested stalks on larger plants can break entirely. Larvae bore into pegs and developing pods of peanuts, and they may feed on the roots of host plants. Damage is most prevalent in crops grown on sandy soils during dry conditions.

Inspection and Control

Fall and winter cleanup of fields and field margins, and rotations with non-host crops substantially reduce the damage. Winter plowing can occasionally provide some control, or at least help reduce the number of insects in the field.

Chemical control is usually not practical in the home garden, but commercial plantings can be treated. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) in the section on Commercial Vegetable Insect Control.

Appreciation is expressed to Mechelle Hampton who, as a student in the Horticultural Insects Course in 1991, developed much of the material included here.

MELON APHID

Aphis gossypii **Glover**

Description

This soft-bodied, pear-shaped insect is pale to dark green in cool seasons and yellow in hot, dry summers. Though winged forms develop periodically, most adults are wingless and measure about $^{1}/_{16}$ inch in length. All forms have a pair of tailpipe-like appendages called cornicles. Nymphs are smaller than wingless adults, but similar in shape and color.

Life Cycle

Melon aphids spend part of the winter on weed hosts and in gardens on cold-tolerant plants. During warm periods, they continue feeding until cold weather inactivates them. In spring, winged females fly to suitable host plants and give birth to living young. Each female produces an average of 84 nymphs. Under favorable conditions, a nymph will mature in about five days and begin producing its own progeny. Most nymphs develop into wingless adult females. However, when crowding occurs or food becomes scarce, winged adults develop and fly to new host plants. Reproduction continues through winter, but at a much slower rate than in summer. This aphid is also a pest of many plants in greenhouses where it breeds continuously. Many overlapping generations are produced each year.

Hosts

A wide range of field and ornamental as well as vegetable crops may be infested by this pest. Some vegetable hosts include asparagus, beans, beet, cowpeas, cucurbits, eggplant, okra, spinach, and tomato.

Damage

Damage usually becomes obvious on cucurbits after the vines begin to run. If weather is cool during the spring, buildup of natural enemy populations will be slow and heavy aphid infestations may result. Congregating on lower leaf surfaces and terminal buds, aphids pierce plants with their needle-like mouthparts and extract sap. When this occurs, leaves curl downward and pucker or cup. Wilting and discoloration follow the loss of plant juices. Aphid damage weakens plants and may reduce fruit quality and quantity. Honeydew secreted by aphids makes plants sticky and enhances development of black sooty mold on plant foliage and fruit, making the fruit unmarketable.

Inspection and Control

Insect parasites and predators are important natural control agents of melon aphids. In addition, damp weather promotes a fungal disease and hard, driving rains tend to kill large numbers of aphids. Aphids can also be controlled by cultural practices. Seeds or transplants planted in a well-prepared, fertile seedbed produce a vigorous crop that is better able to withstand aphid attack. Such a seedbed should not be located near an aphid-infested crop or on land from which an aphid-infested crop has recently been removed.

Insecticides may be applied when it becomes evident that natural and cultural controls are not keeping aphid numbers in check. For specific recommendations, see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

MELONWORM

Diaphania hyalinata **(Linnaeus)**

Alton N. Sparks, Jr., University of Georgia, www.insectimages.org

Alton N. Sparks, Jr., University of Georgia, www.insectimages.org

Description

The melonworm moth has a brown head and a white-tipped abdomen with bushy hair-like scales. Its white wings have a narrow dark band around the margins. The wingspan is about $1\ ^{3}/_{4}$ inches. Larvae are slender and green with two thin, white stripes down the back in all but the first and last instars. They measure 1 to $1\ ^{1}/_{4}$ inches in length when mature.

Life Cycle

Like pickleworms, melonworms do not overwinter in Oklahoma but migrate north and west from more southern regions each year. They reach Oklahoma late in the season and may become a problem in September or October. Eggs are deposited singly or in small clusters on plants and hatch about three days later. Larvae feed for two weeks or more and then pupate in thin cocoons on the plants. New adults emerge five to seven days later. Oklahoma may have one or two generations if food is available and there is not an early frost.

Hosts

Melonworms infest only cucurbits. They prefer foliage of cantaloupes, squash, cucumber, and pumpkin. They very rarely attack watermelon.

Damage

Melonworms are primarily foliage feeders, only occasionally boring into fruits or stems. They have been known to damage late-season pumpkin and squash crops in Oklahoma, but are not usually a serious problem.

Inspection and Control

Larvae on foliage are easy to control with insecticides, but they may not need to be treated if it is late in the season and they are not damaging fruit. If they do become a serious problem, chemical recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

ONION MAGGOT

Delia antiqua **(Meigen)**

Jack Kelly Clark, University of California Statewide IPM Program

Description

The adult is a small gray fly with black legs and measures about $^1/_4$ inch in length. They resemble house flies but are smaller. Larvae are legless, creamy white, and measure about $^1/_3$ inch in length when mature. The head end is pointed and the tail end is rounded. Both adults and larvae are nearly identical to the seedcorn maggot, but larvae found in onions are usually the onion maggot.

Life Cycle

Onion maggots overwinter as pupae in the soil or in piles of cull onions. Adults emerge in spring, a little later than seedcorn maggots, and feed for seven to ten days. After mating, each female may lay several hundred eggs over the next two to four weeks. Eggs are laid on the soil near stems or on host plants and hatch in two to three days. Larvae move through the soil or down behind leaf sheaths and into the bulb where they feed for two to four weeks. Mature larvae leave the plants and pupate in soil. There are three overlapping generations per year, but only the first generation causes significant damage in Oklahoma. As with the seedcorn maggot, damage is most likely in cold, wet springs and on soils with organic debris.

Hosts

This species feeds only on plants in the onion family. Onions are preferred, but garlic, leeks, shallots, and chives may also be infested.

Damage

Infested onions often appear flabby and yellow. Infested seedling onions usually wilt and die. In larger plants, feeding often results in hollowing out of the bulb, particularly if several maggots are feeding in the same bulb. Infested bulbs have a strong odor caused by soft rot bacteria which are introduced and spread by the maggots. Bulbs not seriously damaged usually rot when placed in storage.

Inspection and Control

One approach to controlling this pest is to use seclusion or mechanical barriers to prevent egg laying in the planted area. A cheesecloth tent impervious to flies may be placed over the seed row or transplants at planting time. The cloth should have about 24 threads per inch. The tent base should extend at least 6 inches on each side of the plant stems. Tent construction must allow easy access to the plants for periodic harvesting, weed control activities, or further planting as well as room for growth. Standard fly screen for windows constructed with scrap wood framing should also make an adequate fly barrier.

Onion maggot damage is seldom serious in Oklahoma, but dig up several wilted or dying plants and check for larvae or damage. Insecticides applied as in-furrow treatments at the time of planting will protect onion seedlings from the first generation of maggots. Foliar insecticides can also be applied, but often with only limited success. Chemical recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

PICKLEWORM

Diaphania nitidalis **(Stoll)**

Alton N. Sparks, Jr., University of Georgia, www.insectimages.org

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

Description

The pickleworm moth has a large, pale yellow spot near the center of each dark brown forewing; the pale yellow hindwings have a wide, dark brown border. The wingspan is about 1 $^{1}/_{4}$ inches. A cluster of dark brush-like hairs is present on the tip of the abdomen. Newly hatched larvae are nearly colorless, except for slightly darker jaws and a black spot on each side of the head. Third- and fourth-instar larvae are pale yellow with dark spots, each containing a large bristle. The dark-headed, mature larva has a yellow-green body with no spots and may measure 1 to 1 $^{1}/_{4}$ inches in length.

Life Cycle

Pickleworms do not overwinter in Oklahoma, but moths migrate north and west from more southern regions each spring. In most years, they do not reach Oklahoma until August or September. Eggs are deposited singly or in small clusters on hairy surfaces of plants. Young pickleworm larvae hatch about three days later. After feeding for two weeks or more, larvae spin thin cocoons and pupate within rolled leaves. A new generation of moths emerges five to seven days later. We probably do not have more than one or two generations in the fall.

Hosts

Pickleworms infest only cucurbits. They prefer summer squash, but may also damage cucumber and cantaloupe. Watermelon, winter squash, pumpkin, and gourd are rarely damaged by this pest.

Damage

Unlike the melonworm, the pickleworm causes important economic damage to fruit. Young pickleworms usually feed for a time among small leaves at the growing tips of vines or within blossoms. In squash, larvae can be found hiding under the ring of stamens at the base of large, staminate flowers. When about half grown, pickleworms normally bore into sides of fruit and continue to feed there, causing internal damage and producing soft excrement. Both young and old fruits are attacked, but larvae prefer young fruits prior to hardening of rinds. Pickleworms make holes in the rind and after puncturing it, the fruit soon rots or, in the case of cantaloupes, becomes "sour." As the infestation increases, young fruits and flowers are damaged. Growing vines may become riddled with holes and cease to grow.

Inspection and Control

Insecticide applications should begin immediately when pickleworms or their damage appear, unless it is late enough in the season that harvest is essentially complete. If economically significant infestations develop, chemical recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

POTATO or TOMATO PSYLLID

Paratrioza cockerelli **(Sulc)**

Alton N. Sparks, Jr., University of Georgia, www.insectimages.org

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

Description

Adults are pale with dark bands across the body and look like miniature cicadas. They measure approximately $^{1}/_{16}$ inch in length and fold their wings in a roof-like fashion over the body. Eggs are very small, light yellow, spindle shaped, and are suspended from leaves on stalks. Nymphs are very small, pale green, and look like scale insects.

Life Cycle

Psyllids probably do not survive the winter in Oklahoma. Adults migrate into Oklahoma in early spring and begin feeding and laying eggs. Eggs hatch in three to eight days, depending on temperature. Nymphs feed and mature through five instars in two to three weeks before becoming adults.

Hosts

Various solanaceous plants serve as hosts including tomato, potato, and eggplant. Weed hosts include nightshade.

Damage

Adults and nymphs have piercing-sucking mouthparts and feed primarily on leaves, which are damaged by the removal of nutrients from the plant and injection of a toxin while the insect feeds. Leaves become curled and yellow or purple in response to the feeding damage; this condition is often referred to as 'tomato or potato yellows.' Damage can result in reduced yields and/or death of the plant.

Inspection and Control

In early spring, plants should be closely inspected for occurrence of adult psyllids by examining leaves or by using a sweep net to monitor plants bordering the garden or field. Control measures should be initiated as soon as adults are noticed to prevent the development of plant damage. Recommended insecticides for controlling psyllids can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and/or OSU Extension Fact Sheets.

POTATO APHID

Macrosiphum euphorbiae **(Thomas)**

Description

This soft-bodied, pear-shaped insect ranges in color from solid pink, to mottled green and pink, to light green. It is a large aphid, measuring nearly $^{1}/_{8}$ inch in length, and has a pair of long, slender "tailpipe-like" appendages known as cornicles. Immature aphids are smaller than adults but similar in color and shape. All stages have piercing-sucking mouthparts and feed by sucking sap from plant tissues.

Life Cycle

In northern states, winter is passed in the egg stage, principally on cultivated and wild rose bushes. These eggs hatch in the spring into wingless females, which give birth to live young. With the coming of cool weather in the fall, winged aphids fly to winter hosts and produce females that mate and deposit overwintering eggs. Farther south, eggs and males are not produced and female aphids feed and reproduce without mating year round.

Each female gives birth to about 50 nymphs. During warm weather, each of these nymphs matures in two or three weeks. The life cycle continues in this manner until overcrowding occurs or food becomes scarce. At these times, nymphs develop into winged adults and migrate to new host plants. Once settled, these aphids begin reproducing and the life cycle continues. Numerous generations are produced each year.

Hosts

Potato aphids infest a wide range of host plants. Some important cultivated hosts include potato, tomato, eggplant, sunflower, peppers, peas, beans, apple, turnip, corn, sweet potato, asparagus, clover, and roses. Other common host plants include weeds such as ragweed, lambsquarter, jimsonweed, pigweed, shepherdspurse, and wild lettuce.

Damage

Potato aphid infestations are sporadic and rarely severe enough to kill plants. Damage is caused by both nymphs and adults sucking sap from foliage, especially from terminal growth. New growth may become stunted and curled. The transmission of tomato and potato diseases, such as mosaic virus, leaf roll, and spindle tuber, causes more injury to plants than the direct injury resulting from feeding.

Inspection and Control

Aphids are fed upon by a variety of natural enemies, including lady beetles and their larvae, lacewing larvae, hover fly larvae, and stilt bugs. Fungal diseases, high temperatures, damp weather, and hard rains also limit aphid populations.

Cultural practices are helpful in avoiding aphid infestations. Crops should be planted in well-prepared, fertile seedbeds to promote vigorous growth. When possible, avoid planting sites near infested fields or fields where an aphid-infested crop has been removed.

A number of insecticides are available to control aphids on a wide variety of crops. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

Appreciation is expressed to Mechelle Hampton who, as a student in the Horticultural Insects Course in 1991, developed much of the material included here.

POTATO LEAFHOPPER

Empoasca fabae **(Harris)**

University of Wisconsin, ipcm.wisc.edu

University of Wisconsin, ipcm.wisc.edu

Description

Adults are small, green, wedge-shaped, and measure about $^{1}/_{8}$ inch in length. There are a number of small, pale yellow or white spots on the body. The hind legs are long and enable the insect to jump a considerable distance. Nymphs are pale green and similar in shape to the adults, but they lack wings.

Life Cycle

This insect overwinters in the Gulf Coast states and migrates into Oklahoma in spring or early summer. Large numbers of flying adults often appear suddenly in fields soon after host plants begin growing. Beginning three to ten days after mating, females use their sharp ovipositors to insert eggs into the main veins or petioles of leaves. Each female lives a month or more and produces two or three eggs per day. Eggs hatch in about ten days and nymphs mature in about two weeks. Nymphs usually mature on the leaves where they hatched. Mating occurs about 48 hours after maturation and the life cycle is repeated. There are three or four generations per year in Oklahoma.

Hosts

Potato leafhoppers feed on more than 200 cultivated and wild plants. In addition to fruit trees and forage crops, vegetables such as beans, potatoes, eggplant, and rhubarb are subject to infestation.

Damage

Both nymphs and adults feed on the underside of leaves. By extracting sap, they cause stunting of plants, curling of leaf margins, and crinkling of the upper surface of leaves. While feeding, leafhoppers also inject a toxic substance into plants which, in most vegetable hosts, causes a condition known as "hopper-burn." This condition is characterized by a yellowing of the tissue at the tips and margins of leaves, increasing until the leaves die. Hopper-burn is sometimes confused with drought stress.

Inspection and Control

Insecticide applications may be necessary to control leafhoppers, especially on beans and potatoes. Spray when damage is noted and leafhoppers are present. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

Appreciation is expressed to Mechelle Hampton who, as a student in the Horticultural Insects Course in 1991, developed much of the material included here.

SEEDCORN MAGGOT

Delia platura **(Meigen)**

Whitney Cranshaw, Colorado State University, www.insectimages.org

Description

Adults are small, gray flies with black legs, scattered bristles on the body, and measures less than $^1/_4$ inch in length. Larvae are typical fly maggots, legless and tough skinned with a pointed head and a rounded tail. It is white to yellow-white and measures about $^1/_4$ inch in length when mature. Both adults and larvae are almost identical to those of the onion maggot.

Life Cycle

The seedcorn maggot overwinters as a pupa in the soil. Adults emerge in early spring and feed on nectar and honeydew for a variable period of time. After feeding, fertilized females begin laying an average of 270 eggs, singly or in small clusters, in moist soil. Ovipositing females are attracted to freshly disturbed soil, fields with decaying seed or crop remnants, and organically fertilized soils. Eggs hatch in seven to nine days and larvae feed in seeds or decaying vegetable matter. They remain active at temperatures as low as 40° F. After feeding for one to three weeks, larvae burrow deeper into the soil to pupate. Pupation may last one to four weeks or the entire winter. There are three to five generations per year. Spring and fall generations are the most abundant and destructive. Only a limited number of adults survive during summer. Trapping records in Oklahoma show adults are active primarily from February to early June and from early September to early December.

Hosts

Although it feeds primarily on decaying organic matter, the seedcorn maggot infests seeds and/or roots of nearly 50 kinds of plants. In Oklahoma, damage is most commonly seen in corn, beans, and peas in April (ranges from late March to early May). Larvae also damage spinach foliage by feeding on the terminal buds of overwintered plants in late fall and early spring.

Damage

Seedcorn maggots damage newly planted seeds by feeding on seed contents, often leaving empty shells and resulting in poor germination. Seedlings which do emerge are tall and spindly with few leaves. They rarely reach maturity, or mature late because of poor seed quality. Occasionally, seedcorn maggots tunnel in seedling roots or stems. Either type of feeding allows entry of disease-causing pathogens. Damage is most likely in cold, wet springs and on land high in organic matter. Damage to spinach occurs when larvae feed in terminal leaf clusters. Feeding is often followed within days by invasion from decay organisms, which cause a black discoloration of the leaves. Plants are seldom killed but suffer moderate to serious reduction in weight and are often rendered unfit for use because of quality impairment and contamination.

Inspection and Control

Damage is seldom seen until plants fail to emerge or die soon after emergence or transplanting. If this occurs, dig up the plants or seeds and check for damage or larvae in or around the seed or roots. One means of preventing injury is shallow planting in a well-prepared seedbed, sufficiently late for quick seed germination. Land heavy in manure or having a cover crop turned under should be plowed early in the fall, if possible. This renders the field less attractive to egg-laying flies the following spring. Prompt resetting or replanting of damaged crops usually produces a good stand. It is unlikely that adults will linger to infest new plants. Seed treatments or soil-applied insecticides can be used to prevent seedcorn maggot damage. Spinach can be treated with foliar insecticides when plants are small and leaf clusters are relatively open. Spraying becomes progressively less effective as the cluster becomes tighter. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

SPOTTED CUCUMBER BEETLE
SOUTHERN CORN ROOTWORM

Diabrotica undecimpunctata howardi **Barber**

J.P. Michaud, Kansas State University, www.insectimages.org

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Description

The adult is oblong-oval, bright yellow green, and measures about $^{1}/_{4}$ inch long. The head, legs, and antennae are black. The wing covers are marked with 12 black spots. Larvae are slender and yellowish white with a brown head and plate at the rear of the body. Two short, sharp projections are located on the anal plate.

Life Cycle

This insect overwinters in the adult stage in protected locations. They may be active during the winter any time the temperature is over 65° F. Mating occurs in early spring, and each female will lay 500 or more eggs in cracks in the soil. Larvae feed on plant roots for two to four weeks before pupating in earthen cells located about one inch below the soil surface. There are two or three generations per year and adults are active at least into November.

Hosts

Cucurbits and corn are preferred hosts, but the spotted cucumber beetle is known to feed on more than 100 different plants. These include most vegetables and field crops, many flowers, weeds, and grasses. Larvae develop on the roots of a wide variety of plants.

Damage

Damage to cucurbits is similar to that of the striped cucumber beetle. Adults feed on stems and cotyledons of seedlings and foliage, flowers, and fruit of older plants. They also spread bacterial wilt and squash mosaic virus. Larvae weaken plants by feeding on the roots.

Damage to corn is caused mostly by larvae that bore into the stalk just above the roots and kill the growing point of young plants. They also feed on the roots, which can cause lodging and yield reduction. Damage is more likely in cool, wet springs, in low, wet areas, and where corn has been continuously planted for several years. Adults are sometimes common enough to interfere with pollination by feeding on corn silks.

Inspection and Control

Delayed planting and heavy seeding rates will help ensure a good stand. Cone protectors made of wire or cloth will keep beetles from colonizing home plantings until plants get established. It is important to inspect newly planted cucurbits frequently for adult spotted cucumber beetles. Unfortunately, there is no control for the bacterial disease once the infection has been introduced into the plants. A foliar insecticide applied at the cotyledon stage will retard feeding by cucumber beetle and encourage plant establishment. Where insects are abundant, additional applications may be needed to prevent beetles from spreading bacterial wilt and squash virus. Choice of insecticides is critical in cucurbits because of their sensitivity to chemical injury. Serious damage to home garden sweet corn is not likely, but if it does occur, a preplant treatment could be applied the following year. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

SQUASH BUG

Anasa tristis **(DeGeer)**

Whitney Cranshaw, Colorado State University, www.insectimages.org

Description

Adults are brownish black to dark ashy black and measure about $^{5}/_{8}$ inch long. The body is compact and flat across the back with the wings overlapping toward the rear. They give off a disagreeable odor when handled or crushed. Eggs are somewhat diamond- or spindle-shaped and white when first deposited, gradually turning yellowish brown and finally dark bronze. They are laid in loose masses, mostly on the undersides of leaves. Newly hatched nymphs are pale green. As they grow, they develop a gray body color with black legs. Nymphs are smaller than adults and do not have wings, but the last two nymphal stages have noticeable wing pads.

Life Cycle

Squash bugs overwinter as unmated adults under plant debris or other suitable shelter. They emerge in April or May, search for suitable hosts, and mate. Eggs are laid over a period of several weeks, often in the angles formed by leaf veins, and hatch one to two weeks later. Five nymphal stages grow for four to six weeks before new adults are produced. There are three or four generations per year, but due to the extended egg-laying period all stages are present for most of the season. Nymphs present in late fall are killed by freezing temperatures and adults seek overwintering sites.

Hosts

All cucurbit vine crops are subject to squash bug infestation. The bugs prefer squash, pumpkin, watermelon, cantaloupe, and cucumber, in that order. Hubbard, winter, and marrow squash are often heavily infested.

Damage

Both nymphs and adults feed by sucking juices from plants. The overwintered adults can cause extensive damage as they appear just after plants have emerged. Feeding can greatly stress and even kill young seedlings. Once the plants attain greater size they can withstand a moderate number of squash bugs. Nymphs tend to feed in clusters at first but will disperse as they become older. All stages prefer the leaves but will feed on all above-ground plant parts. They may congregate and feed on unripened fruits, especially late in the season. Squash bugs can increase in abundance quite rapidly and can cause plants to wilt due to feeding in large numbers. When combined with hot, dry weather, feeding stress on plants is greatly increased. However, squash bugs will not kill plants "overnight." If plants wilt and die overnight, one should suspect another causal agent, such as bacterial wilt.

Inspection and Control

Good cultural practices help prevent serious squash bug damage. Proper fertilization of vines produces a vigorous crop that is better able to withstand insect attack. Squash varieties such as Butternut, Royal Acorn, and Sweet Cheese are less susceptible to infestation than pumpkin or summer squash. Removal and destruction of crop debris after harvest eliminates some of the insects, their late season hosts, and some potential overwintering sites. In small gardens, adult bugs and leaves with egg masses can be handpicked and destroyed. The bugs can also be trapped by placing small boards near the host vines. Squash bugs gather under the boards at night and can be collected and destroyed the next morning.

Seedlings should be inspected regularly and treatment applied as soon as adult squash bugs enter the field in spring. If these first insects can be controlled, the late season population can be greatly reduced due to prevention of egg laying. Once plants are established, they should be inspected frequently to detect adult bugs and eggs. Adults spend most of their time within the plant canopy around the stems or on the underside of leaves. They often seek shelter under leaves in contact with the ground. Eggs also are found mostly on the underside of leaves. The key to control is to prevent development of large populations, so chemical treatments should be applied to kill the maximum number of small nymphs. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

SQUASH VINE BORER

Melittia cucurbitae **(Harris)**

Description

The adult squash vine borer is a clearwing moth. The front wings are covered with greenish-black scales, but the hindwings are clear with a brown border. The wing span is 1 to 1 $^{3}/_{8}$ inches. The abdomen of the moth is ringed with orange and black stripes. The larva is a wrinkled, white caterpillar with a brown head, three pairs of short legs, and five pairs of inconspicuous prolegs on the abdomen.

Life Cycle

Squash vine borers overwinter as mature larvae or pupae within cocoons 1 to 2 inches deep in the soil. In spring, moths emerge and fly swiftly and noisily around plants during daylight. Single eggs are glued on stems and leaf petioles. Larvae hatch and tunnel into stems about one week later and are fully grown after feeding for four to six weeks. At this time they leave their burrows, tunnel into the soil, and spin cocoons. New moths emerge two or three weeks later, giving rise to a second generation of larvae in late summer. Two generations may occur in Oklahoma each year.

Hosts

This species feeds primarily on squash and pumpkin. Though they occasionally feed on other cucurbits such as cucumber, watermelon, and cantaloupe, the borers cannot complete their development by feeding only on these plants.

Damage

Damage first appears as sudden wilting of a long runner or an entire plant. Closer examination reveals masses of coarse, greenish-yellow excrement, which the borer has pushed out from the stem. Splitting the stem may reveal the white caterpillar. Commercial squash plantings can be heavily damaged. Home plantings suffer even greater losses as infested vines are often completely girdled and usually become rotten and die. Squash vine borers enter vines near the soil line and feed on vascular tissue of the plant. Small borers may enter leaf stems but are found most often near the base of plants. Later, they may be found throughout stems and even in fruits. Sometimes vines are almost completely severed.

Inspection and Control

Since the insect passes the winter in the ground, do not plant squash in the same area each year. Land should be disked in fall to expose the cocoons and then plowed deeply the following spring. Vines should always be destroyed following harvest to prevent late caterpillars from completing their development. Sometimes injury can be offset by late and staggered plantings and heavy fertilization to promote rapid growth.

Early detection is critical to minimize vine borer damage. Should any wilting occur, check around the bases of plants for masses of excrement or signs of borer entry. In home gardens, it may be practical to remove borers by slitting infested vines with a sharp knife and then covering the injured areas with moist soil. Some gardeners routinely put a shovelful of soil at one or more locations along each vine to encourage plants to develop supplementary root systems. Such plants overcome borer attacks more easily.

A chemical control program can be effective if started at the very first sign of an infestation. Since most insecticides are toxic to honey bees and other pollinating insects, applications should be made in late evening and directed at the bases of plants. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

STRIPED CUCUMBER BEETLE

Acalymma vittata **(Fabricius)**

Description

The adult beetle is oblong, yellowish green, and measures about $^{1}/_{4}$ inch long. There are three black stripes on the wing covers and the head and antennae are black. Larvae are slender, white, worm-like insects with three pairs of legs near the front of the body. The head and a plate on the rear end are brown. There are two short, sharp, curved projections on the anal plate.

Life Cycle

Unmated adults overwinter in protected places—under leaves and trash or around the bases of plants that have not been killed by frost. Adults become active in early spring. They feed, mate, and egg laying begins eight to 25 days later. Each female will deposit 225 to 800 eggs singly or in small clusters into soil cracks at the base of cucurbit plants. Eggs hatch in five to eight days and larvae spend about two weeks feeding on roots and stems of plants. The pupal period is six to seven days. There may be two or three generations per year.

Hosts

Cucumber, cantaloupe, squash, pumpkin, gourd, and watermelon are preferred hosts of adult striped cucumber beetles. They will also feed on beans, peas, corn, and the pollen and flowers of several wild and cultivated plants. Larvae develop mostly on cucurbits, feeding on the roots or stems and fruit in contact with the ground.

Damage

Adults often appear as soon as cucurbit seedlings crack the soil. They chew off the stems or cotyledons, frequently killing the plants. They later feed on leaves, vines, and fruits that survive. They also feed on blossoms and may leave scars on the fruit. More importantly, these beetles spread a serious cucurbit disease known as bacterial wilt. The causative bacterium, *Erwinia tracheiphilia* (E. F. Smith), overwinters in the bodies of hibernating beetles. The beetles introduce the bacteria into the plants through fecal contamination of feeding wounds. This is the only natural method of infection known. This beetle also spreads squash mosaic virus. Larval feeding is not usually serious but weakens the plants and makes them more susceptible to other problems. Larvae can damage cantaloupe fruit by feeding on the surface in contact with the soil.

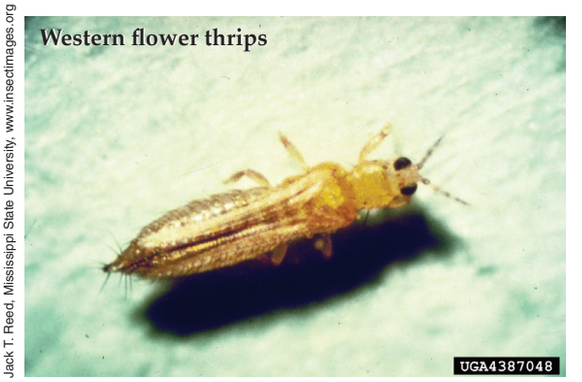
Inspection and Control

Delayed planting and heavy seeding rates will help ensure a good stand. Cone protectors made of wire or cloth will keep beetles from colonizing home plantings until plants get established. It is important to inspect newly planted cucurbits frequently for the presence of any adult striped cucumber beetles. Unfortunately, there is no control for the bacterial disease once the infection has been introduced into the plants. A foliar insecticide applied at the cotyledon stage will retard cucumber beetle feeding and encourage plant establishment. Where insects are abundant, additional applications may be needed to prevent beetles from spreading bacterial wilt and squash virus. Choice of insecticides is critical in cucurbits because of their sensitivity to chemical injury. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

THRIPS

Onion thrips – *Thrips tabaci* Lindeman

Western flower thrips – *Frankliniella occidentalis* (Pergande)



Description

Adults range from pale yellow to dark brown and measure about $^{1}/_{32}$ inch in length. They have two pairs of narrow wings fringed with long hairs. Newly hatched larvae are white, but older larvae are yellow or green. Larvae do not have wings.

Life Cycle

Thrips spend the winter in sheltered areas of live or dead plants, including wheat, alfalfa, and clover. In spring, development resumes and winged adults search for suitable host plants. Adults may migrate from senescing wheat or recently cut alfalfa or clover to other host plants, including vegetable crops. A female thrips produces 10 to 100 eggs, which she inserts singly into tender plant tissue. Eggs hatch four to ten days later and larvae feed for about five days before pupating in soil. New adults emerge about four days later. Although winged adults are weak fliers, they are capable of flying from plant to plant and may be carried long distances by wind. There are probably five to eight generations per year in Oklahoma.

Hosts

Onion, garlic, and related plants are commonly attacked. These species also feed on a wide variety of other vegetables, flowers, weeds, and grasses.

Damage

Thrips rasp tender parts of leaves, flowers, and fruit with their sharp mouthparts and feed on juices that flow to the wound site. Leaves and fruit develop silvery blotches or scratch-like markings. Light infestations tend to delay plant growth and retard maturity. Heavy infestations cause the leaves to become curled, crinkled, and twisted; growth stops and plants may die. Plant injury is more severe under hot, dry conditions. These thrips are also responsible for transmission of tomato spotted wilt virus (TSWV), a serious pathogen causing disease in many vegetable, field, and ornamental crops.

Inspection and Control

Good cultural practices can limit onion thrips populations. Destruction of volunteer plants and crop residue after harvest eliminates many favorable overwintering sites. Since populations build up rapidly on cucurbits, crucifers, strawberries, roses, and carnations, these crops should not be planted near, or rotated with onions. Young onions being grown for bulbs should be sprayed as needed once thrips populations reach one adult per plant. Chemical recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

TOMATO HORNWORMS

Manduca **spp.**

Whitney Cranshaw, Colorado State University, www.insectimages.org

John Himmelman, Moth Photographer's Group, http://mothphotographersgroup.msstate.edu/

Description

There are two species of hornworms that feed on tomatoes in Oklahoma. Adults of both species are large, robust moths, and gray or brown with a wingspan of 3 to 5 inches. There are 5 or 6 pairs of yellow or orange spots on the abdomen. Adults are referred to as sphinx or hawk moths. Larvae are large, green caterpillars with white stripes on each side of the body and a horn near the end of the abdomen. They measure at least 3 inches long at maturity.

Tomato hornworm [*Manduca quinquemaculata* (Haworth)]. The adult is mainly gray with a sinuous, black line near the outer margin of the forewings. The hindwings have three black stripes, all of which are well separated. There are usually five pairs of spots on the abdomen. Larvae have white, V-shaped markings on the sides of the body and a black horn.

Tobacco hornworm [*Manduca sexta* (Linnaeus)]. The adult is brown with an irregular, usually broken sub-terminal line on the forewings. The hindwings have two middle black stripes partially fused. There are usually six pairs of spots on the abdomen. Larvae have white, diagonal lines on the sides of the body and a red horn.

Life Cycle

Hornworms overwinter as pupae in the soil. Adults begin emerging by late spring in most years. Eggs are deposited on the underside of leaves at night. Each moth deposits one to five eggs per plant visit and may lay up to 2,000 eggs. First generation larvae are present by late May or early June. After feeding for three weeks, larvae burrow into the soil and pupate. First-generation adults may emerge by mid-July and second-generation larvae may be present from early August to early October.

Hosts

Hornworms feed primarily on solanaceous plants, including tobacco, tomato, eggplant, pepper, potato, and certain weeds. Tobacco and tomato plants are preferred for oviposition.

Damage

Larvae consume large amounts of foliage and two or three large larvae can virtually defoliate even a large plant. The grower will often see plants with many stems and leaf veins, but with the leaf surfaces completely removed. They will occasionally feed on the fruit if most of the leaves have been eaten. Rather than boring into the fruit, they feed superficially, leaving large open scars.

Inspection and Control

In small plantings, hornworms can be controlled simply by picking larvae off the plants. However, they are well camouflaged and this cryptic coloration can make them difficult to find. In some years, hornworms are kept below economically damaging levels by a parasitic wasp. Parasitized hornworms are easily recognized by the small, white, oblong cocoons attached to their backs. Such worms should be left in the garden so the emerging wasps can parasitize other hornworms.

Larger plantings may need to be treated as larvae and damage begin to appear. A bacterial insecticide, *Bacillus thuringiensis* var. *kurstaki*, can be used against these insects. For specific recommendations, see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

TOMATO PINWORM

Keiferia lycopersicella **(Walsingham)**

Alton N. Sparks, Jr., University of Georgia, www.insectimages.org

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

Description

The adult is a small, gray moth with reddish-brown markings on the head and thorax. The wingspan is $^{3}/_{8}$ to $^{1}/_{2}$ inch. The tiny, oval eggs are light yellow when newly deposited, but turn pale orange before hatching. Newly hatched larvae are yellowish gray. Mature larvae may be yellow, green, or ash gray and have dark purple spots on the body. They are about $^{1}/_{4}$ inch long.

Life Cycle

The tomato pinworm does not overwinter outdoors in Oklahoma, but it may be active year-round in greenhouses. The eggs, usually deposited on the underside of leaves, hatch in about one week. The larvae mine the leaves for about six days and then fold leaves or bore into fruit for another six days. Mature larvae either remain in folded leaves or drop to the soil to pupate. About 12 days later, a new generation of moths emerges. In summer, a generation can be completed every four to seven weeks. In cooler weather, the life cycle is longer. There can be six to eight overlapping generations per year in greenhouses. Several generations can occur outdoors in the summer, beginning in June and continuing into October or early November.

Hosts

Pinworms feed only on solanaceous plants. Common hosts include tomato, potato, and eggplant. Weeds such as nightshade and horsenettle are also subject to attack.

Damage

First and second instar larvae mine the leaves. Mines are widened gradually into one large blotch. Older larvae fold and web leaves to protect themselves and feed from inside these shelters. Some of the larvae bore into stems, buds, and fruit, leaving small "pinholes" on the surface. The fruit usually is entered near calyx lobes or the stem. Larvae usually feed just below the skin. In addition to the presence of pinholes, injured tomato fruits have discolored blotches.

Inspection and Control

Pheromone traps should be used to monitor adult movement into tomato fields and can be purchased from several commercial sources. A minimum of two traps per acre or location should be used to monitor adult moths. Control should be initiated when more than 10 moths per trap per night are recorded. Sanitation and prevention are good control measures for tomato pinworms. Infestations often result from shipped or locally grown greenhouse transplants. Therefore, close inspection of new plants can prevent serious problems later in the season.

Pinworms are difficult to control when heavy infestations have been allowed to develop. A spray schedule (every three to five days) may be needed to break their life cycle. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

TORTOISE BEETLES

Family Chrysomelidae

Whitney Cranshaw, Colorado State University, www.insectimages.org

Description

These oblong-oval beetles are mostly gold with various black and/or red markings depending upon species. Their bodies are slightly flattened and squared at the "shoulders" and somewhat shell-like in appearance. The body margins extend in a roof-like manner over much of the head and legs. Most species are about 1/4 inch long. The spined larvae may be dull yellow, brown, or green depending upon the species. They all have black heads, legs, spots, spine-like setae, and anal forks. The anal forks are long spines near the tip of the abdomen which hold large masses of excrement. The spines are directed forward and hold the excrement above the body as a protective shield. Fully grown larvae are 3/8 to 1/2 inch long. Like adult beetles, pupae are oblong-oval in shape but have spines along the abdomen like larvae. Four species are commonly found on sweet potatoes in Oklahoma. These are the blacklegged tortoise beetle [*Jonthonota nigripes* (Olivier)], golden tortoise beetle [*Metriona bicolor* (Fabricius)], mottled tortoise beetle [*Deloyala guttata* (Olivier)], and striped tortoise beetle [*Agrioconota bivittata* (Say)].

Life Cycle

Tortoise beetles overwinter as adults under bark, in leaf litter, or in other dry, protected places. In the spring, beetles emerge and feed on weed hosts until sweet potato plants are available. Females deposit clusters of 15 to 30 eggs on the underside of leaves. Larvae hatch seven to 10 days later. After feeding for 2 1/2 to 3 weeks, larvae transform into pupae on the plants where they were feeding. About a week later, a new generation of adult beetles emerges. Several generations can occur each year from April or May through August or September.

Hosts

The species included in this information sheet feed almost entirely on sweet potato and closely related plants such as morning glory and bindweed. There are other species of tortoise beetles that feed on other types of plants.

Damage

Both larvae and adults feed on leaves resulting in foliage that is riddled with holes. This type of damage is most threatening to seedlings or newly set plants.

Inspection and Control

Tortoise beetles and other leaf feeding insects do not greatly affect sweet potato production if growing conditions are satisfactory. Cultural practices such as adequate fertilization, good weed control, and well-timed planting effectively deter excessive tortoise beetle injury. Generally, chemical control is not necessary. If treatment is needed, specific recommendations for foliar-feeding pests can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

TURNIP APHID

Lipaphis erysimi **(Kaltenbach)**

Alton N. Sparks, Jr., University of Georgia, www.insectimages.org

Ministry of Agriculture, Food, and Rural Affairs, Ontario, Canada, apps.omafra.gov.on.ca

Description

Turnip aphids are pale gray-green and most commonly wingless. They have a pair of short, swollen cornicles (tailpipe-like appendages) on their abdomens. Adults are about $^{1}/_{16}$ inch long. Winged adults can be recognized by the presence of transverse dark bands on the last two abdominal segments. The wingless nymphs resemble the adults in color and shape but are smaller.

Life Cycle

This aphid continues to feed and breed at reduced rates throughout the winter. Collards are an important overwintering host plant. As warm weather returns, aphid activity increases. Wingless female adults produce large numbers of live nymphs (50 to 100) without mating, which all develop into females. Periodically, winged females develop and fly to new host plants. This aphid is favored by moderate temperatures and dry weather and heaviest infestations occur in the spring (March to May) and fall (September into December). Populations decline during the hottest months of the summer. Many generations are produced each year.

Hosts

Turnip aphids commonly infest mustard, radish, turnip, shepherdspurse, and watercress. They will also injure other crucifers, particularly in their seedling stage.

Damage

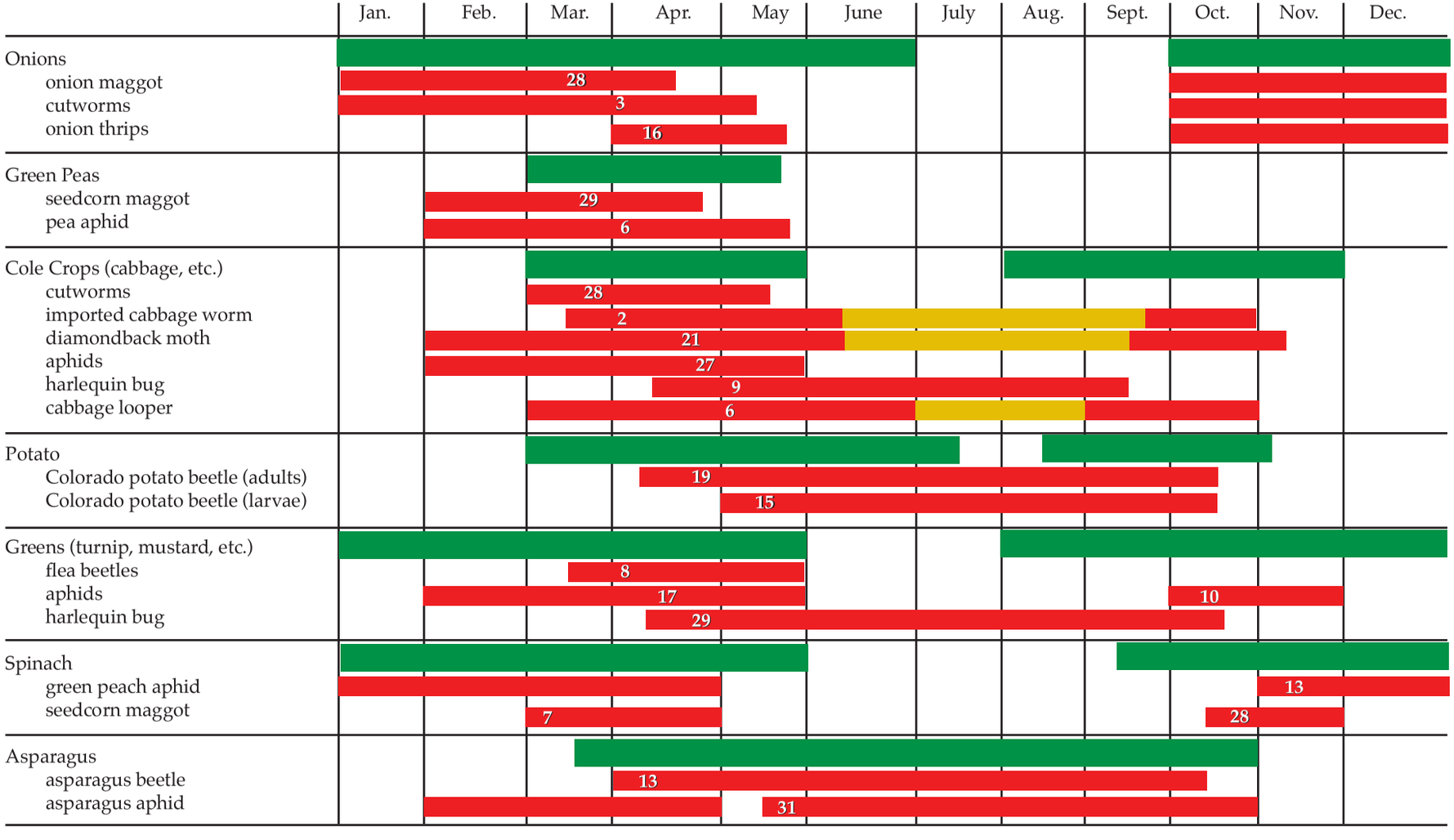
Aphids cluster on the underside of leaves and suck sap, causing infested foliage to curl, wilt, or become distorted. Some infested plants are killed, while others grow slowly, are stunted, and produce small unmarketable heads.

Inspection and Control

Natural control from parasites and predators (such as lady beetles and lacewings), and environmental factors (such as heavy rainfall) can sometimes be effective in reducing aphid populations, especially during fall production. However, the presence of these parasites and predators poses a contamination problem, especially for processed greens. Wild mustards serve as hosts for turnip aphids and may speed the colonization of aphids into greens; therefore, the destruction of these weeds before planting and maintenance of field margins may reduce aphid problems.

Chemical control can be achieved with insecticides, provided care is taken to ensure good coverage. The problem of poor coverage is especially likely in some varieties of spinach or mustard and turnips, plants with overlapping and large clusters of leaves. Economic thresholds for aphids are not well defined for Oklahoma production. Control procedures are usually warranted shortly after aphids initially colonize and numbers should be maintained below 5 percent of the leaves infested, if possible. It is particularly important to keep populations at low levels in broccoli and cauliflower after heading. Fields should be monitored twice per week to gain representative samples of each area of a field and quickly detect aphid immigrations. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7313.

Activity Calendar of Vegetable Pests in Oklahoma

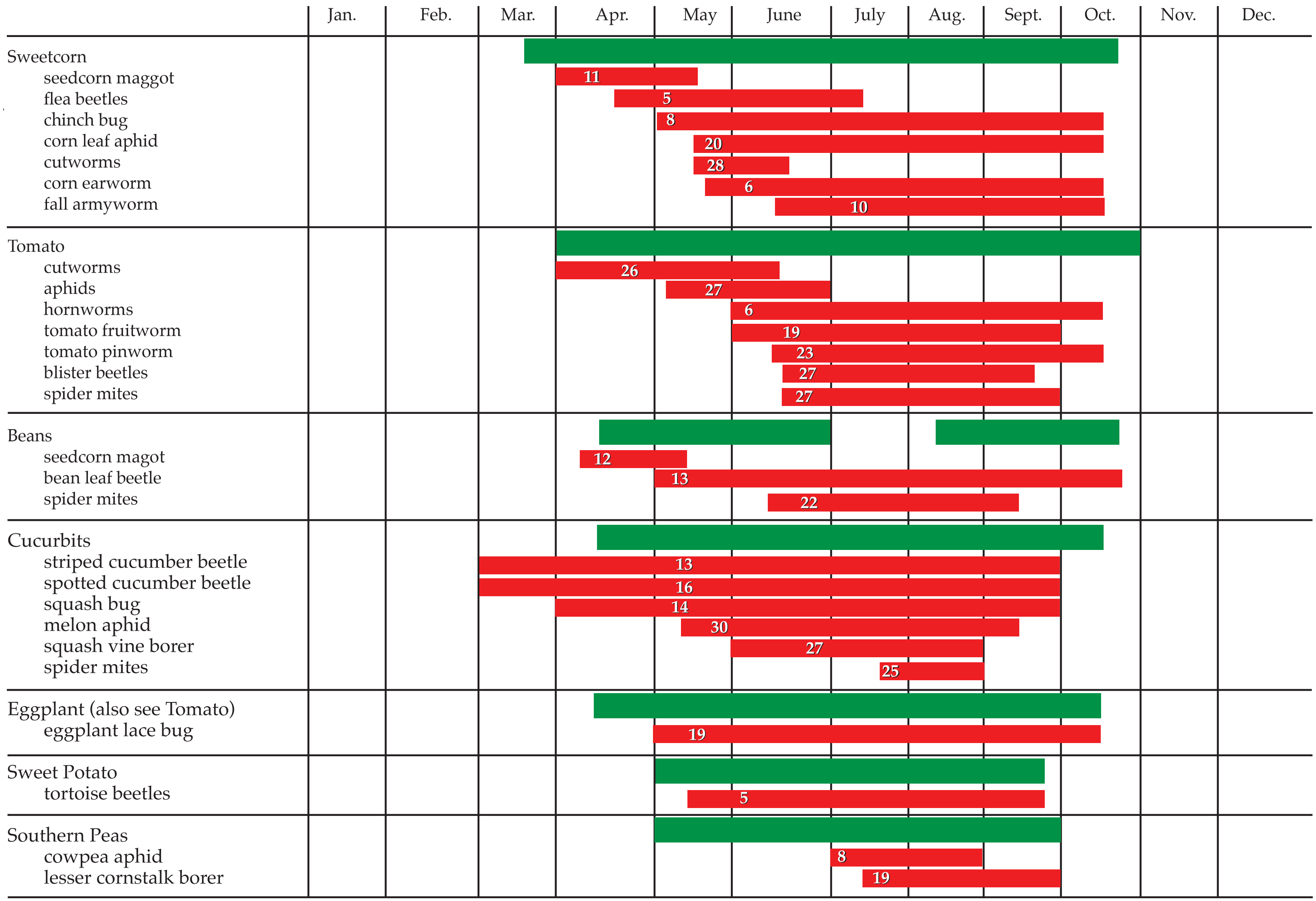


Growing season of vegetable

Active duration of pest

Pest can be found, but is not as active

19 Average "first found" date of pest



Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Sweetcorn
seedcorn maggot 11
flea beetles 5
chinch bug 8
corn leaf aphid 20
cutworms 28
corn earworm 6
fall armyworm 10
Tomato
cutworms 26
aphids 27
hornworms 6
tomato fruitworm 19
tomato pinworm 23
blister beetles 27
spider mites 27
Beans
seedcorn magot 12
bean leaf beetle 13
spider mites 22
Cucurbits
striped cucumber beetle 13
spotted cucumber beetle 16
squash bug 14
melon aphid 30
squash vine borer 27
spider mites 25
Eggplant (also see Tomato)
eggplant lace bug 19
Sweet Potato
tortoise beetles 5
Southern Peas
cowpea aphid 8
lesser cornstalk borer 19

Seasonal Appearance of Some Common Vegetable Pests in Oklahoma

January and February

Few insects active, but preplant applications for cutworm, white grubs, and wireworms can be made, if needed in late February.

Early March

Host	*Pest*
spinach	seedcorn maggot
leafy greens	

Mid March

Host	*Pest*
spinach	green peach aphid
	green peach aphid
	turnip aphid

Late March

Host	*Pest*
cole crops	cutworms
	flea beetles
green peas	seedcorn maggot
onions	cutworms
	onion maggots
radish	flea beetles

Early April

Host	*Pest*
asparagus	cutworms
cole crops	diamondback moth
	imported cabbageworm
green peas	pea aphid
onions	onion thrips
potato	flea beetles
sweetcorn	seedcorn maggot

Mid April

Host	*Pest*
asparagus	asparagus beetle
beans	seedcorn maggot
cole crops	aphids
greens	harlequin bug
lettuce	aphids
pepper	cutworms
potato	Colorado potato beetle (adults)
radish	aphids
tomato	cutworms

Late April

Host	*Pest*
cole crops	harlequin bug
sweetcorn	flea beetles

Early May

Host	*Pest*
beans	bean leaf beetle
cole crops	cabbage looper
cucurbits	spotted cucumber beetle
	striped cucumber beetle
eggplant	Colorado potato beetle
sweetcorn	chinch bug

Mid May

Host	*Pest*
cucurbits	squash bug
eggplant	eggplant lace bug
potato	Colorado potato beetle (larvae)
sweetcorn	cutoworms
	corn leaf aphid

Late May

Host	*Pest*
cucurbits	melon aphis
pepper	aphids
sweetcorn	corn earworm
tomato	aphids

Early June

Host	*Pest*
pepper	hornworms
sweet potato	flea beetles
	tortoise beetles
tomato	hornworms

Mid June

Host	*Pest*
cucurbits	squash vine borer
tomato	tomato fruitworm
	tomato pinworms

Late June

Host	*Pest*
asparagus	grasshoppers
beans	grasshoppers
cucurbits	grasshoppers
dill	black swallowtail butterfly
southern pea	grasshoppers
sweetcorn	fall armyworm
	grasshoppers
sweetpotato	grasshoppers
tomato	blister beetles
	grasshoppers
	spider mites

Early July

Host	*Pest*
southern pea	cowpea aphid

Mid July

Host	*Pest*
southern pea	lessercornstalk borer

Late July

Host	*Pest*
cole crops	harlequin bug
cucurbits	spider mites
eggplant	whiteflies
tomato	whiteflies

August

Nothing new

Early September		Mid September		Late September	
Host	*Pest*	*Host*	*Pest*	*Host*	*Pest*
cole crops	cabbage looper				
Early October		**Mid October**		**Late October**	
Host	*Pest*	*Host*	*Pest*	*Host*	*Pest*
turnip	soutern cabbageworm	cole crops	imported cabbageworm cross-striped cabbageworm	cole crops	diamondback moth
		spinach	seedcorn maggot		
		turnip	aphids		
Early November		**Mid November**		**Late November**	
Host	*Pest*	*Host*	*Pest*	*Host*	*Pest*
spinach	green peach aphid				
		December			
		Little insect activity			

FRUIT INSECTS

CODLING MOTH

Cydia pomonella **(Linnaeus)**

Description

The adult moth has gray to brown front wings with gray crosslines and a characteristic coppery brown spot near the tip of each wing. The hindwings are pale with fringed borders. The wing spread is about $^{3}/_{4}$ inch. The eggs are transparent, flattened, and about the size of a pinhead. They develop a red ring and darken just before hatching. Young larvae are white with a dark head but older larvae are pink with a mottled brown head. They are about $^{3}/_{4}$ inch long when fully developed.

Life Cycle

Codling moths overwinter as larvae in cocoonswhich may be found in tree crotches, branches, weeds, grass, litter, or any other protected place near the tree. They pupate in the spring and adults begin emerging sometime in April, about the time apple trees are in bloom. After mating, females lay eggs at sunset when the temperature reaches 65° F or higher for two or more days. The eggs, about 75 to 100 per female, are laid singly on leaves and branches. Eggs hatch in 5 to 12 days, depending on temperature. Newly hatched larvae crawl to the fruit and tunnel in at the blossom end. Larvae feed for two to four weeks inside the fruit until they reach maturity. Mature larvae emerge from the fruit and pupate in protected places. New adults emerge in 8 to 20 days, beginning sometime in June. A second generation of larvae feeds in July, and second generation moths emerge in August. A small third generation of larvae feeds in September. Some second generation and all third generation larvae overwinter.

Hosts

Apples are the most important host, but the codling moth will also attack pears, walnut, quince, crabapples, hawthorn, loquat, and some stone fruits, mainly apricots.

Damage

This is the primary pest causing "wormy" apples. The larval stage does the damage, tunneling in the fruit to eat the seeds and inner tissue. First generation larvae enter through the blossom end, while second generation larvae are more likely to enter through the side of the fruit. This tunneling also predisposes fruit for disease organisms to enter.

Inspection and Control

Clean cultural practices are essential in controlling this pest. Keep lumber and debris away from the trees, eliminating overwintering places. Collect apples (or other fruit) as they fall from the tree. The longer an apple is on the ground the more likely the larvae will escape to pupate. Infested fruit can be placed in a sealed bag and set in the sun for two weeks to kill the larvae. Infested fruit can also be burned or buried. Wrap a piece of tar paper, burlap, or cardboard around the trunk of the tree about three feet above ground level. The larvae will crawl under the wrapping to pupate. Remove the cover every one to two weeks and destroy any pupae that may be inside.

Except for isolated trees, some spraying will be needed in the pest control program. Since egg hatch varies with local conditions, the decision to spray is is difficult. Pheromone traps can be very useful in determining when to spray. You should use four traps per 5 acres, beginning in early April, even if you only have one or two trees. Sprays should be applied just after the population has peaked (after numbers of moths trapped has peaked and then begun to decrease). The trapping procedure should be repeated in mid-June, early August, and September to monitor subsequent flights that may occur. Sprays can also be applied on a schedule beginning at petal fall. See OSU Fact Sheet EPP-7319 for home fruit treatment suggestions or OSU Current Report CR-6241 for commercial spray schedules.

A bacterial insecticide, *Bacillus thuringiensis* var. *kurstaki*, is effective on codling moth larvae. Also, a variety of chemical insecticides can be used. For specific recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Current Report CR-6241.

EASTERN TENT CATERPILLAR

Malacosoma americanum **(Fabricius)**

Description

The adult moth is red brown with two white stripes running obliquely across each front wing. The wingspread is 1 to 1 $^{1}/_{4}$ inches. The eggs are laid in distinctive masses which encircle small twigs on the host plants. The egg masses are dark brown to black and have a varnished appearance. Mature larvae are black and about 2 inches long. They have an uninterrupted white line down the middle of the back and a series of bright blue spots down each side.

A similar species, the western tent caterpillar *Malacosoma californicum lutescens* (Neumoegen & Dyar), also occurs in Oklahoma. The adult is light brown except for the area between the stripes on the front wings which is red brown. The larvae have a white line down the center of the back interrupted between each segment.

A third common species of tent caterpillar found in Oklahoma is the forest tent caterpillar, *Malacosoma disstria* Hubner. Adults of this species are dull yellow to buff colored moths with two dark stripes running across the forewings. Larvae are dark colored, somewhat hairy caterpillars with a series of what appears to be keyhole-shaped spots along the length of the back.

Distribution

Found in the eastern U.S. as far west as the Rocky Mountains. In Oklahoma, it is found throughout the southeastern $^{3}/_{4}$ of the state as far north and west as Grant and Washita Counties. Western tent caterpillars occur from the Rocky Mountains west to the Pacific Ocean. They are found in the northwestern third of Oklahoma as far south and east as Payne, Caddo, and Jackson Counties.

Life Cycle

The overwintered eggs begin to hatch in the spring at about the time that wild cherry leaves start to unfold, usually about the middle of March. The newly hatched caterpillars gather at a branch fork or crotch and begin to spin a web from which they go forth to feed on newly opened leaves. The larvae spin a fine strand of silk wherever they go. As the larvae grow, so does their tent. Forest tent caterpillars do not make tents but can feed in large aggregations. Feeding continues through April and into early May. Mature larvae leave the plants and pupate in white cocoons in protected places. New adults emerge by mid- or late May and lay eggs. The eggs remain on the plants through the summer, fall, and winter and hatch the following spring. There is only one generation per year.

Hosts

Preferred hosts are black cherry and wild plums (members of the genus *Prunus*), apple, and crabapple. They are occasionally found on a variety of other deciduous trees. The western tent caterpillar also prefers *Prunus* species but is more likely to be found on other trees such as oak, willow, poplar, birch, ash, and redbud.

Damage

Damage is caused by the caterpillars feeding on the leaves. When populations are large, whole trees may become covered with webbing and all leaves can be devoured. On wild hosts the damage is objectionable more from an aesthetic standpoint than from its effect on the host tree. The ugly tents constructed byfeeding larvae make this pest highly objectionable on shade trees.

Inspection and Control

Damage can be reduced on small trees by getting rid of the egg masses during the winter or by clipping and destroying the tents and their occupants on rainy, cool days when they are still small. Larvae do not venture out of their tents to feed during inclement weather. In orchards, check for egg masses while pruning. The destruction of nearby wild cherry and plum trees may also help suppress infestations.

Tent caterpillars can be treated with a variety of insecticides. Sufficient spray pressure is needed to reach and penetrate the tents of these caterpillars. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Fact Sheet EPP-7306.

GRAPE BERRY MOTH

Endopiza viteana **Clemens**

R. Isaacs, Michigan State University

Roger Williams, Ohio Agricultural Research and Development Center

Description

The adult is a small moth with a wingspread of about $^{3}/_{8}$ inch. The front wings are brown with a slight purplish sheen. The head is brown, and the center portion of the forewings may appear to have a dark saddle-like band running across them. Young larvae can be either yellowish green or dull white with a black head capsule. Mature larvae range from olive green to brown in color and are about $^{3}/_{8}$ inch long. Caterpillars, when disturbed, wiggle and squirm vigorously to escape and will drop to the ground if possible.

Life Cycle

This insect overwinters as a pupa in its cocoon. The larva forms its cocoon by cutting out a small piece of leaf and folding it over to form a cavity that it lines with silk. The cocoon is connected with the leaf at each end by a small, uncut piece of leaf tissue. The leaf folds containing the cocoons may remain attached to the leaves or may break off and fall to the ground. The adults emerge in late spring, about the time grapes bloom (April). Females lay their flattened, circular, cream colored eggs at dusk on the fruit, stems, flower clusters, or newly forming grape berries. First generation larvae feed on flowers or very young fruit clusters. This early activity is relatively unimportant in most vineyards. Later generations feed on developing or ripening grapes, often webbing several fruits together. Each larva may destroy three or four fruits. Development from deposition of the eggs to emergence of the adults averages about five weeks. There are as many as three generations per year in Oklahoma.

Hosts

Grape berry moths feed on grapes, both cultivated and wild species. They prefer tender skinned varieties with tight fruit clusters.

Damage

Damage is caused by the larvae feeding in flowers and fruit. Small fruit, when damaged, turn dark purple in color and drop from the stems. Larger fruits are usually webbed into the cluster and shrivel or rot in place.

Inspection and Control

Small caterpillars found among webbed-together fruit are a sure sign of grape berry moth infestation. The leaf folds containing cocoons are also characteristic of this species.

Partial control of this insect may be accomplished by thoroughly cleaning up around the grape vineyards and raking and burning the fallen leaves during the fall or winter. Soil spreading or light plowing to a depth of one or two inches in the spring will cover some cocoons and prevent the emergence of adults. Early fruit gathering is also helpful in control. Some of the overwintering pupae will be killed when temperatures drop below 10° F.

Control with insecticides, if needed, should begin with the third cover spray, applied after petal fall. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Current Report CR-6252.

GRAPE LEAFFOLDER

Desmia funeralis **(Hubner)**

Jack Kelly Clark, University of California Statewide IPM Program

Bruce Marlin, Red Planet, Inc., www.cirusimage.com

Marlin

Description

The adult is a very dark brown, almost black, moth with a wingspread of about 1 inch. The front wings each have two white spots. The hindwings of the female also have two white spots, while those of the male have only one large white spot. There are two white bands across the abdomen. The male antennae are thickened and distorted in the center; the female antennae are smooth. Young larvae have a pale yellow green, translucent appearance, but when they begin to feed the ingested leaf tissue, they have a bright green color.

Life Cycle

This insect overwinters as a pupa in a cocoon, mostly among leaf litter on the ground. The adults begin emerging in May. Eggs are laid singly on the leaves, often in the angles between a vein and the leaf surface. Smoother surfaces are preferred for egg laying. Newly hatched larvae feed in groups between leaves that they have webbed together. After about two weeks, the larvae begin to roll the edges of the leaves and feed singly in these rolls. These rolls are made by spinning strands of silk from the edge of the leaf to points nearer the center. As the silk strands dry, they contract and bend the edge of the leaf. Other strands are then made that curl the edge of the leaf into a roll. The upper leaf surface almost always forms the outside of the roll. After reaching full growth, the larvae pupate in a small leaf fold or envelope at the edge of the leaf. There are probably only two generations per year in Oklahoma, but a partial third generation may occur in some years as larvae have been found in late September.

Hosts

Found primarily on wild and cultivated grapes, but it will also attack Virginia creeper.

Damage

The leaf rolls and folds made by the larvae and their feeding reduces leaf area, thus restricting the leaf in its function of making food for the vines. In severe infestations, the resulting defoliation may expose the berries to sunburn. Larvae occasionally feed on the fruit, breaking the skins of the berries and permitting the entrance of spoilage organisms.

Inspection and Control

First generation damage is usually not serious in Oklahoma. However, if it does occur, controls can be applied when the first generation moths begin emerging (probably late June or early July). Cover sprays, applied at the proper intervals, will often reduce damage by this pest. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832), and OSU Current Report CR-6252.

GRAPE LEAFHOPPER

Erythroneura comes **(Say)**

Jack Kelly Clark, University of California Statewide IPM Program

Description

Adult grape leafhoppers are pale yellow, with light red markings on the wings. These markings can give this leafhopper a somewhat mottled appearance. They are about $^{1}/_{8}$ of an inch in length and somewhat wedge-shaped. Immature forms are pale green or greenish-white and lack the markings and wings of the adult. This insect first becomes active about the time that grape leaves are half-extended. The eggs are inserted into the leaf tissue by the female, which can deposit about 100 eggs.

Life Cycle

This species of leafhopper overwinters as an adult in leaf litter, grasses or other wherever they can find shelter near the vineyard. After emergence, feeding by nymphs can occur for about two weeks before the females begin laying eggs in leaf tissue. Eggs generally hatch in about 10 to 20 days depending on temperature. Nymphs reach maturity in three to five weeks, also depending on temperature. There are three generations per year in Oklahoma.

Hosts

All stages of this insect feed on grape, Virginia creeper, apple and several other plants.

Damage

Leafhoppers feed by inserting their piercing-sucking mouthparts into the plant to remove fluids from the tissue. Feeding by this insect causes the leaves and fruit to appear stippled with very tiny white spots. Eventually, these spots turn brown and may cause the leaves and fruit to shrivel. The leaves may become pale yellow in color and assume a very sickly appearance. Nymphs and flying adults may be noticeable on the undersides of leaves.

Inspection and Control

If the problem with leafhoppers is caught early, then treatment can be focused on young nymphs before they become highly mobile (winged). Insecticide treatments should be directed at the undersides of leaves and high volumes of liquid should be used to ensure adequate coverage, particularly if treating a cultivar with heavy foliage. Thorough sanitation around the vineyard will provide for elimination of overwintering sites for adult leafhoppers and thereby help reduce the reliance on chemical control.

GRAPE PHYLLOXERA

Phylloxera vitifoliae **(Fitch)**

Australian Commonwealth Scientific and Research Association, www.ento.csiro.au

Roger Williams Ohio Agricultural Research and Development Center

Description

Adult grape phylloxera is a tiny aphid-like insect with a yellow body. The aerial or leaf form is sometimes quite common from mid to late season in Oklahoma, but causes very little, if any damage. The leaf form of grape phylloxera causes the formation of tiny galls to form on the leaf. Inside these galls are many, small wingless aphids. Interestingly, this pest can also infest the roots of grapes causing the same sorts of knots and galls to form.

Life Cycle

This insect possesses a very complex life cycle. It overwinters as an egg attached to the canes of grape plants and also in the form of tiny aphids on the galls of grape roots. When plant growth starts in the spring, the root infesting form begins to feed, while those overwintering on the cane hatch after the foliage emerges. As the insect feeds on the foliage, the plant responds to their feeding by forming galls around them. When the phylloxera reaches maturity, it begins to give birth to live young inside the gall that also feed on the leaf and form additional galls. Several generations may be formed on the leaf. Some leaf-inhabiting forms may drop to the ground and burrow down to the roots. Once on the roots, phylloxera feeding causes the formation of the characteristic root galls. Root feeding forms can also produce multiple generations. In the fall of the year, winged forms will leave the ground and lay eggs on vines. These eggs hatch into male and female phylloxera and mating occurs. Each fertilized female lays a single egg on the cane, which overwinters to continue the cycle the following year.

Hosts

Although different phylloxera can be found on other plants, all stages of this species feed exclusively on grapes.

Damage

Phylloxera feeding causes gall formation on leaf and root tissue. Root gall formations can eventually result in rotting of the root, yellowing of the grape foliage and a general overall decline in plant vigor. If roots of European vines become infested, then death of the vines is imminent within three to 10 years. Symptoms from the leaf form of phylloxera are rather obvious, with small galls about the size of a half a pea forming over the entire leaf surface. These galls are open on the underside of the leaf and contain many small, wingless, yellowish aphids. Heavy infestation by aerial phylloxera causes distortion, necrosis, and premature defoliation of French/American hybrids. Premature defoliation may delay ripening, reduce crop quality and predispose vines to winter injury.

Inspection and Control

Fortunately for the U.S. grape industry, American rootstocks are highly resistant to root phylloxera, which is the most devastating form. European or Vinifera grapes can also be successfully raised in the U.S. by grafting them onto American rootstock. Nearly all the grapes sold in nurseries are grafted on American rootstock. Grapes with large leaves are less susceptible to aerial phylloxera than those with small leaves, unfortunately, this means that most of the Vinifera wine grapes are susceptible, while table grapes are resistant. If timed correctly, when crawlers are still exploring leaf tissue, aerial phylloxera can be managed with insecticides.

GRAPE ROOT BORER

Vitacea polistiformes **(Harris)**

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

University of Georgia Archive, University of Georgia, www.insectimages.org

Description

Adult grape root borers resemble paper wasps but are actually moths. There are several similar species found in and around grapes, and these are often attracted to and trapped in grape root borer pheromone traps. Adult males, which are attracted to the pheromone traps, are wasp-like in appearance and possess four pencil-like tufts (claspers) at the end of the abdomen. Two of these tufts are about twice as long as the other two. These may not be preserved in pheromone sticky traps. An additional characteristic that may be noticeable on captured moths is the single, thin, yellow band running across the upper part of the abdomen. Forewings of this species are mostly brown opaque; the hindwings are transparent. The eggs are deposited on leaves, stems or on the ground by the female, which can lay about 300 to 400 eggs. Mature larvae are ivory white, unmarked and almost legless. They have a distinctive square profile, with the head end being somewhat thickened and armed with strong, brown mandibles.

Life Cycle

Grape root borers overwinter as larvae in the root system of developing grapes where they feed for about $1\ ^1/_2$ years. The caterpillars begin to pupate sometime in May and June and adult moths begin emerging in July. Eggs generally hatch in about two weeks depending on temperature.

Hosts

Larvae of this insect feed on wild and cultivated grapes.

Damage

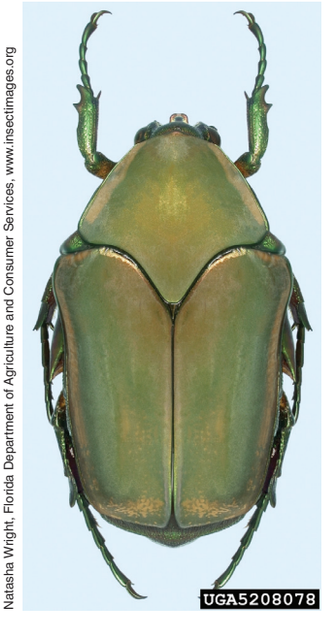
This borer injures plants by feeding extensively on the root system. Because of its location, initial damage may be difficult to detect or diagnose until the plants become severely damaged. Tunnels will increase in size as the larvae grow. Grape root borer larvae have chewing mouthparts and use their strong mandibles to feed on root tissue. Feeding by this insect causes the plant to slowly decline and eventually wilt from the disruption of the vascular tissues that transport water and nutrients. If canes begin to decline and then set new leaves and put out new canes, then damage is not likely from grape root borer. Leaves from infested plants will wilt and entire canes will begin to die.

Inspection and Control

Anticipating problems with grape root borer is an important facet in controlling the insect. Diligent sampling conducted from July 1 until harvest can aid in revealing whether this insect is a problem. An area equal to about a three foot diameter at the base of each plant should be inspected for the presence of shed pupal skins. If pupal skins are found beneath 5 percent of the vines examined, then an insecticide should be applied the next year. If this approach is needed, it should be conducted as late in the season as the label permits. Growers should be cautioned to observe pre-harvest intervals with any materials applied. In addition to this traditional method of controlling grape root borer, growers wishing to take a less expensive and safer approach can simply use a box blade or other shallow tillage tool to heap soil to a depth of about six inches at the base of each plant. This method requires precise timing, before adults emerge in large numbers. Therefore, this approach can be based on capture of the first moths in pheromone traps. Insecticide treatments should be directed at the base of the cordon and require a minimum of about one quart of diluted chemical per plant.

GREEN JUNE BEETLE

Cotinis nitida **Linnaeus**



Description

This beetle is larger and more robust than its closest relatives, the common brown May/June beetles, measuring from $^{3}/_{4}$ to 1 inch in length and about $^{1}/_{2}$ inch wide. The color varies from dull brown with irregular stripes of green to uniform velvet green, the margins of the body being usually light brown varying to orange yellow. The lower surface is metallic greenish or yellow, or metallic dark brown with a yellow green tint. It is **sometimes mistaken for the Japanese beetle**, which is smaller ($^{1}/_{2}$ inch long) with brown wing covers margined with green. The larva is a typical white grub with a brown head and three pairs of short legs, but it is not as often found curled into a C-shape as are most white grubs. They are about 2 inches long when mature. Live larvae are easily distinguished by their habit of crawling on their backs.

Life Cycle

This insect overwinters as a nearly mature larva in the soil. They feed and finish maturing in the spring and pupate in a cell in the soil. A few beetles may emerge in early June, but most do not emerge until mid-June or July. They are common in July and August and some remain active through early October. Eggs are laid in late summer. The female beetles prefer sandy soil that is high in organic matter. They burrow into the soil and lay their eggs 6 to 8 inches below the surface. The eggs hatch in about two weeks and the larvae feed on organic matter in the soil until winter approaches. There is one generation per year.

Hosts

The beetles injure fruits of many kinds, including grapes, peaches, raspberry, blackberry, apple, pear, quince, plum, prune, apricot, and nectarine, and frequently feed as well on the sap of oak, maple, and other trees, and on the growing ears of corn. They are attracted to ripe (especially overripe) fruits. The larvae feed on decaying organic matter in the soil or in well-rotted manure or compost piles.

Damage

Adult beetles damage fruit by feeding on ripening fruits. Beetles gain entry into undamaged fruits by gouging with the horn on the front of the head, then feed on the flesh of the fruit. Several beetles may bury themselves entirely in a ripe peach. Their odor and excrement ruins most pieces of fruit they visit even if feeding damage is not severe.

Inspection and Control

Ripening fruit can only be treated with short residual insecticides. These will kill the beetles that are present but retreatment may be needed if beetles are numerous. Some relief in future years may be gained by eliminating possible breeding sites. For specific control recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

GREEN STINK BUG

Acrosternum hilare **(Say)**

Kevin D. Arvin, www.insectimages.org

Description

This true bug measures from $^1/_2$ to $^3/_4$ inch in length and about $^1/_2$ inch wide. Stink bugs will vary in color from bright green to a dull brown and have a characteristic shield (five cornered) shape. The green stink bug is, as the name implies, green and has piercing mouthparts that they use to remove juices from the tissue once the mouthparts have pierced the surface. Although green stink bugs are common in fruit production systems, other species, such as the brown stink bug create the same damage. The brown stink bug can be mistaken for a beneficial stink bug known as the spined soldier bug. The latter species is easily distinguished from the pest by the general body shape and width of the mouthparts. In the predaceous species, the front portion of the triangular shield is often pointed sharply at the outside edges and the mouthparts are distinctly wider. In addition the spined soldier bug has a distinctive dark spot on the wing tips. The nymphal stages are similar to the adults but lack wings and may also possess bright red, yellow, or orange markings on the abdomen. They may range in size from about $^1/_8$ inch long to nearly $^1/_2$ inch long when mature.

Life Cycle

Stink bugs overwinter as adults in protected areas such as fence rows, grassy field borders, under stones, or the bark of trees. They become active during the first warm days of spring, and can be seen in orchards around the time of bloom through shuck-fall. A few bugs may be present from May through June (primarily brown stink bugs), but the green stink bug is more prevalent in mid to late June and tapers off in fruit trees in July and August with only one generation per year. A second generation of brown stink bugs may occur in July and August. Egg laying can occur anytime when adults are present from May through July and August. Female bugs may move readily between weeds and other alternate hosts, and fruit trees.

Hosts

Damage to stone fruit is caused by adult stink bugs since the nymphs are not mobile enough to move to early-producing fruit trees like peaches or nectarines. In grapes; however, adult stink bugs will often lay their eggs on the leaves early in the season and many small nymphs will begin to suck the juices out of maturing fruit.

Damage

Feeding by stink bugs on fruit, such as peaches early in the season (prior to shuck split), causes the flower or developing fruit to abort.After shuck split, stink bug feeding causes a characteristic dimpling and subsequent catfacing injury to tree fruits. Mature fruits will have depressed lines and multiple corky areas, resulting in a gnarled and mottled appearance.

In grapes and other small fruits, feeding by stink bugs can cause blackened areas that reduce the quality of the fruit; however, severe infestations may cause entire clusters to shrivel from the extensive withdrawal of liquids. In grapes, stink bug nymphs will readily hide when disturbed, therefore, careful inspection is necessary.

Inspection and Control

Stink bugs in an orchard or vineyard can be monitored with tarps and a padded paddle or by sweep sampling ground cover.Yellow pyramid traps may also be helpful to indicatewhen stink bug populations have moved into the orchard; however, these traps capture primarily brown stink bugs and should be used with a pheromone and fruit essence attractant.Early in the season, insecticide applications can help eliminate an increasing stink bug population. Ripening fruit can only be treated with short residual insecticides, so retreatment may be needed if the bugs become too numerous. Some relief in future years may be gained by eliminating possible alternate hosts, in particular weeds and nearby leguminous plants. For specific control recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

LESSER PEACHTREE BORER

Synanthedon pictipes **(Grote and Robinson)**

John Lee, Moth Photographer's Group,
http://mothphotographersgroup.msstate.edu/

Clemson University - USDA Cooperative Extension Slide Series,
www.insectimages.org

Description

Adults are "wasplike" clear-winged moths that are active in the daytime. The wings of the male are transparent with blue trimmings along the margin and veins, and its abdomen is marked with narrow yellow bands on a blue/black background color. Unlike the peachtree borer, the wings and body of the female are quite similar to the male. The wingspread is only about $^3/_4$ inch and the body length is about $^3/_4$ inch. The eggs are reddish brown, distinctly flattened, depressed or concave on one side, and one end is slightly broader than the other. The larva is a white or cream-colored caterpillar with a brown head and yellow plates on the thorax and last abdominal segment. They are about $^3/_4$ inch long when mature. The cocoon is made of silk and covered with particles of bark and excrement.

Life Cycle

The lesser peachtree borer produces two to three generations per year. They overwinter as partly grown larvae in their burrow beneath the bark of the tree. In the spring, the larva resumes feeding, constructs a cocoon under the bark, and pupates inside. Cocoons are generally most numerous up in the branches of the tree. Adults emerge 17 to 25 days later. Moths may emerge any time from late spring to early fall, depending on the maturity of the larva when it overwintered. Each female may lay several hundred eggs which hatch in about 8 to 20 days. Most eggs are laid on the upper portions of the tree in cracks and crevices in the bark, or around the crotch of the tree. Oviposition and damage is often associated with black knot galls or injured areas on limbs.

Hosts

Although primarily a pest of peaches, this insect also attacks plum, cherry, and apricots. The original host plants of this native insect are thought to have been wild plums and cherries.

Damage

The damage is done by the larvae as they feed on the cambium and inner bark of the tree limbs. The damage is often associated with injured areas and additional injury may result in adventitious growth and suckering. A distinct, gummy ooze can be found in and around damaged areas.

Inspection and Control

The presence of the insect in a peach tree is usually indicated by the gummy exudate, particles of bark, and frass on the scaffold branches. The masses of gum and other material are especially conspicuous in wet weather during the growing season. Infested trees can be treated with a residual insecticide generally timed with application for peachtree borer; however, a late season application (September) can be helpful in further reducing heavy infestations. See OSU Extension Fact Sheet EPP-7319 for instructions on making this treatment. Proper timing of the treatment is critical.

Infestation can be at least partially prevented by spraying the trees with insecticides. Specific recommendations and application instructions can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832), OSU Extension Fact Sheet EPP-7319 and OSU Current Report CR-6240.

ORIENTAL FRUIT MOTH

Grapholita molesta **(Busck)**

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Eric LaGasa, Washington State Department of Agriculture, www.insectimages.org

Description

The adult is a small, dark gray moth with a wingspread of about $^{1}/_{2}$ inch. There are scattered light markings on the front wings. The eggs are translucent white, slightly convex, round or slightly oval, and disc-like. Young larvae are white with a black head and dark shields on the thorax and last abdominal segment. Mature larvae are pink or almost red and about $^{1}/_{2}$ inch long. There is a blackish anal fork (comb-like projection) on the ventral aspect of the last abdominal segment above the anal opening.

Life Cycle

The oriental fruit moth overwinters as a full grown larva in cocoons in protected areas on or near the host tree. They pupate early in the spring and moths begin emerging about the time that peach trees are in full bloom (usually early April). There are probably five or six overlapping generations per year in Oklahoma. A large part of the first two generations live as borers within the succulent terminal twigs of peach. In some seasons, substantial numbers attack small green peaches. In subsequent generations most of the insects attack the fruit. The first two or three generations complete their life cycles, but in later generations some of the larvae stop developing and form overwintering cocoons. During the spring and midsummer, a large part of the population is found in peach orchards. In late summer and fall, apple becomes a favored host, and unsprayed quince is almost always heavily attacked.

Hosts

This pest attacks peach, apricot, nectarine, almond, apple, quince, pear, plums, and cherries. It has also been found in cotoneaster, flowering quince, loquat, Christmasberry, Chinese photinia, wild plums, and wild cherries.

Damage

The larvae cause damage by attacking the twigs and fruits of the host plants. In peach, a newly hatched larva enters the tender, growing twig at its tip near the base of a young leaf, consuming the central part, and gradually working its way down the twig for 2 to 6 inches. This causes twig dieback and the production of lateral shoots. Twig damage is seldom important in hosts other than peach.

Larvae may enter the fruit near the stem or through the side. The entrance is usually marked by frass or a gummy exudate. Larvae can also enter fruit through the stem and leave no visible sign of entrance. Inside the fruit, larvae may cause long irregular channels through the soft tissue or confine their feeding to a small area, often around the pit. Frequently, brown rot infection in peaches starts at the entrance or exit holes of larvae.

Inspection and Control

Sanitation may appreciably reduce the number of fruit moths present in bearing orchards. This includes removal of debris (reduction of overwintering sites) and gathering and destroying dropped or culled fruit.

Sprays can be timed with pheromone traps or can be applied on a schedule beginning two or three weeks after petal fall. Information on spray schedules and insecticides can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832), and OSU Current Report CR-6240.

PEACHTREE BORER

Synanthedon exitiosa **(Say)**

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Description

The adults are "wasplike" clear-winged moths. Unlike most moths, they are active in the daytime. The wings of the male are transparent with steel blue trimmings along the margin and veins, and its abdomen is marked with narrow yellow bands on a steel blue ground color. The front wings and body of the female are dark steel blue except for a bright orange band around the fourth abdominal segment. The wingspread is about $1\ ^1/_4$ inches and the body length is about 1 inch. The eggs are a rich chestnut brown, distinctly flattened, depressed or concave on one side, and one end is slightly broader than the other. The larva is a white or cream colored caterpillar with a brown head and yellow plates on the thorax and last abdominal segment. They are about $1\ ^1/_2$ inches long when mature. The cocoon is made of silk and covered with particles of bark and excrement.

Life Cycle

The peachtree borer overwinters as a partly grown larva in its burrow beneath the bark of the tree. In the spring, feeding is resumed and the larval period is completed. When mature, the larva constructs a cocoon under the bark at or near soil level and pupates. Adults emerge 17 to 25 days later. Moths may emerge any time from May to September, depending on the maturity of the larva when it overwintered. Mating usually occurs the day of emergence and egg-laying begins immediately after mating. Each female may lay 500 to 1,200 eggs which hatch in about 10 days. Most eggs are laid on the lower 6 inches of peach trunks or on the soil next to the trunk on a small group of trees surrounding the tree from which the female emerged. There is one generation per year.

Hosts

Although primarily a pest of peaches, this insect will also attack nectarine, plum, prune, cherry, apricot, and almond. The original host plants of this native insect are thought to have been wild plums and cherries.

Damage

The damage is done by the larvae as they feed on the cambium and inner bark of the tree trunk, usually just below, but sometimes just above the soil level. The larger roots are also sometimes subject to borer attack. A distinct, gummy ooze is usually found in and around damaged areas. Peach trees of all ages from nursery stock to the oldest trees are injured. Young trees are sometimes completely girdled by the insect, and though this is less likely to occur on older trees, these are often so severely injured that their vitality is lowered and they are rendered especially susceptible to attack by other insects or by diseases.

Inspection and Control

The presence of the insect in a peach tree is usually indicated by the gummy exudate, particles of bark, and frass at the base of the tree. The masses of gum and other material are especially conspicuous in wet weather during the growing season. One well-timed insecticide application can be effective in controlling peachtree borer.

Infestation can be at least partially prevented by spraying the trunks of the trees with insecticides. Specific recommendations and application instructions can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832), OSU Extension Fact Sheet EPP 7319, and OSU Current Report CR-6240.

PLUM CURCULIO

Conotrachelus nenuphar **(Herbst)**

Description

The plum curculio is a brownish gray beetle about $^{1}/_{4}$ inch long. As in other weevils, it has a prominent snout with chewing mouthparts at its tip. There are four dark colored humps on the wing covers that distinguish it from the closely related plum gouger. The larvae are white, legless grubs with light brown heads. They are about $^{1}/_{4}$ inch long when mature.

Life Cycle

This insect overwinters as an adult under leaves, grass, bark, sticks, and rubbish in woodlands or fence rows near orchards and under grass and trash in the orchard. The adults emerge about the time plums begin blooming, usually in mid-April in Oklahoma. At first they feed on the blooms, and to some extent, on the unfolding leaves. As the small fruit begin to develop, they feed on them, leaving small circular feeding punctures. The females also cut crescent shaped punctures in the fruit in which to lay their eggs. Most of the small fruits that are damaged fall to the ground within a few weeks during May. The larvae develop in the fruits, emerge, and burrow into the soil. They pupate in small cells two or three inches under the soil surface. First generation adults begin emerging by mid-June. They feed on and lay eggs in maturing fruits and the second generation larvae feed in these fruits in July and into August. Adults developing from these larvae seek overwintering quarters in August and September. There are two generations per year. For more information related to the biology and management of plum curculio consult OSU Extension Fact Sheet EPP-7078.

Hosts

This species is primarily a pest of plums and peaches but also damages cherries, nectarines, and apricots. Various species of wild plums are also good hosts. The adults will feed on and damage apples and pears, but few larvae are usually found in these hosts, except where the two types of fruit are grown together.

Damage

The small fruits punctured by the overwintered adults fall to the ground and are lost. Larger fruits punctured by the first generation adults are rendered unmarketable by the feeding of the larvae in the soft tissues and around the pit. The punctures furnish a place for the brown rot fungus to enter. Many infections of brown rot in peaches start in this manner.

Inspection and Control

Sanitation in and around the orchard will eliminate potential overwintering sites and help keep down adult populations. For producers with only a few trees, jarring the trees and collecting and destroying the adults can be an effective control measure if done about every other day during the periods of adult activity. Jarring can also be used to time applications of insecticides. Pyramid traps can be used to trap adults and time insecticide applications. For more information on this trapping scheme see OSU Fact Sheet EPP-7190. Dropped fruit should be picked up and destroyed at least twice per week during the spring drop period (June) and again before harvest.

Control with insecticides involves three sprays at ten-day intervals beginning at petal fall. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832), OSU Extension Fact Sheet EPP-7319, and OSU Current Report CR-6240.

REDNECKED CANE BORER

Agrilus ruficollis **(Fabricius)**

Susan Ellis, www.insectimages.org

James Solomon, USDA Forest Service, www.insectimages.org

Description

The adult is a small, slender beetle about $^{1}/_{4}$ inch long. The head and wing covers are black and the thorax is coppery red or golden. The larva is white with an elongate, flattened body. The first segment behind the head is broader than the rest of the body. This is typical of the family to which they belong—the flatheaded wood borers. Larvae reach almost $^{3}/_{4}$ inch long when mature.

Life Cycle

This insect overwinters as a larva in the stems of its hosts. They begin pupating in April and adults begin emerging in early May. The females deposit their eggs on young growth, first near the root and later at different points on the main stem and branches. A favorite place is near the base of a leaf. Egg laying continues from May into July. The eggs hatch and the minute, white larvae feed on the sapwood just under the bark, proceeding spirally upward or downward in the sapwood and around the cane, girdling it and thereby causing its death. Galls (elongate swellings) are formed where the girdling takes place. Later the larvae bore into the pith, continuing upward or downward. After proceeding for 4 to 8 inches in the canes, they form oval cells in which to pass the winter. There is one generation per year.

Hosts

The rednecked cane borer attacks practically all wild and cultivated varieties of blackberry, raspberry, and dewberry.

Damage

Injury is due mainly to the larvae boring in the canes, thus killing the canes and eliminating any fruit that would have been produced. The adults cause some damage by feeding on the leaves.

Inspection and Control

Most chemicals are not very effective in controlling this insect. They will kill the beetles, but the extended emergence and activity periods would mean many treatments would be needed. An effective method of control is to prune out and destroy infested canes. These are easily recognized by the presence of galls. Pruning can be done early in the spring before adults emerge, but is best done after harvest, anytime in the summer, fall, or winter.

Since this pest is restricted to brambles, the removal of nearby wild hosts should help keep down infestations. Some varieties of blackberries and dewberries are more susceptible to borer injury than others. In general, the prostrate and semiprostrate varieties are more heavily infested than the upright varieties.

SHOTHOLE BORER

Scolytus rugulosus **(Muller)**

J.R. Baker & S.B. Bambara, North Carolina State University, www.insectimages.org

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Description

The adult is a dark brown to black beetle about $^{1}/_{10}$ inch long. The larvae are white, legless grubs with brown heads and are also about $^{1}/_{10}$ inch long when mature.

Life Cycle

Shothole borers overwinter as larvae in their feeding tunnels under the bark of host trees. They pupate in the spring and adults emerge in April or May. After mating, the female beetle bores through the bark and constructs an egg gallery parallel with the grain of the wood between the bark and cambium layer. The larvae feed for about one month in tunnels under the bark. After pupating and transforming to adults they chew small round holes through the bark and emerge. These small holes are the source of the common name. Soon after emergence, the beetles begin to deposit eggs for another generation. In Oklahoma, there are probably three or four generations per year.

Hosts

Common hosts include cherry, peach, plum, apple, and pear. They also breed in wild hosts such as wild plum, black cherry, and mountain ash.

Damage

Adults cause some damage by feeding at the base of small twigs, but this may not be noticed unless large numbers are present. Most of the damage is done by the larvae feeding between the bark and wood of the trunk or limbs of host trees. This damage eventually girdles the limb or trunk and kills the affected part. Adult emergence holes through the bark give the appearance of a "shot gun" blast leaving "shot holes." The shothole borer chiefly attacks trees that have been weakened by attacks of other borers or scale insects, winter injury, drought, disease, unsuitable soil conditions, or mechanical injury. They will, however, attack healthy trees that are near severely infested ones in which the beetles have bred in large numbers.

Inspection and Control

The appearance of small round holes in the bark of fruit trees is a sure sign of borer attack. The branches of injured peach trees often exude quantities of gum from these holes.

Since the borer usually restricts its attack to weakened trees, the best means of controlling it is to do everything possible to keep the trees in a high state of vigor. This includes pruning, cultivation, fertilizing, and watering the orchard when needed. The elimination of breeding quarters is also important in controlling this insect. Trees that have been too seriously devitalized should be pulled up and burned. When only individual limbs are affected, these should be removed. Wild hosts and seedlings that may be furnishing breeding places for the insect near an orchard should also be removed. Prunings should not be allowed to remain on the ground in an orchard very long after they are cut, as the insect also breeds in recently dead material.

Chemical control is not usually effective against this insect. By the time most infestations are discovered, it is too late to undo the damage with sprays.

PECAN INSECTS

Notes

BLACKMARGINED APHID and YELLOW PECAN APHID

Monellia caryella (**Fitch**) and *Monelliopsis pecanis* **Bissell**

Louis Tedders, USDA Agricultural Research Service, www.insectimages.org

Jerry A. Payne, USDA Agricultural Research Service, www.insectimages.org

Louis Tedders, USDA Agricultural Research Service, www.insectimages.org

Description

All forms of the blackmargined and yellow aphid have a yellow or pale yellow background color. Both species are often referred to as yellow aphids and any treatment considerations are similar for both. The most noticeable marking on adult blackmargined aphids is a heavy black margin along the front edge of the forewings and on the edge of the head and thorax in winged forms. Early spring forms may not exhibit the distinct markings. The wings of this species are held flat over the body when the aphids are at rest. Fall female forms have dark bands across most segments of the body. To distinguish yellow aphids from blackmargined aphids is difficult unless adults are present. Yellow aphid adults have wings that are held in a roof-like orientation over the body.

Life Cycle

These aphids overwinter as eggs deposited in bark crevices along the trunk and limbs. Nymphs hatch in April, move to the new spring foliage, and begin to feed. The nymphs mature in about a week and become stem mothers, which reproduce living young asexually throughout the rest of the summer. Many generations (15 to 30) of females are produced each year. Beginning in September, wingless females and winged males develop from some of the nymphs produced by winged females. These mate and the wingless females lay the overwintering eggs.

Hosts

Found on pecan and hickory.

Damage

The most noticeable damage caused by blackmargined and yellow aphids is their deposits of honeydew on the foliage. Honeydew is a sticky fluid excreted by aphids, and it supports the growth of sooty mold fungi. This fungus reduces the amount of sunlight reaching the photosynthetic cells of the leaflets. Heavy spring infestations can injure a tree's vascular system and reduce chlorophyll development and leaflet size. Some studies show aphids also impair overall tree growth. Heavy late summer infestations can defoliate trees. Any cause of early defoliation can reduce nut filling for that particular year and also effect flower formation for next growing season. Therefore, aphid problems and other factors (caterpillar pests, pecan scab, etc.) should be managed with late leaf retention in mind.

Inspection and Control

Pecan trees should be inspected for aphids often, as numbers can increase rapidly. Aphid populations increase sometimes after applications of certain insecticides used in controlling other insects. This increase in aphid numbers is due to the destruction of beneficial insects. Numbers can also decrease rapidly (e. g. after a heavy rain). Generally, pesticide applications should be made when yellow aphid counts exceed 20 per compound leaf from budbreak until July 1 and counts exceed 15 per leaf after July 1. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Current Report CR-6209. For other aphids on pecan, see the next section on black pecan aphid.

BLACK PECAN APHID

Melanocallis caryaefoliae **(Davis)**

Louis Tedders, USDA Agricultural Research Service, www.insectimages.org

Description

Most of the forms of the black aphid are pear-shaped, pale to dark olive green in the nymphal stages, and black as adults. However, the early summer forms, which include the stem mothers and one or two generations of their offspring, are yellow-green with relatively little dark pigment. They have four rows of hairs on their bodies—two along the back and one on each lateral margin. Winged adults are jet black with transparent wings and several snow white, waxy spots on the upper surface of the body. They hold their wings tent-like over their abdomens at rest.

Life Cycle

The black pecan aphid overwinters as an egg in bark crevices. The nymphs hatch in the spring, move to young foliage, and begin to feed. They mature into asexual stem mothers in about a week and begin to produce living young. These offspring in turn mature into asexual females. Many generations (15 to 30) of females are produced per year. The fall forms, wingless females and winged males, begin to appear among the nymphs in October. These forms mate and the females migrate to protected areas of the limbs and trunk and deposit their eggs in cracks.

Hosts

Found on pecan and hickory.

Damage

The first signs of feeding are bright yellow patches in the leaflets that are often rectangular in shape. These yellow areas eventually die and turn brown. The patches are caused by a toxin that the aphid introduces into the leaf tissue while feeding. Only a few damaged areas are necessary to cause the entire leaflet to drop from the tree. The damaged spot will appear and continue to develop even if an aphid is killed after feeding for only a few minutes. Because of the severity of the damage caused by the black pecan aphid, large-scale, premature defoliation can occur in orchards with heavy populations. This defoliation not only contributes to poor nut quality, but also reduces return bloom in the orchard the following year.

Inspection and Control

Controls are usually not needed prior to mid-July in most years. When infestations do appear, begin to treat when an average of three aphids per leaf are found. Close observation is required when scouting after treating an orchard for this pest. Many times, fresh damage will continue to be found even after most or all of the aphids have been killed. As a rule, a single application is sufficient for all but extremely large populations if it is well timed and selected carefully. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Current Report CR-6209. Other aphids on pecan are covered in the previous section.

FALL WEBWORM

Hyphantria cunea **(Drury)**

Pennsylvania Department of Conservation and Natural Resources - Forestry Archive, www.insectimages.org

Pennsylvania Department of Conservation and Natural Resources - Forestry Archive, www.insectimages.org

Ronald F. Billings, Texas Forest Service, www.insectimages.org

Pennsylvania Department of Conservation and Natural Resources - Forestry Archive, www.insectimages.org

Description

Adult moths are almost pure white and have a wingspread of about 1 $^{1}/_{4}$ inches. Some specimens have the front wings more or less heavily marked with small black spots. Larvae may be pale yellow, yellowish green, greenish, or orange, but most have two rows of black spots down the back. The head may be red or black. The body is rather sparsely covered with long white hairs. They are found in webs on the host tree.

Distribution

Found over most of Canada, U.S., and into northern Mexico. They are present over all of Oklahoma, but are more common in the east than in the west.

Life Cycle

Adults of the overwintering generation emerge during May or occasionally in late April. Egg laying occurs in late May and early June. Each female can lay 400 to 500 eggs in masses on the undersides of leaves. The egg masses are covered with white hairs from the abdomen and may have a pale green background color. Two races or forms of this insect can occur in Oklahoma. In one form the larva possesses a black head capsule and black tubercles on the body. This form generally begins hatching in May and immediately begins to spin the web in which they feed. The web is extended as the larvae grow. The larvae mature and leave the trees to pupate in late June. There are three generations per year. The other form, an orange-headed caterpillar also possesses orange tubercles. This form is more common on pecan in Oklahoma. First generation adults emerge during July, and second generation larvae are present from late July into early October. Second generation pupae are the overwintering stage. There are two generations per year. Little overlap is seen between either of these two forms of webworm, hence, the reason why we occasionally appear to have webworms present throughout the season.

Hosts

The fall webworm has been recorded on at least 88 species of shade, fruit, and ornamental trees in the U.S. The preferred hosts vary from one area to another. In Oklahoma, persimmon and pecan are most commonly infested, with black walnut and hickory also common hosts. Sycamore,

birch, and redbud are often attacked in years of heavy infestations. Infestations on cottonwood, American elm, and bald cypress have been reported a few times. The blackheaded form is sometimes common on sweetgum.

Damage

Damage is caused by the larvae feeding on the leaves. They rarely are heavy enough to defoliate trees except for young pecans and persimmons. On most forest and shade trees, the insect is detrimental mainly to the beauty of the host and is therefore more of a nuisance than a threat to the health of the tree. Actual damage can occur on pecan as defoliation affects tree vigor, yield, and nut quality. The earlier defoliation occurs, the more harmful the damage.

Inspection and Control

Small larvae and their small webs may be cut out and destroyed, but larger larvae or those high in trees will need to be treated to achieve control. When using conventional insecticides that rely on contact, sufficient spray pressure is needed to reach and penetrate the webs of these caterpillars. Several insecticides will normally provide control if adequate spray penetrates the webbing. A biorational approach to managing webworms can include the use of *Bacillus thuringiensis* var. *kurstaki*, a bacterial insecticide, or a compound known as Confirm® or Intrepid®, which contain an insect growth regulator that is specific to caterpillar pests. Either of these latter materials can be applied near the webbing area and the caterpillars will eventually expand their feeding into the treatment zone. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832), OSU Extension Fact Sheet EPP-7306, and OSU Current Report CR-6209.

Notes

GREEN STINK BUG

Acrosternum hilare **(Say)**

AND

LEAFFOOTED BUG

Leptoglossus phyllopus **(Linnaeus)**

Kevin D. Arvin, www.insectimages.org

David Cappaert, Michigan State University, www.insectimages.org

Description

The green stink bug is described under the fruit insects section. Damage from both of these insects is quite similar, therefore, they will be considered together in relation to their effects on pecan. The leaffooted bug is also a true bug measuring from $^{3}/_{4}$ to $1\ ^{1}/_{4}$ inches in length and about $^{1}/_{2}$ inch wide. Leaffooted bugs do not vary much in color and exhibit a dull brown background color. They also possess a characteristic shape and leg pattern. The tibial section of the hindleg is flattened and greatly expanded, making it appear somewhat leaflike, hence, the common name. One of the more common species possesses a white or yellow stripe running across the wing covers. The leaffooted bug has characteristic slender mouthparts containing stylets that function to suction plant juices from the tissue once the mouthparts have pierced the surface. The nymphal stages are similar to the adults but lack wings. They may range in size from about $^{1}/_{8}$ inch long to nearly $^{3}/_{4}$ inch long when mature.

Life Cycle

This insect overwinters in the adult stage in protected areas such as fence rows, grassy field borders, under stones, or the bark of trees. They become active during the first warm days of spring (usually around May). In pecan, the greatest adult activity is seen late in the season, starting in July and extending into September or Ocotober with only one generation per year. Egg laying can occur anytime when adults are present from May through July and August. Female bugs may move readily between weeds and other alternate hosts.

Hosts

Stink bugs and leaffooted bugs injure pecan primarily as adults, since the nymphs are not winged early enough and the pecan does not possess much fluid until later in the season. However, fully matured nuts can be fed on by stink bug nymphs if they become available. As pecans begin the maturation and drying process, they will often crack slightly, creating small fissures where stink bug and leaffooted bug mouthparts can penetrate.

Damage

Feeding by stink bugs and leaffooted bugs on pecan will cause the kernel to turn black in that location. This characteristic black pit symptom will make the nut meat have a very bitter taste. They can pierce the nut shuck several times and cause the same symptoms at each location.

Inspection and Control

Monitoring for stink bugs can be done with beating tarps and a padded paddle. Sweep sampling of ground cover can also reveal the presence of stink bugs in an orchard. Yellow pyramid traps may also be helpful in indicating movement of stink bug populations into the orchard; however, these traps capture primarily brown stink bugs. Some relief in future years may be gained by eliminating possible alternate hosts, in particular weeds. For specific control recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

HICKORY SHUCKWORM

Cydia caryana **(Fitch)**

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Larry Line, Mississippi State University

Description

The adult is a small, dark brown to smoky black moth about $^1/_3$ inch long. There is a series of dark and white marks on the outer edge of each front wing near the outer end. The larvae are white or cream colored with brown heads and are about $^1/_2$ inch long at maturity.

Life Cycle

Shuckworms overwinter as pupae in old pecan shucks on the tree or scattered about on the orchard floor. Adults emerge from mid-April to mid-May, mate, and lay eggs. First generation eggs may be laid on hickory nuts, small pecan nutlets, or phylloxera galls. Larvae in pecan nutlets die when the nuts fall from the trees as the nuts are too small to allow development. Larvae in hickory and phylloxera galls develop in May and June and first generation adults emerge in late June and July. These adults lay eggs on pecan nuts and cover them with a gelatin-like material produced by the female. This material becomes creamy white and is a distinctive characteristic of shuckworm egg sites. The larvae feed in the nuts during July and August. Nuts damaged by this generation usually drop from the tree. Second generation adults emerge in late August and early September and give rise to a third generation of larvae. They feed in the pecan shucks during the fall, pupate, and overwinter. There are three generations per year in Oklahoma.

Hosts

The primary hosts are pecan and hickory and the larvae feed mostly in the nut shucks, especially after shell hardening. The first generation larvae commonly feed and develop in phylloxera galls.

Damage

First generation larvae may destroy a few pecan nutlets, but this damage is usually not heavy enough to be serious. Second generation larvae feed in the nuts, causing them to drop from the trees. Third generation larvae mine the shucks, reducing nut fill and causing the shucks to adhere to the shell. This reduces nut quality and yield. Damage to phylloxera galls can be considered beneficial; however, serious shuckworm problems often follow a heavy infestation of phylloxera.

Inspection and Control

Good orchard management can reduce future shuckworm infestations. Remove or burn old shucks, and disk under shucks and dropped nuts to prevent adults from emerging. Treating for phylloxera when needed will reduce breeding sites for the first generation and slow population buildup.

Hickory shuckworms are difficult to control because the larvae are protected once they enter the shuck. If biorational chemicals are applied before young larvae enter the shuck then excellent control can be obtained. Adults exposed to sprays may also be controlled, but insecticide applications must be carefully timed. Light or pheromone traps can be used to determine the peak emergence period, and sprays can be applied accordingly. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Current Report CR-6209.

PECAN CATOCALA

Catocala **spp. (Hulst)**

Louis Tedders, USDA Agricultural Research Service, www.insectimages.org

David Cappaert, Michigan State University, www.insectimages.org

Description

These adult moths are large, quick-flying insects that often inhabit the tree trunks of pecan. One species, *Catocala cerogama* is extremely well camouflaged, with shades of dull gray and white, making the moth blend in particularly well on tree bark. Other species may possess brightly colored hindwings with shades of pink or orange. This explains the common name of this group, known as ilia underwings. The adult wingspan may attain a width of 2 to 3 $^{1}/_{2}$ inches. The forewings are generally held rooflike over the body and appear mottled gray or brownish. The hindwings are not revealed until the moth takes flight. When fully grown, the larvae can attain a length of 2 $^{1}/_{2}$ to 3 inches and are dark gray in color. This coloration allows them to blend in quite well with the tree bark, where they are commonly found. Larvae also sit very still unless disturbed, which is when they will whip their bodies violently from side to side. This serves as a deterrent to most predators.

Life Cycle

Adults emerge from late April to early May. They mate and begin laying eggs shortly after emergence. The larvae will feed on leaves up to about mid-June. Economic damage is rare in well managed orchards. The larvae will eventually spin a loose cocoon attached to the foliage and the pupal stage will overwinter at this site. There is one generation per year.

Hosts

Pecan catocala commonly feed on pecan, hickory, and other trees. The amount of foliage lost is generally minimal unless outbreaks occur in conjunction with other defoliators (e.g., sawflies, unicorn caterpillars, etc.). Repeated or heavy defoliation of younger trees can affect the hardiness of that plant, making it more susceptible to winter injury or other problems.

Inspection and Control

The presence of excessive defoliation should be a concern to any pecan grower, particularly early in the growing season. Close inspection of foliage and twigs will reveal larvae feeding on the leaves or resting on the bark.

Insecticides may be necessary to prevent damage from heavy infestations, although they are rarely justified by the presence of a few caterpillars.

PECAN NUT CASEBEARER

Acrobasis nuxvorella **Neunzig**

Jerry A. Payne, USDA Agricultural Research Service, www.insectimages.org

Jerry A. Payne, USDA Agricultural Research Service, www.insectimages.org

Description

The adult is a small, brownish gray moth measuring about $^1/_3$ inch long. It has a ridge or tuft of dark scales extending across the middle of each front wing. The eggs are flat, very small, and white when newly laid. They develop a pink tint after two or three days and turn entirely light red before hatching. Full grown larvae are about $^1/_2$ inch long with olive green to dark green bodies and yellowish brown heads.

Life Cycle

The pecan nut casebearer overwinters as a small larva in a cocoon-like hibernaculum at the base of a pecan bud. These larvae emerge at budbreak, feed on the buds, and then bore into the tender shoots where they pupate. Adults emerge in late May, mate, and lay eggs on the tips of developing nuts. First generation larvae emerge from eggs about three to six days after ovipositionand begin feeding in the nuts, usually entering through the stem end and completely hollowing out the nut. Each larva moves from nut to nut in a cluster, spinning a silken web over the base of the nuts. Larvae pupate in a damaged nut and new adults emerge about 10 days later. Larvae of the second generation feed on maturing nuts from late July to late August. The larger size of the nuts enables a larva to develop in a single nut. Adults emerging in September give rise to the small larvae which construct hibernacula and overwinter.

Hosts

This species occurs only on pecan. Similar larvae on hickory and walnut belong to other, closely related, species.

Damage

Most of the damage is caused by first generation larvae feeding in the young nuts in late May and early June. Due to the small size of the nuts, each larva feeds in several nuts to complete its development. One larva often destroys an entire nut cluster. Second generation larvae do similar damage, but usually each larva only damages one nut. Overwintered larvae cause a certain amount of damage by tunneling and killing new shoots early in the spring. This latter damage symptom is particularly troublesome on young seedlings or newly grafted pecans.

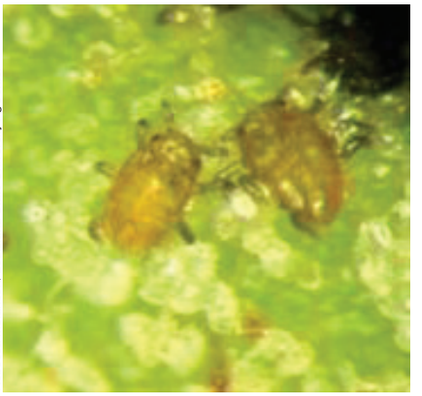
Inspection and Control

Scouting is most commonly conducted by checking the tips of the nuts for the newly laid eggs. A hand lens of 10x to 20x magnification is helpful for finding eggs and determining their color and condition. Egg surveys should be initiated when moths begin emerging. This event can be anticipated by using adult pheromone traps. Computer models based on day degree accumulation can predict moth emergence with reasonable accuracy in most years. Black light traps can also be used in the orchard to monitor moth emergence and abundance.

A light casebearer infestation in a year with a heavy nut set may cause only a beneficial thinning of the nutlets, but heavy infestations in a year with light nut set can cause heavy damage. If more than 1 percent of the nut clusters show viable eggs, control may be needed. In a year with a heavy nut set, up to 15 percent losses may be tolerated. However, caution should be used when attempting to allow the casebearer to do the thinning. Subsequent generations must be monitored carefully to avoid a sudden increase in numbers and dramatic loss of production. The casebearer can be controlled with carefully timed insecticide sprays. If a contact insecticide is used, it must contact the larvae between the time they hatch and the time they enter the nut. Biorational chemicals, like those mentioned for webworms are equally effective and safer on beneficial organisms. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832), OSU Current Report CR-6209, and in OSU Extension Fact Sheet EPP-7189.

PECAN PHYLLOXERA

Phylloxera **spp.**



Rebecca Melanson, Louisiana State University AgCenter

University of Missouri Extension

Description

Phylloxera are tiny, cream colored to pale yellow insects that resemble aphids but lack cornicles (the tubes found on the rear end of aphids). They have sucking mouthparts and are $^{1}/_{10}$ to $^{1}/_{5}$ inch long. Their feeding stimulates the plant to produce galls on the leaves, stems, and nuts. Many phylloxera reproduce inside the galls; however, there are free-living forms that contain winged adults. There are three species on pecans in Oklahoma.

Pecan phylloxera (*Phylloxera devastatrix* Pergande). This species produces a large, green gall on stems, twigs, petioles, midribs, and nuts. The phylloxera produced in the galls are winged.

Pecan leaf phylloxera (*P. notabilis* Pergande). This species produces small galls next to the midribs or secondary veins of the leaflets. The galls are ovoid to globular, open on the ventral surface of the leaf, are evenly green on the top and often reddish beneath when first formed. The phylloxera produced are winged.

Southern pecan leaf phylloxera (*P. russellae* Stoetzel). This species produces small galls between the secondary veins on the leaf surface. The galls are round and flattened, open on the ventral surface, and show a reticulated pattern on their surface. The opening is marked by dense, short, white hairs. The phylloxera produced are not winged.

Life Cycle

All three species of phylloxera overwinter as eggs in protected places on the branches of pecan trees. The young that hatch from these eggs are known as "stem mothers" and first appear about the time that the leaves begin to unfold. The stem mothers migrate to opening buds or leaf tissue and begin to feed on the new growth. This feeding stimulates the development of galls that enclose the feeding insects in a few days. Inside, the stem mother matures, lays her eggs, and dies. Nymphs hatch from the eggs and feed within the galls until they mature. In late May or early June, the galls split open and the new adults emerge.

In the pecan phylloxera, winged, asexual adult females emerge from the galls and migrate to other parts of the same tree or to nearby trees, where they lay eggs of two sizes. The small eggs hatch into male sexual forms and the larger eggs into female sexuals. After mating, the females find protected places on the trees and die with a single, fertilized egg inside them, protected for the winter. There is one generation of galls per year.

In the pecan leaf phylloxera, winged, sexual adults emerge from the galls caused by the stem mother. These sexual forms mate and the females find a protected place to lay a single egg before dying. They also hatch asexual, gall-forming nymphs in the same galls from which the sexual forms emerge. These crawl to new areas of foliage on the same tree and form a second and, in some cases, eventually a third generation of galls in one season.

The southern pecan leaf phylloxera produces wingless, sexual forms in the galls caused by the stem mother. The females crawl to protected places to lay their single egg. The egg is usually not completely laid by the female and remains attached to her dead body. There is one generation of galls per year.

Hosts

These three species of phylloxera are found only on pecan trees. Similar galls found on hickory are caused by other, closely related species.

Damage

The pecan phylloxera, which attacks pecan shoots and fruit, can destroy an entire nut crop and severely weaken and disfigure limb and shoot growth. The weakened and infested shoots tend to sap the tree's vitality and reduce subse-

quent production. The other species, which attack leaves, cause less damage but heavy infestations can cause some defoliation. Galls of all three species can be hosts for first generation hickory shuckworms, and this can lead to population buildups of this pest.

Inspection and Control

The timing of control measures is critical for all three species of phylloxera. Trees with infestations the previous year, and those trees in the immediate vicinity of previously infested trees, should be sprayed. Begin spraying when the majority of buds on the trees have reached the inner scale split stage and before new shoot growth is 2 inches long. If infestations were heavy the year before, a second application 10 to 14 days after the first may be required. Beneficial insects appear to have a significant impact on phylloxera populations and should be preserved as much as possible. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Current Report CR-6209.

Notes

PECAN WEEVIL

Curculio caryae **(Horn)**

Jerry A. Payne, USDA Agricultural Research Service, www.insectimages.org

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

Description

Adults are hard-shelled beetles with long slender snouts and thin legs. They are reddish brown to gray and about $^{1}/_{2}$ inch long. The snout of the female is longer than the body, while the male's snout is slightly shorter than the body. Two long, elbowed antennae are attached at about the middle of the snout. The larvae are creamy white, legless grubs with soft, fleshy bodies and reddish brown heads.

Life Cycle

Adult weevils may emerge from the soil from late July into October, often after rain has softened the ground. Peak emergence is typically between August 10 and September 20. In years of extreme drought during August, peak emergence can be delayed until September or even later. As they emerge, the weevils begin to feed on the pecan nuts and mate.

Egg laying begins when the weevils find nuts in the gel to dough stage. The female drills a hole in the nut with her snout and then places one to four eggs within the developing kernel. Larvae hatch and feed on the kernel, maturing in about 30 days. Maturity may be reached as early as September or as late as December. Mature larvae chew a hole in the nut, fall to the ground, and burrow into the soil. They remain in the soil as larvae for one year. One year after entering the soil, some of the larvae pupate from early September to the middle of October and change into adults about three weeks later. These individuals will not emerge until August or September the following year. The remaining larvae spend another year in the soil. The larvae that spend two years in the soil pupate, reach the adult stage about three weeks later and remain in the soil as adults for a third year. One generation takes two or three years.

Hosts

The only economic host is the pecan, where feeding and breeding take place in the developing nuts. The pecan weevil will also breed in hickory nuts.

Damage

When the adults emerge from the soil, they feed on nuts by puncturing the shuck and shell. If the nuts are still in the water stage, they lose fluid through the puncture and fall from the tree two or three days later. These damaged nuts can be recognized by the dark stains on the outside of the shuck.

The main type of damage is caused by larvae feeding within the nut. One to four larvae develop inside each nut and destroy the entire kernel.

Inspection and Control

In heavily infested areas, it may be best to plant late maturing cultivars as they are often not as heavily damaged as early maturing types. Avoid planting pecan trees near hickories. During harvest, destroy any weevil infested nuts and any larvae that emerge from harvested nuts.

Carefully planned chemical control is the only effective way to manage the pecan weevil in established orchards at this time. Insecticide applications must be timed for adult emergence and continued as long as adults are present. Weevil populations must be monitored or trapped repeatedly to determine when applications are needed.

Trees with heavy infestations can often be spotted by the damaged nuts on the ground. Weevil emergence can be monitored by use of Circle traps. See OSU Extension Fact Sheet EPP-7190 for information on use and construction of these traps. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Current Report CR-6209. Additional information and pictures of the various life stages can be found in OSU Extension Fact Sheet EPP-7079.

SAWFLY

Periclista marginicollis **(Norton)**

Pennsylvania Department of Conservation and Natural Resources - Forestry Archive, www.insectimages.org

Cheryl Moorehead, www.insectimages.org

Description

Sawfly adults are small stingless wasps that are generally darker in color. They do not appear to have the constricted waist of many stinging wasps. Female sawflies have a short, stout, saw-toothed ovipositor. They use these to cut into plant material and deposit their eggs. The larvae are small translucent green caterpillars. Unlike the caterpillars of moths and butterflies, sawfly larvae possess six sets of abdominal prolegs, plus anal prolegs. Butterflies and moths will have one to four sets of abdominal prolegs, plus anal prolegs. The larval stage of this insect can often assume a slug-like appearance, looking somewhat shiny and expanded at the head end. As they increase in size (up to $^{2}/_{3}$ inch) the caterpillars assume a somewhat spiny appearance.

Life Cycle

There is one generation of this pest per year in Oklahoma. Wasps emerge in early spring to deposit their eggs on new foliage. Larvae feed on the leaves in April and May. The larvae are often gregarious and feed in groups, but **do not spin webs** in which to feed. Larval feeding on the foliage causes initially, very tiny holes in the leaves. As the caterpillars mature and if numbers are excessive, then leaves can assume a very tattered appearance, like they were shot with a shotgun. This generally occurs in Oklahoma prior to or near the time of catkin formation. Mature larvae leave the trees and pupate in the soil to overwinter.

Hosts

Larvae feed on foliage of many trees including pecan. Hosts include black and English walnuts, butternut, pecan, pin oak, and various species of hickory.

Damage

Excessive numbers of these caterpillars can defoliate trees and severely affect tree vigor, yield, and nut quality. The earlier defoliation occurs, the more harmful the damage. Trees can withstand two or three consecutive years of heavy defoliation before they die. Epidemics were rare when standard, petroleum-based insecticides were used; however, now that many of the biorationals have been heavily adopted for insect control in pecan, these insects have assumed a more prominent role. It is unlikely that they will assume the status of a major pest, but may need to be managed more carefully in the future.

Inspection and Control

Sawfly caterpillars are attacked by many species of parasites and predators and several diseases. These beneficial organisms often keep numbers low or cause the collapse of outbreaks. The bacterial insecticide, *Bacillus thuringiensis*, is ineffective, as are other biorational products.

Larvae can be controlled with a variety of insecticides. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Current Report CR-6209.

TWIG GIRDLER

Oncideres cingulata **(Say)**

Description

The adults are typical longhorned beetles that range from $^{1}/_{2}$ to $^{5}/_{8}$ inch long. They are grayish brown in color with a broad, ashy-gray band across the middle of the wing covers. The antennae are at least as long as the body. The eggs are white, elongate oval, and about $^{3}/_{32}$ inch in length. The larvae are whitish, cylindrical, legless grubs that reach about $^{3}/_{4}$ inch in length at maturity.

Life Cycle

Adults emerge from late August to early October. They feed on tender bark near branch ends and mate before laying eggs and girdling twigs. Twigs are girdled because larvae are unable to survive in living twigs. The girdling extends through the bark and well into the wood in a complete circle around the stem and leaves only a thin column of the center wood attached, which breaks easily. Twigs from $^{1}/_{4}$ to $^{1}/_{2}$ inch in diameter are most commonly girdled. Eggs are laid during or after the cutting process, but never before the beetle initiates the cut. Eggs are inserted singly beneath the bark or slightly into the wood, usually near a bud scar or adjacent to a side shoot. The number of eggs per twig normally ranges from three to eight, but may range up to 40. Adults live six to 10 weeks. Each female deposits 50 to 200 eggs which hatch in about three weeks. The small larvae overwinter in the dead twig either in the tree or on the ground. Larvae grow rapidly in the spring and tunnel toward the severed end of the twig, feeding only on the woody portion and leaving the bark intact. The mature larva closes off the gallery with shredded fibers to form a pupation chamber. Pupation occurs during August and September and lasts 12 to 14 days. The adult chews a circular hole in the bark to emerge. There is one generation per year.

Hosts

Twig girdlers are commonly found on pecan, hickory, persimmon, and elm. They also attack oaks, honeylocust, hackberry, poplar, dogwood, sourwood, and various fruit trees.

Damage

It is not uncommon to see the ground under infested trees almost covered with twigs that have been cut off. This affects the beauty and aesthetic quality of ornamental plantings. The fruiting area of heavily infested pecan trees is often greatly reduced, resulting in low nut yields the following year and sometimes longer. This type of injury causes the development of many offshoots that adversely affect the symmetry of the tree. Pecan nurseries located close to heavily infested woodlots occasionally suffer considerable loss from girdled seedlings. Repeated girdling of terminals causes forks, crooks, and other stem deformities in young timber plantations as well as in natural reproduction.

Inspection and Control

The presence of severed twigs on the ground, hanging loosely attached, or lodged in the canopy is good evidence of infestation. The nature of the girdle distinguishes the twig girdler from other branch pruners. The cut by the twig girdler is the only one made from the outside by the adult beetle. It is a uniform V-shaped cut with a small central area and a jagged surface caused by the break. Since the twigs are girdled while the leaves are present, the severed twigs retain the brown leaves for some time. Close inspection of the severed twigs will reveal small egg niches in the bark.

In orchards, nurseries, and ornamental plantings, the severed twigs can be gathered and de-

stroyed during the fall, winter, and spring when the eggs and larvae are in the twigs. The same practice should be followed in nearby woodlots when plantings in the vicinity have a history of serious damage from this pest. Insecticides may be necessary to prevent damage from heavy infestations, although they are probably unnecessary in natural forest stands. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Current Report CR-6209.

Notes

WALNUT CATERPILLAR

Datana integerrima **Grote & Robinson**

Ronald F. Billings, Texas Forest Service, www.insectimages.org

Lacy L. Hyche, Auburn University, www.insectimages.org

Description

Walnut caterpillar moths are light brown with four rust-colored lines on each front wing and a dark red brown thorax. The wingspan is about 1 $^{3}/_{4}$ inches. The larvae possess a dark red or burgundy background color when young but this becomes black when they reach maturity. Larvae have many long, white hairs on the body. When disturbed, they usually raise the front and back thirds of the body. Mature larvae are about 2 inches long. The eggs are round and white and are laid in loose masses on the undersides of leaves. This species is often called the walnut datana.

Life Cycle

There are two generations of this pest per year in Oklahoma. Moths emerge from mid-May to early June and in late July and early August. Larvae feed on the leaves in June and July and from late August into October. The larvae are gregarious and feed in groups, but **do not spin webs** in which to feed. Small larvae skeletonize the leaves but larger larvae consume all but the leaf rachis and petiole. They migrate back to the trunk or larger limbs in groups each time they are ready to shed their skins. Evidence of their presence will be marked by these caste skins left behind by large masses of larvae molting together. Mature larvae leave the trees and pupate in the soil. Pupae of the second generation overwinter.

Hosts

The larvae feed only on foliage of trees of the family Juglandaceae. Hosts include black and English walnuts, butternut, pecan, and various species of hickory.

Damage

These large caterpillars can defoliate the trees and severely affect tree vigor, yield, and nut quality. The earlier the tree is defoliated, the more harmful the damage to the tree. Trees can withstand two or three consecutive years of heavy defoliation before they die. Epidemics seldom last longer than two years in any one location.

Inspection and Control

Walnut caterpillars are attacked by many species of parasites and predators and several diseases. These beneficial organisms often keep numbers low or cause the collapse of outbreaks. The bacterial insecticide, *Bacillus thuringiensis* var. *kurstaki*, is quite effective as a control agent, as are insect growth regulator products (e.g., Intrepid). It is also possible to remove and destroy masses of larvae when they are small.

Larvae can be controlled with a variety of insecticides. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Current Report CR-6209.

TREE AND SHRUB INSECTS

Notes

APHIDS ON ORNAMENTALS

Family Aphididae

Debbie Roos, North Carolina Cooperative Extension

Eric Rebek, Oklahoma State University

Description

Aphids are small (usually $^{1}/_{8}$ inch long or less), delicate, more or less pear-shaped insects with long legs and antennae. Their color can vary from green to brown to red or black. They may be winged or wingless, but wingless forms are more common. Most aphids have a pair of tube-like structures, called cornicles, projecting backwards near the rear of the body. They have piercing-sucking mouthparts and feed by sucking sap from plant tissue.

Distribution

Various species of aphids are found worldwide. Some species have worldwide distributions, while others are found only in certain small areas where their host plants grow. Common species found on ornamental plants in Oklahoma are the green peach aphid, ivy aphid, melon aphid, oleander aphid, potato aphid, and spirea aphid.

Life Cycle

The "typical" aphid species may produce several wingless generations in the spring, followed by a generation of winged forms. The winged forms can fly to other plants where many more wingless summer generations may be produced. As days become shorter and cooler, a generation of winged aphids may be produced which fly back to the winter host. Some aphids have distinct winter and summer hosts (the winter host may be an evergreen and the summer host an annual weed or deciduous plant). Aphids can increase rapidly in an extremely short time. During warm weather some species can complete a generation in less than two weeks. In many species, most or all of the summer generations consist of females that give birth to live female young, which are produced without sexual reproduction (parthenogenesis). Males may be produced near the end of the season. The overwintering stage may be eggs or the adults may be active through the winter.

Hosts

Nearly all species of plants have one or more aphid species that feed on them. Many species feed on one or a few closely related species of plants. Therefore, knowing the host plant is often helpful in identification. Only a few species, such as the green peach aphid, feed on a large number of unrelated hosts.

Damage

Aphids usually prefer to feed on succulent young shoots and leaves, although some species occur on flowers, twigs, branches, or even roots. They seldom kill plants, but their feeding can cause stunted plant growth, curled and yellowed leaves, or distorted stems and fruits; some species cause galls on roots, leaves, or stems. Damage results primarily from the loss of plant sap, although some aphid species transmit plant viruses or inject toxins into plants while feeding.

Aphids and certain other sap-sucking insects excrete large amounts of honeydew, a sticky substance often seen on leaves, pavement, automobiles, or other surfaces below infested foliage. Honeydew consists mainly of excess sugar ingested by the insects and passed through the body. Ants are often attracted to the sugary honeydew and occasionally tend the aphids much as humans

tend cattle; some ants even carry aphids to new plant parts to establish more colonies. Honeydew also attracts flies, wasps, and bees, thus adding a nuisance element for humans. A black sooty mold often grows on plant parts covered with honeydew. This fungus can detract from the plant's appearance and reduce the amount of light reaching leaves (thus reducing photosynthesis).

Inspection and Control

Aphids are often controlled by natural forces, such as driving rains, or high or low temperatures. Also, fungal diseases develop in damp weather and sometimes provide control of aphids. Parasitic wasps may deposit their eggs inside the bodies of aphids. The eggs hatch into larvae that feed inside the aphid and consume its internal parts. Insect predators also can help keep aphid populations in check. Predators include lady beetle adults and larvae, lacewing larvae, and syrphid fly larvae.

Aphids on ornamental plants can be easily controlled with many readily available ornamental insecticides. You should follow dilution rates and other directions given on the label of the product you purchase. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306. Also, see more specific coverage of arborvitae, conifer, and giant bark aphids later in this chapter.

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ARBORVITAE APHID

Cinara tujafilina **(Del Guercio)**

Oklahoma State University

Description

This is a relatively large aphid with adults ranging up to $^{1}/_{8}$ inch long. It is brownish and partly covered with a whitish, waxy secretion. It has a broad body and long legs. The cornicles are broad, short, and cone-shaped.

A second species, C. *idahoensis*, is occasionally found on arborvitae in Oklahoma. It is similar to *C. tujafilina* in size and shape but is green. Other species of *Cinara* in the state are found on pines.

Distribution

The arborvitae aphid is found over most of the U.S. It can probably be found in any part of Oklahoma where arborvitae is grown, although it is most commonly reported in the western half of the state.

Life Cycle

This aphid can appear on arborvitae anytime between late October and early December (most commonly about the middle of November). They feed and reproduce whenever temperatures allow, probably producing several generations in mild winters. They can tolerate relatively cold weather, but at least part of the population will be killed if temperatures drop much below 10° F. Large numbers may be found as early as late January, but are more commonly found in March and April. Numbers usually begin to decrease in April and infestations disappear in May. Oversummering forms have not been found in Oklahoma; however, they probably occur on the roots of infested arborvitae.

Hosts

For all practical purposes, the only host in Oklahoma is arborvitae. This species has, however, been reported on Italian cypress, red cedar, and retinospora in other areas of the country.

Damage

This species has been reported to cause foliage to turn brown and kill branches of arborvitae and Italian cypress. We seldom see serious damage in Oklahoma, but it probably occurs in mild winters when heavy infestations are present for long periods of time. They may have considerable annoyance value as they produce large amounts of honeydew, which can drip on cars, sidewalks, etc. and attract flies, wasps, and other insects to infested plants. These aphids sometime leave infested plants in March or April and can be found crawling on sidewalks, walls, or other trees or shrubs.

Inspection and Control

Arborvitae aphids are found on the stems of host plants and very closely match the color of young stems. They can be difficult to find in the early winter when only small numbers are present. When numbers have increased in the spring, look for large sticky spots on the foliage. Aphids will be found on stems just above the honeydew they have produced. Infestations are more likely to build up on plants in protected locations or on the south side of hedges or exposed plants. Several insecticides will control this aphid. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

ASH or LILAC BORER

Podosesia syringae **(Harris)**

David Cappaert, Michigan State University, www.insectimages.org

Whitney Cranshaw, Colorado State University, www.insectimages.org

Whitney Cranshaw, Colorado State University, www.insectimages.org

Description

The adult is a clearwing moth that is mostly dark brownish black. There are orange to chestnut brown markings on the head, at the base of the wings, and on the sides of the body. The legs are marked with yellow and orange. The wingspan is about 1 inch. Adults bear a striking resemblance to certain species of paper wasps. Mature larvae are about 1 inch long and are creamy white with shiny brown heads.

A closely related species, *P. aureocincta* Purrington & Nielsen, is known as the banded ash clearwing. They closely resemble the ash borer but adults have a narrow orange-yellow band on the fourth abdominal segment.

Distribution

P. syringae occurs over the entire eastern U.S. and southern Canada as far west as Saskatchewan and Utah. *P. aureocincta* is found from New York south to Florida and west to Indiana and Oklahoma.

Life Cycle

Mature ash borer larvae overwinter in their tunnels within host plants. They pupate in the spring and adults emerge from late April into July. Peak flight should be in May or early June in Oklahoma. Females live about one week and are able to produce an average of 395 eggs, which are laid singly or in clusters on the bark of the host plants, usually in bark crevices or on ridges. Activity and egg laying occur during the daylight hours, which is unusual for moths. After hatching, the young larva chews into the bark and feeds laterally and vertically in phloem tissue. Larger larvae feed in sapwood and tunnel upward in the plant. There is one generation per year.

The banded ash clearwing overwinters as a small (second instar) larva. They resume growth in the spring and mature and pupate in the summer. Adults emerge and lay eggs from August into October.

Hosts

Ash borer larvae primarily injure ash and lilac and are occasionally found in privet, fringe tree, and other trees and shrubs of the olive family (Oleaceae). The banded ash clearwing appears to be limited to feeding on various species of ash.

Damage

Damage is caused by larvae boring within the stem or trunk of the host plant. This damage can kill shrubs and small trees and seriously weakens larger plants. Even larger trees can be killed by heavy infestations over several years. Larval damage causes nursery cull, decline and mortality in shelterbelts and ornamental plantings, and decline in timber stands.

Inspection and Control

The first symptom of injury is a slight sap flow mixed with frass at the penetration site. Later, "sawdust" will accumulate at the entrance site and on the ground below it. Each larva that completes development produces two characteristic holes in the trunk of its host: an irregularly shaped entrance at the bottom of the gallery, and a round exit hole at the top. Empty pupal skins may often be found protruding from the exit holes.

Borer larvae can sometimes be killed by inserting a flexible wire or injecting a fumigant into their burrows. Heavily infested plants or branches should be cut and burned to limit future borer attacks. Insecticides can be applied to the trunk and branches of host plants when the moths are active (beginning in early May for the ash borer or in early August for the banded ash clearwing). Two or three treatments at two week intervals will be needed, beginning 10 to 14 days after the moths become active. Traps baited with a male attractant can be used to monitor moth flight and determine the optimum times to spray. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) And OSU Extension Fact Sheet EPP-7306.

Appreciation is expressed to Mark Hackler who, as a student in the Horticultural Insects Course in 1991, developed much of the material included here.

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ASTER LEAFHOPPER

Macrosteles quadrilineatus **Forbes**

Whitney Cranshaw, Colorado State University, www.insectimages.org

Description

The adult is similar in shape to the potato leafhopper, but can be distinguished by six dark spots between the compound eyes. The adult aster leafhopper measures about $^{1}/_{8}$ inch in length and has a light green to yellow color.

Life Cycle

Adults or eggs overwinter in the southern U.S. and migrate by wind to the northern states in spring. During warmer months, aster leafhoppers can be found anywhere in most of North America surviving on a wide variety of plants. The lifespan of the adults ranges from one to two months. The female has been reported to lay up to 200 eggs in its life, and the eggs can develop into adults in 24 days. There are five instars. The first instar has brownish coloration and is less than $^{1}/_{16}$ inch long. Later instars are yellowish. There are up to six generations per year.

Hosts

Aster leafhoppers feed on more than 180 plant species. Plants fed upon include vegetables (carrot, lettuce, onion, potatoes), herbaceous plants (celery, parsley, dill, composites), fruits (tomatoes), and ornamental perennial and annual plants.

Damage

All stages penetrate plant tissue with their piercing-sucking mouthparts and extract plant sap. Nymphs tend to feed on the underside of leaves causing leaf chlorosis. Adults are capable of transmitting North American aster yellows, a disease caused by a phytoplasma. Aster yellows symptoms include an initial yellowing of the leaf veins followed by chlorosis of new leaves. Finally, stunting and irregular growth occurs and symptoms vary according to plant species.

Inspection and Control

Plants should be monitored for presence of the aster leafhopper and aster yellows symptoms. There is no remedy once plants are infected with aster yellows and infected plants should be destroyed to prevent further spread of the disease. Specific recommendations for leafhopper control can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

Appreciation is expressed to Lisa Overall who, as a graduate student in the Department of Entomology and Plant Pathology, developed much of the material included here.

BAGWORM

Thyridopteryx ephemeraeformis **(Haworth)**

Pennsylvania Department of Conservation and Natural Resources - Forestry Archive, www.insectimages.org

Pennsylvania Department of Conservation and Natural Resources - Forestry Archive, www.insectimages.org

Description

Adult males are small moths with a black, hairy body and clear wings measuring about 1 inch in wingspan. Adult females are wingless, have no functional legs, eyes, or antennae, and are almost maggot-like in appearance. The female's body is soft, yellowish white, and practically naked except for a circle of woolly hairs at the posterior end of the abdomen. Mature larvae are about 1 inch long and have a dark brown abdomen, while the head and thorax are white and spotted with black. Both larvae and adult females are found in silken bags on their host plants.

Distribution

Bagworms are found in most states east of the Rocky Mountains. It is most common from Pennsylvania to Nebraska and south to Florida and Texas. It is common in all areas of Oklahoma.

Life Cycle

Overwintered eggs (contained within the bags of 1-year-old females) begin to hatch in late April or early May and young larvae begin to feed and construct bags immediately. The first evidence of an infestation is normally a small bag, about $^{1}/_{4}$ inch long, standing almost on end. As larvae grow, silk and fragments of the host plant foliage are added to the bag until it reaches $1\,^{1}/_{2}$ or 2 inches long. When larvae are mature they fasten the bag to a plant stem with silk. Pupation occurs in the bag in late summer and males emerge in late summer to early fall. They engage in a mating flight in search of the wingless females, who remain inside their bags. After mating, the female lays several hundred white eggs inside her old pupal case, drops from the bag, and dies. There is one generation per year.

Hosts

In Oklahoma, the most common hosts are eastern red cedar, other junipers, and arborvitae. They sometimes damage pines, spruce, bald cypress, maple, boxelder, sycamore, willow, black locust, oaks, and roses. The bagworm has been recorded on 128 different plant species in various parts of the U.S.

Damage

Bagworm larvae damage their hosts by feeding on the foliage. Heavy infestations can completely defoliate small plants. Defoliation usually kills hosts such as red cedar and other junipers. Broadleaf hosts are not killed but are weakened and become more susceptible to woodboring insects and pathogens.

Inspection and Control

Infestations can be reduced by hand picking bags, and overwintering eggs, during fall, winter, or spring before eggs hatch. Chemical controls are most effective if applied early when larva are small. In Oklahoma, it is normally a good practice to make applications of insecticide by early June. *Bacillus thuringiensis* var. *kurstaki*, a bacterial insecticide, is reported to provide good control of bagworms. Repeat applications may be needed later in the summer in order to keep susceptible plants free of bagworms. This is not due to the occurrence of multiple generations. Rather, not all eggs will hatch at the same time in some years and there may be migration of larvae between host plants. In most years, treatment in early June will catch most of the emerging larvae and provide fairly good, season-long control. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

BOXELDER BUG - REDSHOULDERED BUG

Boisea trivittata **(Say) -** *Jadera haematoloma* **(H.-S.)**

Whitney Cranshaw, Colorado State University, www.insectimages.org

Whitney Cranshaw, Colorado State University, www.insectimages.org

Description

Adults of both species are grayish black bugs with red eyes and red markings and measure about $^{1}/_{2}$ inch long. The boxelder bug has three red stripes behind the head, red lines on the outer edges of the wings, and a red margin on the back edge of the front half of the wings. The redshouldered bug has only two red stripes behind the head and doesn't have any red markings on the wings. Nymphs are smaller than adults and do not have fully developed wings. They usually have more red markings than adults.

Distribution

The boxelder bug is known from eastern Canada throughout the eastern U.S. and west to Nevada. The redshouldered bug is found from northern South America to the southern U.S. as far north as North Carolina and Colorado. Both species can be found in all parts of Oklahoma where suitable hosts occur.

Life Cycle

Adults of both species overwinter in protected places. They emerge in the spring when buds of their host trees open. In late April to early May, they fly back to their host plants, where they lay their eggs. Both bugs prefer to feed on fruiting structures, including seeds that have matured and fallen to the ground, but they will also feed on leaves. First-generation bugs mature and repeat the cycle. There are two generations per year in Oklahoma.

Hosts

The boxelder bug is found mostly on female (seed-bearing) boxelder trees. The redshouldered bug prefers chinaberry and golden rain tree. Both are occasionally found on ash, maple, and some fruit trees.

Damage

These bugs do very little damage to their host plants even when they are present in large numbers. They are primarily nuisance pests when they begin to seek overwintering quarters in the late summer and fall. At this time, they may congregate in large numbers around homes, on shrubs and trees, and in lawns. They commonly attempt to enter homes and other buildings for protection. Problems may also occur on warm days during the winter and when they leave their overwintering quarters in the spring. They do not cause damage in the home by feeding but may stain fabrics or walls if they are crushed.

Inspection and Control

Removal of the host trees from the premises may help reduce problems. However, both bugs can fly well and may still invade a home at some distance from their hosts. These trees might be avoided when considering new plantings, especially if there have been problems in the past. Male boxelder trees could be planted as the boxelder bug is found mostly on female trees. Caulking, or otherwise closing, openings around windows and doors, in walls or foundations, and under siding will help prevent bugs from entering the home. Bugs in the home can be removed with a vacuum cleaner.

It may be helpful to spray infested trees during summer while the bugs are in immature stages and still concentrated on their host trees. However, it may be impractical to spray large landscape trees. As boxelder or redshouldered bugs mature and leave trees, they are far more difficult to kill. It has been reported that somewhat better control may be realized if you add a high phosphate detergent (e. g. Tide) to your spray (at the rate of 1 to 2 tablespoons per gallon or up to 1 cupful of powdered detergent in 3 gallons of spray).

Inside the home you can get partial control with ready-to-use household sprays applied to cracks and crevices and other areas identified on the insecticide label. You should consider having a pest control company make the treatment if you encounter heavy infestations of the bugs in the attic or in the crawl space under a home.

Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7312.

BROWN ELM SCALE

Parthenolecanium corni **(Bouche)**

Oklahoma State Univeristy

Description

The mature female is brown with a smooth, hemispherical (dome-shaped) body that measures $^1/_8$ to $^1/_4$ inch in diameter. During growth the body is soft and plastic but at death becomes a hard, brown shell, fastened loosely to the bark, and serves as a covering for several hundred white eggs. Immature scales are light brown, smaller, and more flattened than mature females. This is a species of soft scale; therefore, the outer covering is part of the body of the scale and the scales produce honeydew.

Distribution

The brown elm scale (also known as the European fruit lecanium) is found in all areas of the U.S. It has been reported in all parts of Oklahoma except the Panhandle. It was originally thought to be a native of Europe but is now considered to be native to North America.

Life Cycle

Eggs are laid beneath the body of the female in late April and early May and hatch into tiny, lice-like nymphs in early and mid May. The immatures, called crawlers, emerge from beneath the scale covering and migrate to leaves and small limbs. As they grow during summer, their bodies become opaque and they attach along the veins of leaves and to limbs. Before leaves drop in autumn, the scales migrate to the bark of the smaller branches where they spend the winter as second-instar nymphs. With the beginning of sap flow in the spring, the scales start to feed. Adult males, if they are present in the population, emerge in the spring. They are small (1 1/4 mm long), brown, and gnat-like. They are incapable of feeding and live but a short time. There is one generation per year.

Hosts

This species has been found on a wide variety of trees and shrubs and is a serious pest of fruit trees in some areas. In Oklahoma, it has been found on ash, mulberry, plum, pecan, maple, and occasionally on other trees, but it occurs chiefly as a pest of American elm.

Damage

Heavy infestations kill small branches, stunt tree growth, and devitalize the tree until it is subject to attacks of woodboring insects and pathogens. Also, heavy infestations result in large quantities of honeydew (a sticky excretion), which often coats leaves or falls on sidewalks, buildings, or cars parked under trees.

Inspection and Control

The best control of brown elm scale is usually achieved by spraying the trees with dormant horticultural oil during winter. Since honeydew and damage are not usually noticed until April or May, trees with a history of scale infestation should be inspected in late winter.

Research has shown that good results can be obtained by spraying in March just before trees leaf out, during or shortly after blooming, but when the leaf buds are still dormant. Oil sprays at this time may kill the blooms but will not harm the tree. Summer sprays to control the scales on leaves and small branches have not been shown to be effective. It is very important to get thorough coverage of all the smaller branches and twigs on the tree, especially those in the lower portion of the crown. Thorough treatment with at least 5 to 6 gallons of total spray material for an average-sized shade tree is needed for control of scale. A larger amount of total spray is needed for larger trees.

A few precautions should be followed when using horticultural oils to control brown elm scale. Do not spray when it is windy or when the temperature is below 40° F. Do not spray when the temperature is likely to drop below freezing within 24 hours after treatment. Avoid getting spray on houses or automobiles.

Insecticides applied in late April or early May when crawlers are active will normally provide good control. Insecticides used alone or in combination with summer horticultural oil may provide some control of the scale during the growing season. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

CATALPA SPHINX

Ceratomia catalpae **(Boisduval)**

Herbert A. "Joe" Pase III, Texas Forest Service, www.insectimages.org

Lacy L. Hyche, Auburn University, www.insectimages.org

Description

Adults are large, stout-bodied moths with a wingspan of 2 $^{1}/_{2}$ to 3 inches. The front wings and body are grayish brown with irregular darker and lighter bands and markings. The hindwings are almost uniformly brownish gray. Larvae reach about 3 inches long when mature. There are two forms of larvae in Oklahoma. The dark form is black above and pale yellow beneath the body. The pale form is pale yellow with markings and patches of black on the back and sides. Larvae have a black head and a large black horn on top of the abdomen near the rear of the body.

Distribution

Catalpa sphinx are located from New York to Florida and westward to Michigan, Kansas, and Texas, but they are most abundant in the southeastern states. In Oklahoma, it is most common in the east and gradually decreases in number to the west.

Life Cycle

Winter is spent as pupae in the soil, usually under or near catalpa trees. Moths emerge in spring shortly after catalpas have come into full leaf, usually from the middle of April to early May in Oklahoma. Adults are seldom seen as they are active at night. Females lay eggs in large masses on the underside of leaves or in smaller masses on twigs or branches. Eggs hatch in 10 to 14 days. Small larvae feed in groups and often on one leaf, but larger larvae disperse and feed singly. There are probably two generations per year in Oklahoma. Larvae of the first generation are present in May, June, and July. Second generation larvae may be present in August, September, and October.

Hosts

This species feeds exclusively on catalpa trees.

Damage

Larvae feed on catalpa leaves and can completely defoliate a tree when they are abundant. Injury is of relatively minor significance to large trees that have sufficient energy reserves. However, repeated defoliation over multiple generations and years can deplete energy stores as trees refoliate. Young nursery trees are also unable to withstand heavy defoliation from large caterpillar populations.

Inspection and Control

Catalpa sphinx larvae are often seen with masses of small, white objects attached to their backs. These are the cocoons of a small parasitic wasp (*Cotesia congregata*). Larvae with these cocoons should not be destroyed if you are trying to control the caterpillars; however, they should be destroyed if you are raising catalpa worms for fish bait.

Hand picking of larvae is effective on small trees. Larvae can be destroyed or used for fish bait. They can also be frozen and used as bait at a later date. Chemical control is generally not difficult. Several insecticides applied with sufficient volume of finished spray to cover all foliage will normally kill the caterpillars. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

CONIFER APHID

Cinara watsoni **Tissot**

Oklahoma State University

Edward H. Holsten, USDA Forest Service, www.insectimages.org

Description

This is a relatively large aphid with adults ranging up to $^{1}/_{8}$ inch long. It is grayish brown with numerous small, black dots on the abdomen and black legs. There is a wide, pale yellowish band at the middle of the tibiae on the second and third pairs of legs. The cornicles are broad, short, and cone-shaped. Nymphs are similar to adults but smaller.

There are four other species of *Cinara* which might be found in Oklahoma. Two of these, *C. tujafilina* and *C. idahoensis*, are found only on arborvitae. *Cinara pinivora* is found on pines but has a broad, pale band on all three pairs of tibiae. *Cinara braggii* might be found on pines, but it has pale femora.

Distribution

Conifer aphids are found New York to Florida and west to Michigan and Oklahoma. In Oklahoma, it is found in the eastern edge of the state where pines are native. It is occasionally found on planted pines as far west as Payne, Oklahoma, and Carter Counties.

Life Cycle

The life cycle of this aphid is not well known but appears to be somewhat similar to that of *C. tujafilina* on arborvitae. They probably spend the summer months (July to September) as eggs on the bark, or perhaps roots, of pines. They are present on pine twigs and branches from October to May and sometimes into June or even July. They reproduce and feed whenever temperatures allow, probably producing several generations in mild winters. They can tolerate relatively low temperatures, but many are probably killed when temperatures drop much below 10° F.

Hosts

This aphid is found on the twigs and small branches of pine trees. It has been found on shortleaf and slash pines in Oklahoma. It is reported from loblolly, shortleaf, slash, spruce, and pond pines in Florida and red, pitch, Scotch, and Virginia pines in Pennsylvania.

Damage

This aphid is seldom found in large numbers, and reports of damage caused by this aphid are rare. Several related species occasionally damage pines or other conifers in some areas of the U.S. It is possible that heavy infestations could cause some twig dieback. These aphids are known to produce large amounts of honeydew on which sooty mold often develops.

Inspection and Control

Look for this aphid on the twigs of pine trees in fall and again in late winter. Heavy infestations are most likely seen February to May in mild winters. Control is not recommended unless extremely high numbers are present or honeydew secretion becomes a problem. Specific recommendationscan be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

COTTONWOOD BORER

Plectrodera scalator **(Fab.)**

Whitney Cranshaw, Colorado State University, www.insectimages.org

James Solomon, USDA Forest Service, www.insectimages.org

Description

The adults are large, robust, longhorned beetles, 1 to 1 $^{1}/_{2}$ inches long. The basic body color is black but is obscured by patches and cross stripes of fine, pure white hairs that surround black, hairless areas. There is a strong spine on each side of the thorax and the antennae are as long as the body (females) or a little longer (males). Larvae are legless, elongate, moderately robust, and yellowish white. They reach a maximum length of about 1 $^{1}/_{2}$ inches.

Distribution

This species is most common in the Southeastern states but is found as far north and west as New York, Michigan, Montana, and Texas. It is common in most areas of Oklahoma.

Life Cycle

Adult cottonwood borers begin to emerge in late spring (late May or early June in Oklahoma) and feed on the tender shoots of young trees. Mating and egg laying occur over an extended period during the summer. To oviposit, the female first digs away the soil at the base of the tree, cuts a niche in the bark, and deposits one or more eggs. Upon hatching, larvae mine downward in the inner bark and penetrate into the sapwood as cold weather approaches. Larvae resume feeding during spring, feed throughout the next summer, and the much larger larvae create large tunnels at the base of the tree, where they again overwinter. They pupate within the gallery the second spring, so the entire life cycle is completed in two years. The new adult chews through the pupal chamber and digs its way to the soil surface to escape.

Hosts

The cottonwood borer feeds in the lower trunk and roots of living cottonwood, poplar, and willow trees.

Damage

Adult feeding can cause some damage, especially on young trees, but larvae cause most of the damage. Young trees may be hollowed, partially severed, or girdled at or slightly below the root collar, causing breakage. Damage has been greatest in nurseries, young plantations, and young natural stands growing on sandy soils. Larvae are seldom numerous enough to cause major damage to older trees, although significant infestations may predispose the trees to other problems.

Inspection and Control

Since most larvae feed below the soil line, they are well protected from both predators and parasites. Woodpeckers capture a few larvae exposed above the soil line. A fungal disease has been found killing larvae but it does not appear to be common. Extended flooding has been reported to kill many larvae.

Borer populations and damage in nurseries can be reduced by using borer-free planting stock and by plowing out and destroying nursery rootstock at three-year intervals. Damage can often be kept to a minimum by planting on good sites and utilizing cultural practices that maintain a vigorous, healthy stand.

Adult beetles can be collected and destroyed or insecticide treatments can target adult females before they lay eggs. Several treatments would likely be needed during the summer months. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Appreciation is expressed to Peter Loy who, as a student in the Horticultural Insects Course in 1991, developed much of the material included here.

ELM CALLIGRAPHA

Calligrapha scalaris **(LeConte)**

Oklahoma State University

Description

Adults are elongate-oval, creamy white beetles measuring about $^{3}/_{8}$ inch long. The head and thorax are dark, metallic green. Each wing cover bears from 10 to 14 metallic green spots, a dark green, boot-shaped spot at the base, and a dark, metallic green, irregular stripe along the inner edge. Mature larvae are hump-backed and have yellow heads. The body is light yellow or cream with a black line down the middle of the back.

Distribution

This beetle is found in scattered areas in eastern Canada and the eastern half of the U.S. and in most areas of Oklahoma.

Life Cycle

Adults overwinter in bark crevices, sheltered places around the base of the tree, or in the topsoil. They become active in late March or early April and lay eggs in April. Larvae feed during late April and May. First-generation adults are active from mid June to late July and give rise to a second generation of larvae, which feed during July and August. Second-generation adults are active in September and October and then seek overwintering quarters.

Hosts

Elm calligrapha is found almost entirely on American elm, though a species of dogwood has been found hosting these beetles on a few occasions.

Damage

Adults chew oval or circular holes in the leaves. Larvae devour entire leaves except the veins. Either or both can be present in sufficient numbers to defoliate American elms in Oklahoma. Damage seems to be more common in the central half of the state and reported less often in the far eastern and western counties.

Inspection and Control

Look for the beetles when damaged leaves are noted on American elms. Damaging numbers are present only occasionally and in scattered areas. Heavy infestations can be treated with a variety of insecticides. For specific recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

ELM LEAF BEETLE

Pyrrhalta luteola **(Muller)**

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Description

The adult beetle is about $^{1}/_{4}$ inch long with a yellow body. The wing covers are dark yellow to olive with a broad black stripe down each side. Overwintering adults (seen in late fall and early spring) tend to be darker and duller in color than summer adults. The yellow-orange eggs are somewhat pointed at the outer end, and laid in clusters on the undersides of leaves. Newly hatched larvae are black, but mature larvae are pale yellow with two black stripes running down their sides and measure about $^{1}/_{2}$ inch long. Pupae are yellow and are usually found near the base of the tree.

Distribution

This insect was accidentally introduced into the eastern U.S. early in the nineteenth century. It now occurs throughout the country wherever elms are important shade trees. It is common in all parts of Oklahoma.

Life Cycle

Elm leaf beetles overwinter as adults in houses, attics, sheds, and in protected places outside. They emerge in April and fly back to elm trees. After feeding and mating, egg laying begins in late April or early May. Each female can lay 600 to 800 eggs during her life. Eggs hatch in about one week and larvae begin feeding on the leaves. Fully developed larvae crawl down to the base of the tree where they pupate in bark crevices, sidewalk cracks, lawns, or under stones or other litter on the ground. First-generation pupae are usually found in early or mid June. There is a second generation in late June and July and a third generation in August and September. In late summer and early fall, adults begin to seek overwintering quarters and often become a nuisance in and around homes.

Hosts

All species of elms and the related Japanese zelkova are attacked, but some species are more suitable as food than others. Siberian elm (*Ulmus pumila*) seems to be the most favored host in most areas of Oklahoma and English elm (*U. procera*) and "urban elm" are also good food sources. American elm (*U. americana*), lacebark or Chinese elm (*U. parvifolia*), and some other species are less favored but may be attacked in the absence of other hosts.

Damage

Elm leaf beetles are exclusively foliage feeders. Adult feeding causes small, roughly circular holes in the expanding leaves. Larval feeding results in skeletonization of the foliage with the upper surface of leaves and the veins left intact. This is the most severe form of damage caused by this insect. Badly affected leaves soon turn brown and drop from the trees prematurely. Trees which lose their leaves as a result of elm leaf beetle damage commonly put out a new flush of growth which will be consumed by later generations of the insect if the trees are not treated. When infestations are severe and trees are without leaves for several consecutive years, limbs or the entire tree may die.

Inspection and Control

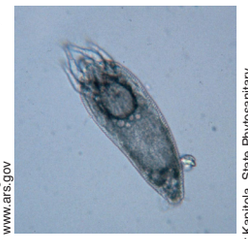
Insecticide treatments will reduce infestations and damage to leaves and help stop indoor migrations. Trees should be treated with a high pressure, high volume sprayer to ensure thorough coverage. For best results with sprays, treat when most of the eggs have hatched and larvae are just beginning to feed (usually this will be late May or early June). Other treatments may be needed to control later generations of beetles throughout the summer as they will migrate from nearby trees.

Another approach to controlling elm leaf beetles involves the use of soil-applied granules or soil and/or trunk injections of systemic insecticides. These materials are picked up by the roots and translocated to the leaves. To control the first generation of beetles, the material should be applied in late February or March. This allows sufficient time for the chemical to be picked up by the roots and moved to the leaves. A second application in May will help control later generations of beetles. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

ERIOPHYID MITES

Superfamily Eriophyoidea



USDA Agricultural Research Service, www.ars.gov

Petr Kapitola, State Phytosanitary Administration, www.insectimages.org

Petr Kapitola, State Phytosanitary Administration, www.insectimages.org

Description

There are three families of mites that are commonly referred to as eriophyids. All have a single distinguishing characteristic that separates them from other mites: they have only two pairs of legs, even as adults. All other species of mites have four pairs of legs as adults and three pairs when newly hatched. They are among the most specialized of plant-inhabiting mites. Many species are commonly known as gall, rust, bud, or blister mites, depending on host reaction to their feeding.

The typical eriophyid is spindle or wedge-shaped, soft and wormlike, with the legs near the front of the body just behind the mouthparts. The remainder of the body is referred to as the abdomen and is often encircled by rings, giving it a segmented appearance. Microtubercles are often found along the abdominal rings.

These mites are extremely small (0.10 to 0.33 mm long) and impossible to see with the naked eye. With the aid of a 10x to 20x hand lens, it is usually possible to detect the mites on plant tissue.

Distribution

More than 1,250 species of eriophyid mites are known to occur in the U.S. Many occur wherever their host plants grow. Geographic distribution is poorly known for many species due to a lack of specialists and regional surveys. Most of the specimens collected in Oklahoma have not yet been specifically identified. A few important species known to occur here are the wheat curl mite (*Aceria*=(*Eriophyes*) *tulipae* Keifer), the bermudagrass mite (*A. cynodoniensis* Sayed), the zoysiagrass mite (*A. zoysiae* Baker, Koni, and O'Neill) and the pecan leafroll mite (*A. caryae* Keifer).

Life Cycle

The typical four stages of the life cycle are the egg, protonymph, deutonymph, and adult. A resting stage occurs before the second nymphal stage and before the adult stage. Eriophyids overwinter as eggs or adults, depending on the species.

In addition to the direct life cycle, some species develop through a complicated cycle (known as deuterogyny) that includes alternation of generations. The more complex life history is predominant in species that infest deciduous plants and apparently is an adaptation to seasonal changes in the condition of their hosts. There are two forms, one consisting only of overwintering females (called deutogynes) and the other consisting of normal females (protogynes) and males. Protogynes and deutogynes of the same species may be conspicuously different morphologically and may cause different types of galls.

Hosts

Eriophyids inhabit all known groups of plants and are extremely host specific. Many appear to be confined to one species of plant and most others are found only on a few closely related plant species. Because of this specificity, knowledge of the host and type of damage is extremely valuable in eriophyid identification.

Damage

Many eriophyids live in protected areas afforded by the host, such as under bud scales, inside needle sheaths, or among leaf hairs. Other species "create" their own suitable microenvironments by inducing the plant to produce various kinds of structures (galls), inside which the mites are protected from predators and have sufficient food and moisture. Abnormal plant growth is a response to the growth regulator injected with mite saliva during feeding. These growth regulators are effective only on embryonic host tissue; once a leaf is expanded and hardens off, galls or blisters cannot be formed.

Various symptoms of injuries caused by eriophyid mites may appear on the following parts of the plant: (1) buds, shoots, stems, and twigs - bud blisters, bud and twig rosette and stunting, discolored buds and bud scales, enlarged buds, premature bud drop, galls, shoot and twig clustering or brooming, and shoot, stem, and twig distortion; (2) flowers - abnormal shape, blisters, discoloration, failing to open, galls, and premature drop; (3) fruits -abnormal shape, blisters, damaged seeds, discoloration, galls, hardening, and pre-

mature drop; and (4) leaves - abnormal shape or distortion, blisters, discoloration, erineum, galls, mosaic virus disease, stunting, webbing or coating, russeting, bronzing, and withering.

Several species are capable of transmitting viral diseases to the host. One of the most noteworthy is the wheat curl mite, which is known to transmit the virus that causes wheat streak mosaic. Another species is being investigated as a vector of rose rosette disease. The disease causes distortion of terminal growth and buds and is being examined as a possible biological control for multiflora rose.

Inspection and Control

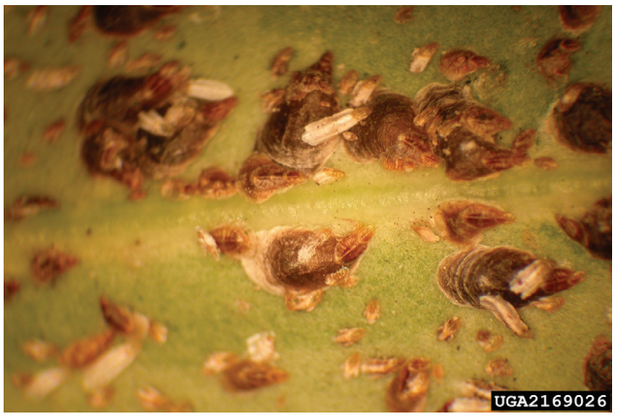
Gall-forming species are usually left uncontrolled because their damage is aesthetic rather than economic. The damage is usually done long before it is noticed, and spraying is unwarranted because the galls do not permanently affect the host. Chemical control of species such as the wheat curl mite is not economically feasible but cultural controls (e.g., destroying volunteer wheat) may be useful.

Chemical controls may be necessary on species such as the bermudagrass or zoysiagrass mite and those attacking fruit and nut crops. Spray treatments must be very thorough so that all plant surfaces are covered with chemical during the application. Dormant oils have been used with success against some species. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

EUONYMUS SCALE

Unaspis euonymi **(Comstock)**



Lisa Ames, University of Georgia, www.insectimages.org

Description

Adult female scales are brown or dark gray, pear shaped, and slightly longer than $^{1}/_{16}$ inch. The first exuvium (molted skin) is at the narrow end. The adult male is a small, gnat-like insect. As usual with armored scales, the actual body of the female is yellowish orange and saclike with well-developed mouthparts but lacking legs, eyes, and antennae. Immature males are elongate, white, and strongly tricarinate (shows three raised lines).

Distribution

Euonymus scale was introduced from Japan or China. It can now be found over most of the U.S. and southern Canada. It should be found in any area in Oklahoma where euonymus is grown.

Life Cycle

Euonymus scale overwinters as fully grown, fertilized females. Eggs are deposited under the female scale covering in early spring. Egg laying and hatching occur over an extended period from mid April to mid June in Oklahoma. The newly hatched nymphs (crawlers) move to other parts of the host plant or are blown by wind to other susceptible hosts. Soon afterward, they settle and begin to feed. There are three more generations during July, August, and September. This species can have as many as 12 generations per year under greenhouse conditions.

Hosts

This scale attacks many species and varieties of euonymus and is a serious pest of susceptible varieties. It is occasionally found on several other plants, including camellia, celastrus, ivy, hibiscus, holly, and ligustrum.

Damage

Euonymus scale is often overlooked until it has caused serious damage. One symptom of a light attack is the occurrence of yellow or white spots on the leaves. Female scales are usually found along the stems and leaf veins of the host plant. At times, however, the whole plant is whitened by the covers of the smaller male scales. When this occurs, leaves may drop and sometimes a normally green plant becomes bare by midsummer. Heavily infested plants are usually killed if not treated. Plants growing close to buildings seem to be damaged more than those growing where there is free air circulation.

Inspection and Control

Euonymus kiautschovica appears to resist heavy attacks of euonymus scale even when grown among heavily infested susceptible plants. It could be planted in place of the common, and very susceptible, *E. japonica*. Other species that appear to be resistant are *E. alatus*, *E. sachalinensis*, and *E. sanguinea*.

Insecticide applications should be applied when the susceptible life stage, crawlers, are at peak activity. Heavy infestations of euonymus scale can be controlled by applying "superior" type spray oil at summer rates (label may indicate growing season rate) during late February or early March. Use a 98 percent spray oil that is superior grade 60 or 70 and/or one specifying unsulfonated residue of 91 or 92. Other insecticides can be applied with the oil treatment. The first insecticide treatment should be applied by mid to late April when crawlers are usually abundant. For heavy infestations, the oil treatment should be followed by a summer spray schedule with a properly labeled insecticide applied from late May to mid June and a second application about 14 days later. Follow-up treatments in mid July and in mid August will help control later generations. Dormant horticultural oil applied in February or March may provide adequate control of euonymus scale. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

FLATID PLANTHOPPER

Metcalfa pruinosa **(Say)**

linda_nc, Dave's Garden, http://davesgarden.com/

Description

Adults are whitish gray and about $^{1}/_{4}$ inch long. They are somewhat wedge-shaped, becoming narrower toward the rear end, and are covered with a white, powdery substance. Nymphs are whitish, somewhat flattened, and will jump when disturbed. They produce masses of white, woolly material at their feeding sites.

A related species, *Anormenis septentrionalis* (Spinola), is similar in shape but is pale green. Nymphs are similar to those of *M. pruinosa*.

Distribution

This planthopper is abundant throughout the U.S. and southern Canada but is probably more common in the southern states. It can be found in all areas of Oklahoma.

Life Cycle

The insect overwinters as an egg inside the twigs of its host plant. Eggs are scattered singly, each inserted through a slit in the bark cut by the ovipositor. Small nymphs hatch and suck sap from the stems, producing the white, woolly material, probably for protection. Nymphs are most common in June and July. Most have matured by mid July and adults are present into early October. There is one generation per year.

Hosts

These planthoppers are found on a wide variety of trees, shrubs, vines, and ornamental plants, and occasionally on vegetables and weeds.

Damage

Light infestations do very little damage to most plants. Occasionally, one or both species will be present on certain plants in large enough numbers to cause wilting or dieback. Oviposition punctures may kill small twigs. Also, the white filaments of wax material that are made by nymphs affect the ornamental value of a plant.

Inspection and Control

Look for masses of white material on the stems of plants and check to be sure nymphs are still present. Control is not needed unless obvious damage is occurring and nymphs are still present. If chemical controls are needed, they can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

GIANT BARK APHID

Longistigma caryae **(Harris)**

Herbert A. "Joe" Pase III, Texas Forest Service, www.insectimages.org

Description

This is the largest aphid in North America with adults averaging about $^{1}/_{4}$ inch long. They also have long legs, which make them appear even larger. Males and some females are winged, but egg-laying females are wingless. They are brown with black markings (giving them somewhat of a mottled appearance) and have short, black cornicles. When alive, they are often partially covered with a bluish white, waxy secretion.

Distribution

These aphids occur from New England south to Florida, and west to Minnesota and Oklahoma. It has been found over the eastern half of Oklahoma as far west as Noble, Oklahoma, and Grady Counties.

Life Cycle

Giant bark aphids overwinter as eggs. Newly hatched nymphs become adults in late April in Oklahoma. An adult female gives birth to live young and a colony is formed on the underside of the branches of host trees. Several generations occur during summer and fall. Activity continues into mid November in some years. In latefall, females lay eggs in bark crevices or on the smooth bark of smaller limbs. Eggs are yellow when laid, but later turn black.

Hosts

This aphid feeds on a wide variety of deciduous trees. Oklahoma reports of host plants that include American elm, pin oak, live oak, post oak, blackjack oak, pecan, hickory, sycamore, and golden rain tree. Other trees that might be infested include maple, basswood, birch, beech, walnut, chestnut, and willow.

Damage

This aphid sucks sap through the bark of small branches. Serious damage can occur, though it is seldom reported in Oklahoma. Heavy infestations can kill infested twigs or branches. This aphid produces large amounts of honeydew, which may fall on sidewalks, parked cars, etc. under infested trees.

Inspection and Control

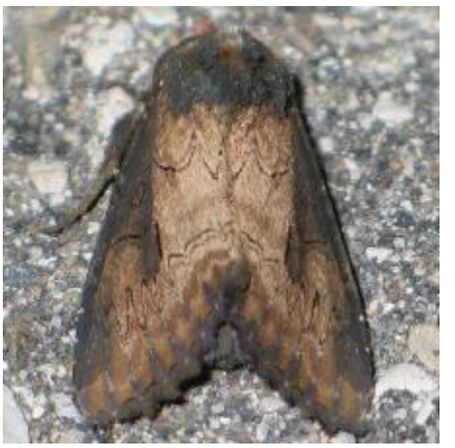
Check the underside of tree limbs beginning in May as heavy infestations are most likely in May and June. The mottled appearance of the aphids matches the color of bark so close inspection is often needed to detect them, especially if they are present in small numbers.

Good control of giant bark aphids requires thorough pesticide coverage of the tree. The spray equipment used needs to be able to reach the highest areas of the tree. Direct the spray application to twigs, stems, and branches where the aphids congregate. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

IRIS BORER

Macronoctua onusta Grote

Steve Mayer, Purdue University Extension, Marion County



Robin McLeod, Mississippi State University

Description

Adults are brown to dark brown moths with black markings and a wingspan of about 2 inches. Young larvae are white with brown heads. Mature larvae show a definite pink tinge and are about $1\ ^1/_2$ inches long.

Distribution

These borers are distributed from Nova Scotia to South Carolina and west to Minnesota, Oklahoma, and Mississippi. In Oklahoma, it is most often reported from the eastern third of the state.

Life Cycle

Adults emerge in late August or September to lay eggs on iris leaves and other plant materials. Eggs overwinter and hatch in late April or May, usually when new leaves are about 6 inches tall. Larvae crawl up the iris leaves and make pinpoint holes where they enter. They then mine the interior of the leaves, causing water-soaked spots to develop. By early July, they work down into the rhizome (root) where they continue feeding and doing damage until they are mature. In August, the mature larvae move to the soil where they pupate. There is one generation per year.

Hosts

Iris is the only known host of this insect.

Damage

As larvae mine in the leaves, they cause water-soaked spots and a ragged appearance, but this damage is not very serious. Most of the damage is done by the large larvae feeding in the rhizomes. Damaged rhizomes are usually attacked by bacterial soft rot and the combination of larvae and soft rot can rather quickly destroy a bed of iris if not controlled.

Inspection and Control

Fall sanitation destroys quite a few borer eggs. After the first hard frost, clean up and destroy old iris leaves, stems, and nearby debris. If the iris planting is small, the young larvae may be crushed (in the spring) by pressing the water-soaked, damaged areas of the leaves between the thumb and forefinger.

If there is a heavy infestation, dig up and destroy the affected rhizomes. If the infestation is light, remove the rhizome from the soil and destroy the borers with a piece of wire forced into the cavities made by the borer. It is also advisable to sift the soil by hand for motile (freely moving) larvae and pupae. Replant the healthy rhizomes once the borers are eliminated. Every few years, iris beds should be thinned after they have flowered to keep them vigorous and to check for borers.

Insecticide treatments have shown some success in control of iris borers. The treatment involves trying to kill young larvae by beginning treatment when plants are about 3 inches tall and retreating at five- to seven-day intervals for four or five total applications. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

JAPANESE BEETLE

Popillia japonica **(Neuman)**

David Cappaert, Michigan State University, www.insectimages.org

John A. Weidhass, Virginia Polytechnic Institute and State University, www.insectimages.org

Description

Adult Japanese beetles (*Popillia japonica*) are robust and measure about $^{3}/_{8}$ inch long and $^{1}/_{4}$ inch wide. The body is metallic green with bronze wing covers. A row of five white tufts of hair are found along each side of the body next to the outer edges of the wing covers. The larva is a typical white grub with a brown head and three pairs of short legs and measures about 1 inch when fully grown.

Distribution

The Japanese beetle is native to Asia, and the first U.S. report is from Riverton, New Jersey in 1916. The beetle is common in all states east of the Mississippi River, except Florida and Mississippi, and has been found as far west as Colorado. The distribution of Japanese beetle in Oklahoma is currently limited to Cherokee, Kay, Oklahoma, and Tulsa counties.

Life Cycle

Japanese beetles have one-year life cycles. Overwintering larvae migrate upward in March and April and resume feeding on plant roots until May. They then move deeper in the soil, form an earthen cell, and pupate. Adults emerge late June through July and are active during the day, commonly found feeding and mating in large numbers on susceptible plants. Females repeatedly enter the soil and can lay 40 to 60 eggs during their lifetime. Eggs hatch one to two weeks later and newly emerged larvae begin feeding on plant roots. Larvae continue feeding into the fall, reach the third-instar stage of development, then dig deeper into the soil to overwinter.

Hosts

Larvae feed on roots of turfgrasses as well as those of other plants. Adults feed on more than 300 different plant species and are considered major pests of ornamental, fruit, and vegetable plants.

Damage

Adult beetles will feed voraciously on the foliage, fruits, and flowers of their host plants, where they can be found in large numbers. Damage to foliage appears as skeletonized tissue with all but the leaf veins entirely consumed. Adult feeding activity on fruits and flowers typically is characterized by holes in affected tissue; large numbers of beetles will often consume these plant tissues in their entirety. Healthy plants can survive even complete defoliation by the beetle, but young or weak host plants may not be able to withstand heavy attacks.

Inspection and Control

Adults are highly mobile and frequently hitch rides in airplanes and cars. Japanese beetle has the potential to be found anywhere in the U.S., including Hawaii and Puerto Rico, due to shipping grub-infested nursery stock, sod, and soil. As a result, the U.S. Domestic Japanese Beetle Harmonization Plan exists to prevent the spread of this pest to non-infested states via these avenues.

Japanese beetles are especially fond of linden, flowering crabapple, roses, and grapes, so it is best to avoid planting these highly susceptible host plants. Also avoid planting Japanese maple, Rose-of-Sharon, *Prunus* spp., and American elm as these are also favored by adult beetles. However, some varieties of certain host plants such as roses are less susceptible than others. Japanese beetle traps, which contain a sex pheromone and a floral lure to attract both males and females, have been commercially available for several years. However, these traps attract more beetles than they capture, leaving landscape plants vulnerable. Adult Japanese beetles can fly one mile or more, so beetles that are caught in traps are readily replaced in the landscape by flying individuals. Biological control of Japanese beetle is an active area of research, and several species of natural enemies have been released against this pest. However, establishment has been limited for parasitic flies and wasps released for Japanese beetle control. Efforts are now being directed toward biological control of these beetles with disease-causing microbes. There are many insecticides labeled for Japanese beetle control, and several are available to homeowners.

JUNIPER SCALE

Carulaspis visci **(Schrank)**

United States National Collection of Scale Insects Photographs Archive, USDA ARS, www.insectimages.org

Description

Like all armored scales, the visible portion is not the actual insect. Rather, it is a protective cover composed of the molted skins (exuviae) of the earlier stages. The actual body of the female is yellowish and sac-like and has well-developed mouthparts but lacks legs, eyes, and antennae. Immature males are elongate, white, and slightly tricarinate (shows traces of three raised lines). The adult male is a small, gnat-like insect. The adult female is white or whitish green, circular, and the first exuvium is central.

A closely related species, minute cypress scale, *Carulaspis minima* (Targioni), can also be found on junipers in Oklahoma. The two species can be separated only by microscopic characters. A third species, redwood scale, *Aonidia shastae* (Coleman), is also occasionally found. It resembles juniper scale but both male and female scales are elongate oval instead of circular.

Distribution

This is a common species occurring quite generally throughout the U.S. It should be found in all parts of Oklahoma where its host plants occur.

Life Cycle

This scale overwinters as partially grown or mature females on the host plant. They begin to lay eggs under the scale cover in early April in Oklahoma. Eggs hatch in about two weeks, and the yellowish crawlers usually seek a site to settle on the same host plant. However, crawlers are light enough to be blown by the wind to other hosts. After settling, the crawlers develop rapidly. There is probably only a single generation each year.

Hosts

Juniper scale is known to attack red cedar, various ornamental junipers, and a few other closely related evergreens.

Damage

One of the first indications of damage is the loss of normal, lustrous color of a healthy plant. The infested foliage fails to develop new growth and the tree or shrub looks discolored. The needles, particularly of Pfitzer juniper, turn yellow as a result of sap loss to the scales. As the infestation progresses, the foliage of individual branches will yellow and die. Entire plants are known to die as a result of scale infestation.

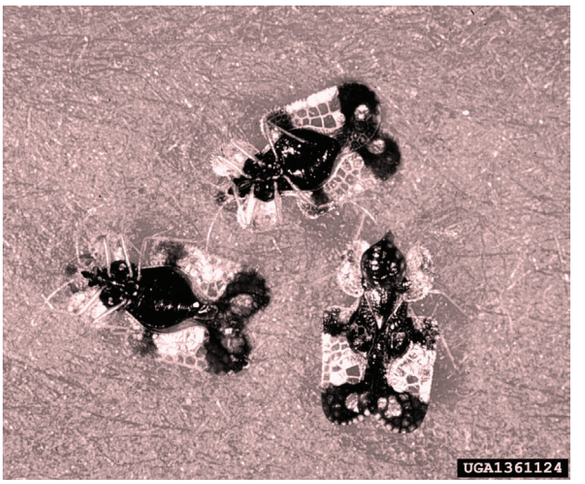
Inspection and Control

Early signs of an infestation should be checked closely as it will be very similar to spider mite damage. Treatment in the early spring before growth starts with a dormant horticultural oil plus an approved insecticide, or with a concentrated lime sulphur solution (one part lime sulphur + ten parts water), will help suppress scale problems. The early spring treatment should be followed with a treatment by mid-May and again during the middle part of June for best results. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

LACE BUGS

Corythucha **spp.**



USDA Forest Service Archive, USDA Forest Service, www.insectimages.org

Description

Adult lace bugs have beautifully sculptured wings that resemble an intricate, lacy network. There are also lacy extensions at each side on the front part of the body and an expanded, lacy hood that extends over the head. Some species are almost entirely white while others are marked with black or brown. They range in size from $^{1}/_{8}$ to $^{3}/_{16}$ inch. Nymphs do not have wings but usually have spines on the back.

Common Oklahoma species include the following: sycamore lace bug, *C. ciliata* (Say) - white with a small brown spot on each wing; oak lace bug, *C. arcuata* (Say) - with an ill-defined, dark crossbar near the end of the wings and other markings that are dark brown; elm lace bug, *C. ulmi* Osborn & Drake - without an apical crossbar on the wings and other markings pale brown; and hawthorn lace bug, *C. cydoniae* (Fitch) - with a larger-than-normal hood and extensive dark brown markings.

Distribution

Various species of *Corythucha* can be found over the entire U.S. and in all parts of Oklahoma where their host plants are present.

Life Cycle

Lace bugs overwinter as adults in bark crevices, branch crotches, or similar protected areas of their host plants. They emerge about the time leaves of the host develop in the spring. Small black eggs are attached to the underside of leaves with a sticky brown substance. Within a few days, the eggs hatch and nymphs begin feeding on the leaves. With their sucking mouthparts they pierce the leaf and withdraw fluids and cell contents. A complete life cycle, from egg to adult, may be completed in approximately 30 days. Several generations occur each year in Oklahoma.

Hosts

Most lace bugs have very specific host preferences. The sycamore lace bug feeds on sycamore, the elm lace bug on American elm, the oak lace bug on oaks, and the hawthorn lace bug on pyracantha, hawthorn, and quince. Other Oklahoma species of *Corythucha* feed on buckeye, black cherry, black walnut, and hickory, and alder and birch. One species feeds on sunflowers and related plants.

Damage

Feeding causes yellow or white (chlorotic) spots to appear on the upper surface of the leaf. These are similar to leafhopper and spider mite damage but usually more extensive. Positive identification of lace bug damage is confirmed by the presence of shiny, black droplets of excrement on the underside of damaged leaves. Frequently, the cast skins of the nymphs remain attached to the underside of the leaves.

Inspection and Control

Natural enemies, including lacewing larvae, assassin bugs, spiders, and predaceous mites, sometimes keep lace bug infestations under control. Heavy infestations may, however, need to be treated. Lace bugs are not particularly difficult to control with most readily available ornamental insecticides, but thorough coverage is critical. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

LOCUST BORER

Megacyllene robiniae **(Forster)**

Kevin D. Arvin, www.insectimages.org

Description

Adult beetles are about $^{3}/_{4}$ inch long. Their jet black background color is marked with bright yellow bands extending across the thorax and wing covers. The third band on the wings is W-shaped. Legs and antennae are moderately long and yellow. Adults closely resemble the painted hickory borer but are active in the fall instead of the spring. Full grown larvae are legless, white, robust, and about 1 inch long.

Distribution

The original range probably coincided with that of its host tree, the black locust: along the Allegheny Mountains from Pennsylvania to Georgia and in the Ozark Mountain Region. The widespread use of black locust as a shade tree and in reforestation and land-reclamation plantings have allowed the borer to disperse over most of the U.S. It may now be found from eastern Canada to the Gulf States and westward to Washington, Colorado, and Arizona, anywhere that black locust grows.

Life Cycle

Adults are active in late August through October. They are commonly seen feeding on the pollen of goldenrod blossoms during the morning hours. Later in the day and sometimes well after sunset, they are seen on the trunks of black locust trees searching for egg-laying sites. Eggs are usually deposited in rough bark crevices and around wounds on the trunks of living trees. Newly hatched larvae bore into the inner bark and construct small hibernation cells in which they spend the winter. Activity is resumed in the spring when the leaf buds begin to swell. At this time, oozing sap may be seen around larval entry holes in the trunk. Larvae soon bore into the wood where they continue to feed until mature, around mid July. As the larva grows, it enlarges its tunnel to the exterior, through which it pushes its granular frass to the outside, eventually pupating and emerging as an adult beetle. There is one generation per year.

Hosts

This species is restricted to black locust (*Robinia pseudoacacia* L.). It is not known to attack other species of *Robinia*, nor does it damage honeylocust.

Damage

Larvae tunnel into and through the trunk and limbs of infested trees, physically weakening them and making them susceptible to wind and ice breakage. Repeated attacks often result in the production of little more than sprout growth.

Many of the trees used in reforestation and land reclamation have been planted in soils badly eroded by wind or water and severely depleted of soil nutrients by poor farming practices. Trees growing on such poor sites are especially susceptible to borer attack and often suffer serious damage during periods of prolonged drought.

The degree of damage varies in different locations according to tree vigor and the influence of environmental factors such as light, temperature, drought, fire, grazing, and pruning. As the vigor of the tree increases, borer damage decreases. Within locust stands older than 10 years, the thrifty, dominant trees are able to overcome attack, but the slowly growing, overtopped trees are badly damaged or killed.

Inspection and Control

The most obvious signs of severe borer attack in a stand of black locust are the numerous dead and broken limbs. Closer inspection reveals knotty swellings on the trunks. The activity of young larvae in the inner bark is marked by the development of wet spots on the bark in early spring when buds swell. In late spring or early summer, developing larvae work into the sapwood and push white wood dust from their tunnels. When the larvae bore more deeply and reach the heartwood in late summer, the wood dust becomes yellow.

Interplanting black locust with other tree species helps discourage the buildup of borers,

Notes

as does removing heavily infested brood trees. General maintenance for vigor also discourages attacks. Fertilizing and watering during dry periods can help prevent damage to shade trees. If attacks are recent enough, larvae can be killed by piercing their bodies with a flexible wire inserted at the attack point.

When practical, insecticides can also be used. Timing of spray applications should coincide with adult activity. A suggested three-treatment spray schedule to kill adults before eggs are laid is: mid August, late August, and mid September. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

MIMOSA WEBWORM

Homadaula anisocentra **Meyrick**

Michael Masiuk, Penn State University

Eric Rebek, Oklahoma State University

Bob Patterson, Moth Photographer's Group, http://mothphotographersgroup.msstate.edu/

Description

Adults are small, steel-gray moths with small black dots on their front wings. Eggs are oval, white, and very small. Small larvae are dark greenish brown, but mature larvae are grayish brown with five light-colored stripes running the length of the body. They reach about $^{3}/_{5}$ inch in length. Pupae are light brown and enclosed in tough, white, silken cocoons.

Distribution

The mimosa webworm, a native of China, was first found in the eastern U.S. in 1940. It has now spread through most of the eastern and mid-western states and has been found in California. It has been found in all eastern counties of Oklahoma and west as far as Garfield, Caddo, and Jefferson Counties.

Life Cycle

Adults emerge in May, and live for several weeks. Females lay their eggs on the foliage of host plants, which hatch in late May and early June. The small larvae web the leaflets together and feed within this protected area. Some of these larvae reach maturity by the first of July. They spin cocoons and pupate in crevices in the bark of infested trees or any tree nearby, in cracks and crevices around the house, under trash on the ground, in old larval webbing in the trees, or in any other protected place near the host plant. First-generation moths emerge during July, mate, and lay eggs. Larvae of the second generation are often so numerous they destroy most of the foliage on the host tree. A third generation occurs in September and October and third generation pupae overwinter. Due to overlapping generations there are usually some larvae present on infested trees from June through most of October.

Hosts

This webworm attacks mimosa and honeylocust trees, including the thornless varieties of honeylocust. Observations in Indiana indicate that the locust cultivar, Sunburst, is highly susceptible to attack while Moraine, Shademaster, and Imperial are less susceptible.

Damage

Larvae skeletonize the leaves of host trees. By the second generation, they are often so numerous they completely defoliate a tree. Damage to the foliage may be difficult to assess due to the large masses of unsightly webbing covering the tree.

Inspection and Control

It is not advisable to make large plantings of mimosa or honeylocust trees unless you make plans for chemical control. Spray should be applied as soon as young larvae are detected in trees (late May or early June). The webbing must be penetrated with adequate spray to obtain good control. Any of several common insecticides can be used. Also, *Bacillus thuringiensis* var. *kurstaki*, a bacterial insecticide, is labeled for webworm control. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

OBSCURE SCALE

Melanaspis obscura **(Comstock)**

United States National Collection of Scale Insects Photographs Archive, USDA ARS, www.insectimages.org

Description

The adult female scale covering is dark gray, circular, and flattened with the first exuvium (molted skin) sub-central and blackish. The exuvium is a small bump or nipple-like structure located more or less in the center of the scale. The male scale is similar but smaller and more elongate. They closely resemble the bark of the trees on which they occur. This scale is unusual in having a whitish, ventral, protective covering as well as the usual dorsal covering.

Distribution

Obscure scale is widely distributed in the U.S. but more prevalent in the south. It should be found over most of Oklahoma where its host trees occur.

Life Cycle

The biology of this insect has not been studied under Oklahoma climatic conditions. The following is what is considered to be the most likely life cycle in Oklahoma. The overwintering stage is immature male and female scales. They begin to develop in the spring and mature during July or August, the time varyies depending on host. Most eggs are laid in July, but females will continue laying eggs to some extent into September. The newly hatched crawlers may be common in July, August, or September (depending on host, date of scale maturity, etc.). They settle and feed until the onset of cold weather. There is one generation per year.

Hosts

The most common hosts in Oklahoma are pin oak, burr oak, and pecan. This scale is also known to attack other oaks, hickories, beech, Persian walnut, willow, maple, grape, dogwood, wild myrtle, chinquapin, and hackberry.

Damage

This scale attacks the trunks and larger branches of both young and old trees. Dieback of branches, limbs, and sometimes of entire trees occurs where these infestations are not controlled. These scale insects suck sap from the phloem cells, depriving the tree of food manufactured in the leaves. This species is a pest of ornamental and orchard trees, but is not a pest in forests.

Inspection and Control

Obscure scale infestations often go unnoticed because they are small and closely resemble the bark on which they occur. They can be found by brushing your hand over the lower surface of the lower limbs of host trees. This removes the upper scale covering but leaves the lower covering in place. These small, white spots are quite noticeable against the bark.

Several factors make it difficult to effectively control obscure scale. The insects tend to settle close together, resultingin layers of scales as they grow and enlarge. Egg laying occurs over a relatively long period, which results in an extended period of crawler activity. Crawlers often settle beneath old clusters of scales where eggs were laid and consequently are never exposed to insecticides. Also, as with all armored scales, the waxy cover of the live insect provides protection.

Treatment with dormant or summer horticultural oils may help control this pest. Summer oils can be mixed with another approved insecticide. Several treatments of insecticide at seven- to ten-day intervals may be needed to clean up a heavy scale infestation. For specific recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

PAINTED HICKORY BORER

Megacyllene caryae **(Gahan)**

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

Description

The adult beetle has a jet black background marked with bright yellow bands extending across the thorax and wing covers. The third band on the wing covers is W-shaped. Legs and antennae are moderately long and yellow. They are about $^{3}/_{4}$ inch long. Adults closely resemble the locust borer but are active in spring instead of fall. Larvae are robust, creamy white grubs about 1 inch long at maturity.

Distribution

This species is widely distributed in the eastern U.S.

Life Cycle

Adults emerge in early spring and deposit their eggs beneath bark scales on logs that were cut the previous winter. The larvae feed for several weeks under the bark and then bore into the sapwood and later the heartwood. Pupation occurs in fall at the end of the larval mine behind a wad of fibrous frass. Winter is spent in the pupal stage and there is one generation per year.

Hosts

Freshly cut hickory logs are preferred for breeding, but dead trees of several other hardwoods such as black locust, honeylocust, oak, hackberry, mulberry, walnut, butternut, and ash are also attacked occasionally.

Damage

Hickory wood cut during winter may be completely riddled by midsummer. This species will occasionally attack diseased or otherwise weakened living trees. Larval boring causes a weakening of the trunk or branches and can lead to breakage during wind and ice storms.

Inspection and Control

Since this borer usually restricts its attacks to diseased or weakened trees, the best control method is to do everything possible to maintain trees in a high state of vigor. This includes proper pruning, watering, and fertilization. Trees that are heavily infested should be cut down and burned.

To help avoid damage by the painted hickory borer, cut timber or firewood in July or August so that it can dry before adults emerge the following spring. It is possible, however, that other borers may be active during the summer and fall and may infest the cut wood.

Control with insecticides is seldom practical or necessary.

Appreciation is expressed to Mark Hackler who, as a student in the Horticultural Insects Course in 1991, developed much of the material included here.

Notes

PERIODICAL CICADAS

Magicicada **spp.**

Pennsylvania Department of Conservation and Natural Resources - Forestry Archive; www.insectimages.org

Description

The periodical (or 17-year) cicadas are about 1 $^{1}/_{2}$ inches long. They have mostly black bodies, red eyes, and orange-tinted wings. There are three species in Oklahoma, separated by minor differences in colors and markings. There is also at least one species of 13-year cicada in the state and is very similar to the 17-year species.

Distribution

The various species of periodical cicadas are found only in the eastern half of the U.S. In Oklahoma they have been found as far west as Woodward, Canadian, and Comanche Counties.

Life Cycle

Periodical cicadas have long life cycles. Adults that emerged in 1998 had spent 17 years in the soil as nymphs feeding on tree roots. Their parents were active in 1981 and their offspring will not emerge until 2015. Sometime during mid to late May, nymphs will emerge at night from the soil and crawl up on a tree trunk or other nearby vertical surface. The nymphal skin (exuvium) splits down the back and the adult emerges. The empty, brownish shells will be left clinging to the tree trunk. All cicadas in a given area will normally emerge within one to four nights. Adults live for three to five weeks. After mating, females lay eggs (oviposit) in slits in the bark of small twigs. When the eggs hatch, the tiny nymphs drop to the ground, burrow into the soil, and begin another 17 years of feeding.

Although a given cicada population emerges only once every 13 or 17 years, the thirteenth or seventeenth year differs from place to place in the eastern U.S. This is because sub-populations of the original ancestral population somehow became displaced over time. All populations that emerge in the same year are members of a brood and may include one to several species; a brood is simply a year class. Broods are numbered sequentially according to their year of emergence. Any brood numbered XVII or less is a 17-year brood; a brood numbered from XVIII to XXX is a 13-year brood.

Most periodical cicadas in Oklahoma belong to brood IV. They were active in 1964, 1981, 1998 and will be back in 2015. We also have smaller emergences of broods II and VI and perhaps a few others. Brood XIX (a 13-year brood) is known to occur in McCurtain County. It was active in 1972, 1985, 1998 and will be back in 2011 and 2024.

Hosts

Both nymphs and adults feed on a wide variety of deciduous forest, shade, and fruit trees. Trees that show the most conspicuous symptoms of oviposition injury are oak, hickory, ash, maple, hawthorn, apple, black locust, birch, and dogwood.

Damage

Periodical cicadas usually do not cause a great deal of damage. Nymphs suck sap from small tree roots, which could kill some of the roots, but is probably not economically important. Adults suck sap from trees, but cause very little damage. The adult females cut slits in small twigs of trees in which to lay their eggs. This may kill the twig, but on large trees this causes no more damage than moderate pruning. Small trees, however, can be seriously injured when the cicadas are numerous. Periodical cicadas do not bite or sting and are harmless to people.

Inspection and Control

In fruit orchards where large cicada populations are expected, do not plant young trees for a year or two before the spring when cicadas will emerge. Also, delay pruning until the cicadas have disappeared. Injured branches can then be removed. To protect small trees, shrubs, and ornamentals, cover them with cheesecloth, mosquito netting, or tobacco shade cloth while cicadas are present. Protective netting is impractical for large nurseries, so insecticides may be necessary but are usually not effective when cicada populations are large.

PINE SAWFLIES
Family Diprionidae

John A. Weidhass, Virginia Polytechnic Institute and State University, www.insectimages.org

W.H. Bennett, USDA Forest Service, www.insectimages.org

Arnold T. Drooz, USDA Forest Service, www.insectimages.org

Description

Adults are wasp-like insects but do not have the narrow waist found in other Hymenoptera (bees, ants, and wasps). Females are reddish brown with dark brown, black, or bluish black markings. Males are mostly black. Adults measure about $^{1}/_{2}$ inch long. Larvae are caterpillar-like but have eight pairs of abdominal prolegs (caterpillars never have more than five pairs). There are three species in Oklahoma. See page 3 for images of larvae.

Redheaded pine sawfly, *Neodiprion lecontei* (Fitch). Larvae are yellowish white with six rows of black spots running down the body. The head is reddish orange.

Blackheaded pine sawfly, *Neodiprion excitans* Rohwer. Larvae are dull or olive green with a series of elongate spots running down each side of the body and a large spot on the top of the last segment. The head is black.

Loblolly pine sawfly, *Neodiprion taedae linearis* Ross. Larvae are dull or olive green with a black stripe running down each side of the body. The dark spot on the last segment is absent or has a lighter central area. The head is reddish brown to dark brown.

Distribution

The redheaded pine sawfly is found throughout the entire eastern U.S. and southeastern Canada, while the blackheaded pine and loblolly pine sawflies are found in the southeastern U.S. In Oklahoma, all three species are found only in the eastern edge of the state where pines are native.

Life Cycle

Pine sawflies overwinter as cocoons in the soil or duff, mostly under pine trees. Adults emerge in May or early June and mate. Females have a saw-like ovipositor, which they use to insert eggs into pine needles. Larvae feed on the needles for three to five weeks before leaving the trees to pupate. The loblolly pine sawfly has only one generation per year. The blackheaded pine sawfly probably has two generations per year and the redheaded pine sawfly appears to have three generations per year in Oklahoma.

Hosts

The redheaded pine sawfly prefers young trees of jack, red, shortleaf, loblolly, slash, longleaf, pitch, and Swiss Mountain pine. It will also feed on white pine, larch, deodar cedar, and Norway spruce. The blackheaded pine sawfly prefers older trees of loblolly and shortleaf pine and will also feed on slash, longleaf, pond, and sondregger pines. The loblolly pine sawfly feeds on loblolly, shortleaf, and longleaf pines, but it prefers feeding on older loblolly pines.

Damage

Sawflies damage pine trees by feeding on the needles. They are present to some extent in eastern Oklahoma every year but only occasionally become common enough to cause much damage to forest trees. They are more likely to damage one or a few trees in an ornamental situation. Complete defoliation can occur if numbers are heavy. Defoliation usually does not kill a tree but does cause considerable growth loss, reduces the attractiveness of ornamental trees, and weakens trees so they are more susceptible to other insects and diseases.

The redheaded pine sawfly is usually found in nurseries or young plantings while the blackheaded and loblolly sawflies are more likely to occur on older trees in forest situations. They may occasionally appear in large numbers over large areas. The largest outbreak in recent years was in 1971 when two generations of blackheaded pine sawfly defoliated pines over parts of seven counties in southeastern Oklahoma.

Notes

Inspection and Control

Sawfly larvae have a number of parasites, including parasitic wasps and tachinid flies that attack the larvae and emerge from the cocoons. They usually keep infestations low in Oklahoma and help cause the decline of occasionally heavy infestations.

Larvae are most likely to damage pines during May and June, but damage can also occur in July and August. Inspect trees for signs of needle damage and clusters of larvae during this period. Ornamental or nursery trees can be treated with a variety of insecticides. Insecticidal soap can be used to control sawflies, but *Bacillus thuringiensis* and other biorational products are not effective against sawflies. For specific recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

Information on sawflies commonly found on deciduous trees and shrubs can be found in the section titled Sawflies.

PINE SAWYERS - PINEWOOD NEMATODE

Monochamus **spp. -** *Bursaphelenchus xylophilus* **Nickle**

Joseph Berger, www.insectimages.org

Herbert A. "Joe" Pase III, Texas Forest Service, www.insectimages.org

Description

Adult pine sawyers are mottled gray and brown beetles ranging from $^{3}/_{4}$ to 1 $^{1}/_{4}$ inches long. They have long antennae, those of the male often being two to three times as long as the body. There is a sharp spine on each side of the thorax and the elytral sutures may be prolonged into sharp spines. Larvae are white, legless grubs with a brown head and may measure 2 inches long or more when mature. The name sawyer has been used to describe the larvae because they frequently make loud noises while feeding. The pinewood nematode is a microscopic, worm-like animal that is moved from one host tree to another by pine sawyer beetles.

Distribution

At least two species of pine sawyers, *Monochamus carolinensis* (Oliver) and *M. titillator* (Fab.), occur in Oklahoma. Both species occur widely in the southern and eastern U.S., and west into eastern Oklahoma and Texas. Other species of *Monochamus* occur in other areas of the U.S. and Canada. The **pinewood nematode** is found throughout much of the U.S. It has been positively identified in the eastern half of Oklahoma as far west as Payne and Grady Counties.

Life Cycle

Female beetles lay their eggs in small cavities they chew in the bark of recently dead, dying, or declining pine trees. Young larvae feed on the inner bark, cambium, and outer sapwood, forming shallow excavations (surface galleries). Older larvae bore into the heartwood and then back toward the surface, forming characteristic U-shaped tunnels. After the last stage of larval development, they form a pupal cell at the outer end of the tunnel near the surface of the wood. After pupation, the adult emerges by chewing a hole through the remaining wood and bark. In mid summer the beetles can complete a life cycle in 50 to 60 days, with an average of 2 $^{1}/_{2}$ generations per year in Missouri. Most adults emerge and are active from May through late September. However, pine sawyers do not enter diapause during the winter, so some larvae feed, pupate, and emerge as adults during warm periods all year. Newly emerged adults may visit healthy pines and feed on the bark and/or visit stressed or dying trees and feed, mate, and lay eggs.

Hosts

Both Oklahoma species of pine sawyers and the pinewood nematode appear to be found only in various species of pines.

Damage

Pine sawyers are primarily secondary invaders of pine trees that are declining as a result of stress. They prefer to attack freshly cut, recently dead, or dying trees. They can cause heavy losses in wind-thrown or fire-killed timber, in sawed logs left too long in the woods before milling, and in improperly handled pulpwood. This damage occurs primarily in southeastern Oklahoma where pines are native.

In ornamental situations, pine sawyers are primarily a problem because they spread the pinewood nematode. The nematodes cause pine wilt disease which has caused the decline and death of numerous pines in Oklahoma and many other states. The most serious problems occur in introduced species such as Scotch, Japanese red, Japanese black, and Austrian pines. It is believed native species of pines have defense mechanisms that provide protection from the nematodes and even if they become infected they are not as seriously affected.

Notes

Adult beetles that emerge from nematode-infected pines usually pick up some of the nematodes on their bodies (body hairs, legs, antennae, etc.) and many of the nematodes enter the beetles' respiratory openings (spiracles) and are thus carried in the tracheal system. Infested beetles that visit healthy trees to feed on bark can introduce nematodes into the feeding wounds, thus infecting the pine (introducing pine wilt disease). In this type of introduction, newly infected pines usually take one month or longer for the nematode population to feed and reproduce such that the tree expresses symptoms or shows signs of decline. Pine sawyers that are attracted to stressed or dying pines both feed and lay eggs in the bark, which provides two entry paths for nematodes that may be on or in the beetles' bodies. These pines have usually already been infested by other wood borers or bark beetles that have introduced fungal diseases (such as blue stain), and this provides an excellent early food source for newly introduced nematodes.

In Missouri, trees measuring 12 feet tall or more (12- to 15-year-old pines) have been observed to be infected with pinewood nematodes more commonly than smaller trees. Further, experience has shown the disease is far more common or more readily expressed in fall following a drier than normal summer. Most pine wilt disease problems are reported in landscape pines rather than plantation or nursery plantings. Likely, pines in large-scale plantings are subjected to less stress by extensive cultural/chemical maintenance and are normally younger pines than those in landscapes, possibly explaining observed differences in susceptibility to nematodes.

Inspection and Control

Positive identification of pine wilt disease can be made from large branch sections of recently killed pines suspected of being infected. Branch sections placed in plastic bags can be submitted to the Plant Disease and Insect Diagnostic Lab at OSU for pinewood nematode extraction and identification.

Unfortunately, there is no effective control for nematodes infecting pines and chemical control of the vectors (pine sawyers) is not very feasible because of the possibility for year-round emergence of adults during warm periods. Products labeled for "borer" control may provide some protection to landscape pines. Sprays would have to be applied preventatively to otherwise healthy pines from at least May through late September at approximately 30-day intervals. This might be of some help in killing the pine sawyers that visit healthy trees to feed on the bark. One would need to provide very thorough coverage and spray the bark to the point of runoff. See the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) for specific recommendations on controlling pine sawyers.

The only suggestion for pines showing rapid decline and for dead trees is to remove and destroy them by burning. This would kill beetle larvae and pupae that were in the infected trees before they could emerge and spread the nematodes to other pines.

Appreciation is expressed to Peter Loy who, as a student in the Horticultural Insects Course in 1991, developed much of this information.

REDBUD LEAFFOLDER

Fascista cercerisella **(Chambers)**

Crystal Hall, Deep Fork Tree Farm, Arcadia, Oklahoma

Oklahoma State University

Description

The adult is a small moth with dark brown wings that have 10 small white spots. The head and collar are also white. It is slightly longer than $^1/_4$ inch and has a wingspan of about $^1/_2$ inch. Eggs are oval, white, and very small. Small larvae are white, but during the latter part of the next to last instar dark alternating cross bands appear. The mature larva has alternating white and black bands and is about $^1/_2$ inch long. The dark brown pupa is held to a leaf by a sparse, loosely made web.

Distribution

This insect is widespread over the native range of redbud, Delaware and Maryland west to Illinois and Kansas and southward. It is found over most of Oklahoma as far west as Woods and Tillman Counties.

Life Cycle

The redbud leaffolder overwinters as a pupa attached to a fallen leaf. They may become detached from the leaf and come to rest in debris or on the surface of the soil. Adults emerge in late April and early May and lay eggs on leaves near the veins during May. The first generation continues through June. Second and third generation eggs are laid in a thin web in a folded leaf. The second generation occurs in late July and August and the third in September and early October. The third generation overlaps the second in the fall. During rainy weather a fungal disease sometimes attacks and kills the larvae.

Hosts

Redbud is the only known host.

Damage

In Oklahoma, this insect often causes severe damage to the foliage of redbuds. Characteristic injury is folding of the edge of the leaf onto the upper surface and fastened with strands of silk. Where the infestation is heavy there may be from two to four folded areas on a leaf. Leaves may also be tied to each other or to nearby surfaces. Within the folded areas, larvae feed on the upper surface layer of the leaf. This brings about drying of the leaf, which then turns brown. When damage is severe, affected leaves die and drop from trees.

Inspection and Control

Look for the characteristic folded leaves to find this insect. Damage is often confined to a tree or group of trees and the insect does not spread rapidly. The best control of this pest is usually achieved by spraying the foliage during late April or early May. A spreader/sticker is often helpful to hold the insecticide on the leaves. Another application should be made about one month after the first. Thorough coverage is a must and the application should cover the upper surface of the leaves. Spraying foliage to run off or heavy drip will normally insure adequate coverage. Chemical controls can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

REDHEADED ASH BORER - BANDED ASH BORER

Neoclytus acuminatus **(Fab.)** – *N. caprea* **(Say)**

Gyorgy Csoka, Hungary Forest Research Institute, www.insectimages.org

Description

The adult ranges from $^{1}/_{2}$ to $^{5}/_{8}$ inch long. The head and thorax are reddish; the body is light brown with the apical part of the elytra sometimes much darker. Elytra are marked with four transverse bands of fine yellow hairs and the middle and hind legs are long and reddish. Antennae are about half as long as the body. Larvae are cream-colored, fleshy, legless grubs.

A closely related species, *N. caprea* (Say), is known as the banded ash borer. Adults are dark brown to almost black and about $^{1}/_{2}$ inch long. There is a line of fine, white or yellowish hairs on the thorax and four bands of the same tissue and color across the elytra. The first two bands meet, almost forming circles.

Distribution

The redheaded ash borer occurs generally throughout the eastern U.S. and southeastern Canada. The banded ash borer occurs in eastern Canada and throughout much of the U.S. Both species are quite common in Oklahoma.

Life Cycle

The redheaded ash borer overwinters in the trunk of infested trees, probably in the pupal stage. Adults emerge early in the spring and deposit eggs beneath the bark of dead, unseasoned wood. Larvae feed first beneath the bark then tunnel into the sapwood and often reduce it to powder. There are probably two or three generations per year in Oklahoma.

Banded ash borer adults emerge in the early spring and deposit eggs in the crevices of bark. Ash logs cut during the winter are especially vulnerable to attack. Larvae feed for a while under the bark, then bore into the sapwood where they feed for the remainder of the summer. Pupation occurs in the fall, but the adult does not emerge until the following spring. There is usually one generation per year; however, if the infested material is sawed, stored, and dried out, the life cycle may require several years.

Hosts

Redheaded ash borers will attack nearly all dying and dead hardwoods but chiefly prefer ash, oak, hickory, persimmon, and hackberry. Unseasoned logs of ash, oak, and hickory with the bark intact are especially subject to heavy attack.

The banded ash borer have been found in ash, hickory, elm, and mesquite. In the eastern U.S., it commonly breeds in ash logs.

Damage

Both species breed primarily in dying or recently cut trees. Therefore, most of their damage is to wood cut for lumber or firewood. Both species often emerge from firewood brought into homes in the late winter or early spring. They cause no damage in homes but are a nuisance pest.

The redheaded ash borer will attack weakened or newly planted living trees and is a pest in young nursery stock in the north central states. Larvae work in the inner bark and summer wood, cutting off the flow of sap. In young trees, burrows may extend both horizontally and vertically through the trunk, making it subject to breakage during high winds or ice storms.

Inspection and Control

The appearance of small, round holes is a fairly common sign of borer attack. Limbs broken by high winds or ice should be investigated for borer infestation. Young nursery stock should be inspected for borer damage or infestation.

Since these borers usually restrict their attacks to weakened trees, the best method of control is to manage trees to an increased state of vigor. This includes proper pruning, cultivation, fertilizing, and watering practices. Ridding the area of breeding grounds is important in controlling populations of these insects. When individual limbs are attacked, they should be removed and destroyed. Limbs that have been removed during pruning should not remain on the ground for long after they are cut, since these insects breed in dying wood. Treatment with insecticides is not practical in most instances.

Appreciation is expressed to Mark Hackler who, as a student in the Horticultural Insects Course in 1991, developed much of the material included here.

SAN JOSE SCALE

Quadraspidiotus perniciosus **(Comstock)**

United States National Collection of Scale Insects Photographs Archive, USDA ARS, www.insectimages.org

Description

The female scale covering is gray, circular, and slightly convex with the exuvium (first molted skin) subcentral and pale or reddish yellow. The exuvium appears as a nipple-like structure surrounded by a circular depression. The male scale is similar in color to the female but is elongate-oval with the exuvium near one end.

Distribution

San Jose scale first appeared in the U.S. in 1870 on a shipment of ornamental plants from the Orient. It is now common throughout the U.S., Canada, and many other parts of the world. It can be found in all areas of Oklahoma.

Life Cycle

Partially grown male and female scales overwinter and mature in the spring. After mating, females produce living young, unlike most scale insects which lay eggs. Feeding and development proceed rapidly, resulting in four or five overlapping generations per year.

Hosts

This species is known to infest more than 60 species of fruit and ornamental trees and shrubs. Pyracantha and cotoneaster are especially susceptible to severe damage. In Oklahoma, it has been recorded from pecan, quince, poinsettia, rubber plant, ivy, Oregon grape, apple, trifoliate orange, plum, pyracantha, pear, and spirea. It occurs mostly on the bark but will infest fruit and occasionally leaves.

Damage

Damage is caused when nymphs and adult females pierce plant tissue with their long, thread-like mouthparts and suck out plant fluids. The greenish host tissue of shoots and leaves around the scale often turns red. On twigs and small branches the red color extends deeply into the inner bark to the xylem, but the color is not visible at the surface of thick bark.

A high population will cause twig and branch dieback, and the entire plant may die if some degree of control is not exercised. All parts of the host plant except roots may be attacked. However, the greatest populations occur on twigs and branches where the buildup of scale covers forms a gray crust.

Inspection and Control

Adult females produce a sex pheromone, which attracts the small, winged males. A synthetic pheromone is now commercially available and can be used to trap males. Treatment should be applied when new scales are being produced soon after males become active.

Treatment with dormant or summer oils may help control this pest. The summer oils can be mixed with another insecticide. Several treatments of insecticides at seven- to ten-day intervals may be needed to clean up a heavy scale infestation. For specific recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306. For information about oil sprays on fruit trees see OSU Current Report CR-6241.

Notes

SAWFLIES
Family Tenthredinidae

Herbert A. "Joe" Pase III, Texas Forest Service, www.insectimages.org

Patrick J. Barry, USDA Forest Service, www.insectimages.org

Description

Adults are wasp-like insects but do not have the narrow waist found in most Hymenoptera (bees, ants, and wasps). They are small to medium in size, rarely measuring more than $^{3}/_{4}$ inch long. Some are brown or black but many are brightly colored. Larvae are much like caterpillars but have seven or eight pairs of abdominal prolegs; caterpillars never have more than five pairs. Many species are striped or spotted and rather brightly colored. Mature larvae range from $^{1}/_{2}$ to $1\,^{1}/_{4}$ inches long.

Distribution

Various species of the common sawflies (Tenthredinidae) are found over the entire U.S. and in all parts of Oklahoma. They are more common in the eastern part of the state than in the west. Common Oklahoma species include the rose slug [*Endelomyia aethiops* (Fabricius)], blackheaded ash sawfly [*Tethida barda* (Say)], brownheaded ash sawfly [*Tomostethus multicinctus* (Rohwer)], pin oak sawfly [*Periclista sulfurana* Stannard], and black locust sawfly [*Nematus tibialis* Newman].

Life Cycle

Most species of common sawflies overwinter as larvae in cocoons in the soil, leaf litter, or in other protected locations. Adults emerge in spring, mate, and lay eggs. Eggs are usually inserted into plant tissues, often leaves, with the saw-like ovipositor of the female. Small larvae usually skeletonize leaves, but larger larvae tend to feed on the edges of leaves. Most species are exposed foliage feeders but some are gall makers or leafminers. Many species have only one generation per year, in the spring and early summer, but others have two or three generations per year.

Hosts

The common sawflies feed on a wide variety of deciduous trees and shrubs. A few species feed on conifers, blackberries, weeds, or grasses. Most species are quite host specific and a known host plant is helpful in identification of the larvae.

Damage

Damage is caused by larvae feeding on, or occasionally in, the leaves. Small larvae are often found in groups skeletonizing one or a few leaves. Larger larvae tend to disperse and are often found singly. Large larvae tend to feed on the edges of leaves; when feeding, they usually have the body (or the posterior part of it) coiled over the edge of the leaf. Defoliation can occur when large numbers of larvae concentrate on one or a few ornamental plants, but most species are not common enough to cause serious damage to forest trees in Oklahoma.

Inspection and Control

Damage from common Oklahoma sawflies most likely occurs in April, May, and June. During this period, look for leaf feeding and larvae that resemble caterpillars but have more than five pairs of abdominal prolegs. Most species can be controlled with the same insecticides recommended for control of caterpillars. Note that *Bacillus thuringiensis* and some other biorational products are not effective at controlling sawflies. For specific recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306. Additional information can be found in the section titled Pine Sawflies.

SHARPSHOOTERS

Family: Cicadellidae

Description

Sharpshooters are similar in appearance to the aster and potato leafhoppers in having a wedge-shaped body but are larger, usually greater than $^1/_4$ inch in length, and may reach lengths of $^1/_2$ inch or more. They can easily be identified by their enlarged clypeus or forehead. Some are ornate in coloration; for instance, *Graphocephala coccinea* Forster is red with blue venation. The broad-headed sharpshooter, *Oncometopia orbona* (Fabr.) measures about $^1/_2$ inch long, and has an orange head and blue coloration on the wings and pronotum. Other species are black, green, or blue-green.

Life Cycle

Adults overwinter in wooded landscapes and move to ornamentals, perennials, and fruit trees in spring. Adult females lay eggs singly or in groups and will insert the eggs into the surface of plant stems. Eggs will hatch in 10 to 30 days depending on temperature and species. Sharpshooters generally pass through five instars before reaching adulthood. Adult longevity can vary from 50 to 80 days, again depending on temperature and species. Sharpshooters have two to four generations per year depending on species and temperature.

Hosts

The broad-headed sharpshooter has been observed to feed on almost 50 plant species and to oviposit on nearly 20 species. This sharpshooter favors okra, sunflower, lambsquarter, ash, oak, crapemyrtle, and peach. The versute sharpshooter, *Graphocephala versute* Say, feeds on 30 plant species including both woody and non-woody plants. In general, sharpshooters feed and lay eggs on a wide variety of host plants.

Damage

Sharpshooters inflict little damage through their feeding; however, large numbers of sharpshooters have been observed feeding on apple trees in Northeastern Oklahoma, causing significant plant wilting. Economically important sharpshooters are vectors of phytopathogens, in particular, *Xylella fastidiosa* Wells et al. *Xylella fastidiosa* is the causative agent of many plant diseases including those of peach and plum, leaf scorch of oleander, almond, elm, oak, and sycamore, and Pierce's disease of grapes. Shade trees susceptible to bacterial leaf scorch include red maple, boxelder, sweet gum, flowering dogwood, hackberry, American sycamore, and many oak species. Symptoms of leaf scorch include cell death beginning at the margins of the leaf with a chlorotic band separating the dead tissue from the healthy. Trees affected with *X. fastidiosa* commonly show symptoms from year to year and will eventually die. It should be noted that these symptoms are similar to that seen with nutrient imbalances, other pathogens, or root problems.

Inspection and Control

There exists no effective remedy for diseases caused by *X. fastidiosa.* Preventing spread of the bacteria is possible by removing symptomatic shoots or entire plants. The use of healthy or resistant plants and/or control of the insect vectors are options. Specific recommendations for leafhopper/sharpshooter control can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

Appreciation is expressed to Lisa Overall who, as a graduate student in the Department of Entomology and Plant Pathology, developed much of the material included here.

Notes

SMALLER EUROPEAN ELM BARK BEETLE

Scolytus multistriatus **(Marsham)**

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

William M. Ciesla, Forest Health Management International, www.insectimages.org

Description

The adult beetle is dark reddish brown, shiny, and about $^{1}/_{8}$ inch long. The underside of the rear end of the body is concave, with a noticeable projection or spine pointing toward the rear. Larvae are small, white, grub-like, and are found under the bark of dying or dead elms. The egg galleries run parallel with the grain of the wood and larvae feed across the grain.

Another bark beetle that might be found in elms in Oklahoma is the native elm bark beetle [*Hylurgopinus rufipes* (Eichhoff)]. It is dull brownish black and less than $^{1}/_{8}$ inch long. It does not have the concave outline and spine near the rear of the body. Their egg galleries extend across the grain of the wood and larvae feed parallel to the grain.

Distribution

The Smaller European Elm Bark Beetle was first observed in North America in 1909 at Boston, MA. Since then, it has spread over most of the U.S. and into southern Canada. It has not been reported from some areas of southern and western Oklahoma, but probably occurs across the entire state. Dutch elm disease (also imported from Europe) spread with the beetle and now occurs across most of Oklahoma.

Life Cycle

Adult beetles pick up the spores of Dutch elm disease as they live in diseased elm wood. Beetles emerge from under the bark of dead or dying elms in the spring and move to and feed on tender bark in twig crotches. Feeding injuries are most numerous in twig crotches near the outer crown of the tree. Beetles that emerge from late April to the first of July (overwintering and first-generation adults) are most likely to transmit the disease to healthy elm trees. During this period, the long vessels of the elm's spring wood are open and functioning. Beetle feeding will cut into these vessels and potentially introduce spores of Dutch elm disease. Vessels produced later in the year are shorter and the movement of materials throughout the tree is slower. Dutch elm disease transmission is most likely if beetles feed in twig crotches that are at least one year old in spring or early summer.

After feeding, adults tunnel into the inner bark of weakened, dying, or recently dead elm trees. They lay their eggs in galleries parallel with the grain of the wood. Larvae hatch and feed in the layer under the bark of the tree. The life cycle may be completed in five to six weeks. Adults that emerge in spring produce a generation that emerges in June. These first-generation adults also feed in twig crotches and can transmit Dutch elm disease. They then produce a second generation of larvae. Many of these larvae enter a developmental diapause and overwinter, but a portion continues to develop and begins to emerge in August. These adults produce a partial third generation. Second and third generation adults also feed in twig crotches, but usually do not transmit Dutch elm disease since the trees are not as susceptible at this time. Due to overlapping of generations, adults may be present almost continuously from April to October.

Hosts

This species breeds in all species of elms and the related Japanese zelkova, but Dutch elm disease is primarily a problem in American elm.

Damage

Adult feeding can cause small twigs to fall from the trees. Larval feeding may hasten the death of a tree, but they seldom are found in a tree unless it is already in bad condition. Most of the damage is caused by the spread of Dutch elm disease which can kill even healthy, mature American elm trees.

Inspection and Control

One method of controlling elm bark beetles is to destroy their breeding places promptly. They breed only in dead or dying elm wood with the bark intact, such as broken limbs, wood piles, recently felled trees, or those that have died rapidly from disease or other causes. The dead trees must be cut at ground level. All such materials should be burned. Since the beetles are capable of flying several miles, this method of control must be applied throughout relatively large areas to be fully effective.

Since Dutch elm disease is largely transmitted by the first brood of bark beetles, valuable trees can be protected by applying approved insecticides. A preventative spray approach to control bark beetles includes: (1) treatment in late fall after the leaves have fallen to control the last brood of adults that will be entering the trees to lay overwintering eggs, and (2) an early spring treatment before bud swell to kill emerging adults that would feed on susceptible trees. The most effective method known to prevent bark beetles from feeding in healthy elms is to thoroughly spray all bark surfaces, especially smaller branches and twigs in the crown. In treating, complete coverage of bark is essential, especially for one-year-old twigs in the tops and outer branches. Treat as late in the spring as possible before buds open (usually before early April in Oklahoma). This can be supplemented with a second treatment in May or early June. Trunk-injected products are available for controlling bark beetles and the fungal pathogen, but these can only be applied by a certified applicator and treatment can be expensive. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832). Additional information on Dutch elm disease and its control can be found in OSU Extension Fact Sheet EPP-7602.

Notes

Notes

SPIDER MITES

Family Tetranychidae

Description

Spider mites, often called red spiders, are very small and barely visible to the naked eye. The newly hatched mite has six legs but all other active stages have eight legs. All mites are arachnids, not insects, and closely related to spiders and ticks. Several different species of spider mites occur in Oklahoma. Some are reddish in color but others are brownish or pale greenish. Some have two or more darker spots on the back. Several common species such as two-spotted spider mite spin fine, irregular webs over the infested parts of plants but other species spin little or no webbing.

Distribution

Many species of spider mites occur in all areas of the U.S. Many of these are widespread and occur in Oklahoma. Two of our most common species are the two-spotted spider mite and the Banks grass mite.

Life Cycle

Some species overwinter as adults and others overwinter as eggs. They become active or hatch as the weather warms in spring. Hot, dry weather is favorable for most spider mites, and during the summer months they can complete a generation in one to two weeks. Females lay as many as 300 eggs in their webs or on plants. Therefore, mite infestations can increase rapidly and cause extensive damage to plants in a short time. Infestations usually decline as the weather becomes cooler and wetter in the fall.

Hosts

Some species of spider mites are restricted to one or a few kinds of host plants, while others feed on many different kinds of plants. Tomatoes and marigolds are probably most commonly attacked in Oklahoma, but very few plants are completely immune from all species of spider mites.

Damage

Damage occurs when spider mites suck plant juices with their small, needle-like mouthparts. Light infestations leave a pattern of small, pale spots on the infested plant. With heavier infestations the individual spots run together and can cause the death of a leaf or needle. This type of damage is often the only sign of an infestation in species that do not spin webs.

Inspection and Control

If no webbing is present but leaves are lightly discolored , you can check for the presence of spider mites by holding a white sheet of paper under the foliage and jarring the leaves with your hand. Mites falling on the paper will appear as tiny specks and will start to move in a short period of time.

A high pressure water spray can be used to dislodge many of the mites from infested plants. This seldom provides complete mite control but can provide some relief from mite problems. Several chemicals have rather broad registrations for the control of spider mites. Read the label carefully to ensure the product you plan to apply is labeled for use on the plant or plants you intend to treat. Frequently, two or three applications at five-, seven-, or ten-day intervals are needed to reduce mite populations. Also, consider alternating/changing chemicals at each treatment to help reduce the chance of developing resistance. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

SPRING CANKERWORM

Paleacrita vernata **(Peck)**

USDA Forest Service - Northeastern Area Archive, USDA Forest Service, www.insectimages.org

Jerald E. Dewey, USDA Forest Service, www.insectimages.org

Description

Larvae vary from green or light brown to dark brown, gray, or nearly black. They are nearly 1 inch long when mature and are relatively long and slender. There is one pair of prolegs on the sixth abdominal segment and a second pair on the last segment. The adult male is a fragile-looking, gray moth with a wingspan of 1 to 1 $^{1}/_{4}$ inches. Female moths are wingless and about $^{1}/_{2}$ inch long. Both male and female moths have two transverse rows of stiff, reddish spines, pointed posteriorly, on the top of each of the first seven abdominal segments.

Several other species of cankerworms (especially the linden looper and possibly some fall cankerworms) are usually present during cankerworm outbreaks; therefore, larvae with a variety of colors and markings may be found during the same time period.

Distribution

The spring cankerworm is found from southeastern Canada to Georgia and west to Alberta, Colorado, and Texas. It should be found in all parts of Oklahoma, but is most common in the eastern two-thirds of the state.

Life Cycle

Adults begin to emerge and mate in late February most years. The wingless females must crawl up tree trunks to lay their eggs. Eggs are spindle shaped and laid in clusters of 100 or more in the crevices of rough bark on larger limbs and the trunk in late February and March. Young larvae feed on buds and unfolding leaves and older larvae feed on larger leaves. Larvae move from place to place with a looping motion and may drop from branch to branch or from trees on a silken thread. Their coloration is often similar to the bark of host trees. When disturbed, they will often stand nearly erect on the posterior prolegs and remain motionless, resembling small twigs. Larval development requires three to five weeks after which they enter the soil, usually in late May or early June. Larvae remain in the soil through summer, fall, and most of winter. Pupation occurs in late winter and adults appear about the time frost leaves the ground. There is usually only one generation per year.

Hosts

Cankerworms may infest oaks, elms, hackberry, apple, wild plums, and many other trees in Oklahoma. Favored hosts of spring cankerworm appear to be apple, American elm, and hackberry.

Damage

Spring cankerworms feed on the leaves of trees. In a few instances, trees may be completely defoliated. In other instances, particularly involving late-budding trees, new leaves are consumed as soon as they appear. Tree defoliation is rare under normal conditions. However, when large populations of cankerworms are present, property owners need to understand these insects and be able to properly deal with the problem before large-scale damage occurs.

Inspection and Control

Because the female moth must climb tree trunks to lay eggs, attempts have been made to control populations by banding tree trunks with a sticky material such as Tanglefoot. A 3- to 4-inch wide band of this material can be applied around the tree trunk approximately 4 feet above the ground. Early placement is necessary to catch female moths. This method is only partially successful because emergence of female moths and subsequent egg laying may be erratic and prolonged. Also, newly hatched larvae often descend on silken threads and may be blown to nearby trees during windy weather. The sticky material may need to be reapplied two or three times to remain effective since dust and debris can coat the material, allowing moths and/or larvae to move across the barrier.

Notes

The best control is achieved by spraying the tree with a residual insecticide soon after larvae become active and after leaves have expanded. However, foliage should be inspected to assess damage before sprays are applied. It is recommended that property owners apply sprays only to those trees where extensive foliage damage is evident and larvae are still present. Newly transplanted trees or special landscape trees should be checked more closely for these insects.

A biological insecticide (*Bacillus thuringiensis* var. *kurstaki*) will effectively control this insect. The bacterial insecticide is very safe to use as it is nontoxic to humans, pets, and wildlife. If a biological insecticide is used, treatment is recommended late in the afternoon when temperatures are cool. Also, it is advantageous to add a small amount of liquid detergent to the spray solution. The detergent acts as a spreader-sticker and allows for more effective spray coverage. When using a biological insecticide, it is important to remember that control will be slower (i.e., it takes about three days for worms to die); however, once caterpillars have fed on the material they will stop feeding on foliage immediately.

Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

TWOLINED SPITTLEBUG

Prosapia bicincta **(Say)**

Description

This insect has dark brownish black wings marked by two horizontal orange lines. The thorax is also dark and crossed by a thin orange line. The head and underside of the body are reddish. They measure about $^{3}/_{8}$ inch long.

Distribution

Twolined spittlebug occurs from Massachusetts to Florida and west to Kansas and Texas. In Oklahoma, the insect is found mostly in the eastern half of the state.

Life Cycle

Twolined spittlebugs overwinter as eggs in hollow stems, behind leaf sheaths, or among plant debris. Nymphs hatch in the spring, seek sheltered, humid hiding places among plants and begin feeding. Soon they exude a white, frothy "spittle" mass which protects them from natural enemies and desiccation. Nymphs feed for at least a month and develop through four instars before becoming adults. Adults live about three weeks and females spend the last two weeks of this period depositing eggs. Hatching occurs about two weeks later. There are probably two generations per year in Oklahoma.

Hosts

Nymphs are known to feed on the lower stems and roots of turfgrasses. Adults feed mostly on redbud, holly, and wild cherry.

Damage

In Oklahoma, damage is most common on redbud in mid and late June. Large numbers of adults can cause wilting and twig dieback by sucking sap from the leaves and small branches. Damage to holly has been reported in other areas. Feeding on young or immature leaves may result in distortion, stunting, discoloration, or necrosis at the site of stylet penetration. Nymphs have been reported to cause serious problems on turfgrasses in the Gulf Coast states, but this type of damage has not been recognized in Oklahoma.

Inspection and Control

The colorful adults are easily seen on the foliage of redbuds beginning in early June. Also, look for wilting or other damage near the ends of branches. If damaging infestations are found, they can be treated with insecticides recommended for leafhoppers and treehoppers. See the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

VARIABLE OAKLEAF CATERPILLAR

Lochmaeus manteo **Doubleday**

Lacy L. Hyche, Auburn University, www.insectimages.org

Lacy L. Hyche, Auburn University, www.insectimages.org

Description

The adult moth is ash gray with three dark wavy lines across the front wings and a wingspan of about 1 $^{3}/_{4}$ inches. The color of the larvae is variable, but is generally yellowish green with a narrow white stripe down the center of the back, bordered dorsally with purplish brown markings, and one or two yellowish stripes on each side. The yellow brown head has one white and one black stripe on each side. Larvae are about 1 $^{1}/_{2}$ inches long when mature.

Distribution

This insect is found from southern Canada and the eastern U.S. west to Ontario and Texas. It is found in the eastern half of Oklahoma.

Life Cycle

This species overwinters as larvae in cocoons in the leaf litter or topsoil. They pupate and adults emerge in spring (mid April to early May). First-generation larvae feed during May and June and then pupate in the soil. Adults emerge by late July and lay eggs. Second-generation larvae feed from mid August to late September or early October and then enter the soil to overwinter. There are two generations per year in Oklahoma.

Hosts

Larvae of this insect feed on a large number of deciduous trees. All species of oaks are susceptible to defoliation, with white oaks generally preferred. Infestations are common on southern red, northern red, pin, willow, black, laurel, burr, and post oaks. Other frequent hosts include exotic oaks, beech, basswood, paper birch, and American elm. Occasional hosts are walnut, black birch, hawthorn, eastern hophornbeam, apple, boxelder, and persimmon.

Damage

Young larvae skeletonize the lower surface of the leaf while older larvae devour the entire leaf, except the main veins. Trees of all sizes are susceptible to attack. The first generation is usually light and causes very little damage in Oklahoma. The second generation is also light in many years but occasionally occurs in large numbers and over large areas. Since the greatest amount of feeding usually occurs in August or later, trees of sapling size or larger can withstand two or three consecutive years of extreme defoliation before extensive injury occurs. Infestations very rarely last longer than this.

Inspection and Control

Insect parasites and predators attack eggs and larvae of this pest. Winter mortality also helps keep most infestations in check. Parasites and predators, however, are not known to be effective in controlling rapidly increasing populations of this insect.

Chemical control is occasionally needed to protect high-value trees and in urban or other populated areas. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

WALKINGSTICK

Diapheromera femorata **(Say)**

Bruce W. Kauffman, Tennessee Department of Agriculture, www.insectimages.org

Description

The adult of this species is 2 $^{1}/_{2}$ to 3 $^{1}/_{2}$ inches long, and females are usually larger and thicker than males. Both sexes are slender and wingless with long thin legs and antennae. Some adults are entirely brown or green, while others are mottled or multicolored with dark or light shades of gray, green, red, and brown. Their overall shape and coloration, plus their habit of remaining motionless for long periods, make them closely resemble the twigs of their hosts. Nymphs are similar to adults but smaller.

Distribution

This insect ranges from southeastern Canada through the entire eastern U.S., plus parts of western Texas, New Mexico, and Arizona. In Oklahoma, they are most common in the eastern quarter of the state, but are occasionally found in the central and western counties.

Life Cycle

Walkingsticks overwinter as eggs in leaf litter. Nymphs hatch in June and feed on low-growing plants until mid summer. They then move to nearby trees and continue to feed. Adulthood is reached in late July or early August and mating occurs about a week later. Egg laying continues until October or the arrival of cold weather. Each female may lay up to 150 eggs at an average rate of three per day. Eggs are dropped from wherever the insect happens to be on the tree. There is one generation per year.

Hosts

Preferred hosts of the adults are Northern red oak, black locust, black cherry, honeylocust, black oak, white oak, and post oak, in descending order. They also feed to some extent on blackjack oak, mockernut hickory, American elm, sycamore, sweetgum, red maple, sassafras, winged sumac, dogwood, and blackgum. Nymphs feed on low-growing plants such as rose, blackberry, dewberry, sweetfern, and blueberry.

Damage

With the exception of the basal parts of the stout veins, the entire leaf is consumed. During heavy outbreaks large stands are often completely defoliated. Because walkingsticks do not fly, infestations are often localized and expand only a few hundred yards during the season. Defoliation late in the season does not cause a great deal of damage but three or four heavy infestations in succeeding years can cause some branch dieback.

Inspection and Control

Birds, parasitic wasps, and tachinid flies attack walkingsticks and help keep numbers low in most areas most of the time. However, they are seldom numerous enough to control heavy infestations late in the year.

Treatment with insecticides can seldom be justified due to the large areas often infested and the small amount of damage manifested. Treatment might be considered in especially scenic areas, high use areas such as campgrounds, or on ornamental trees. Walkingsticks can be controlled with the same chemicals used for leaf-feeding beetles and caterpillars. These can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

Notes

WILLOW LEAF BEETLE

Chrysomela interrupta **Fabricius**

Oklahoma State University

Description

The adult is a somewhat flattened, red or red orange beetle and is about $^{3}/_{8}$ inch long. Six large black spots, which tend to run together, are present on each wing cover. The thorax is black with broad, red orange outer margins. Mature larvae are gray with several rows of black spots running down the body. The head and legs are black. Small larvae are entirely black.

Distribution

Willow leaf beetles are found throughout the eastern half of the U.S. In Oklahoma, it is found mostly in the eastern half of the state.

Life Cycle

Adults overwinter under bark, litter, or debris under or near willow trees. They begin to emerge in late March or early April and egg laying is underway by mid April. Larvae feed on willow leaves in late April and May. Larvae have a row of glands down each side of the body that produce a foul-smelling milky fluid. When disturbed, larvae emit a droplet of this fluid from each gland. Predators rarely attack these larvae, and it is assumed that they are repelled by the odor. Pupation is underway by late May with pupae hanging head downward from the leaves. New adults emerge by early June. Several other generations occur during the summer and fall but seldom cause much damage. There appear to be three or four generations per year in Oklahoma.

Hosts

This species prefers willows, including weeping willow. It is sometimes found on cottonwood and alder.

Damage

Young larvae feed in groups on the underside of the leaves. After a few days of aggregated feeding they separate and feed alone. They typically skeletonize leaves and when the damaged leaf dries, it tatters in the wind, breaking off and leaving only the main vein. Adults also feed on leaves. First-generation damage can be serious on ornamental willows but is not of much concern on wild trees. Later generations seem to cause very little damage.

Inspection and Control

Look for the beetles on willows early in the spring. Small black larvae with a foul odor are almost certainly this species. Heavy infestations can be treated with a variety of insecticides. For specific recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7306.

YELLOW-BELLIED SAPSUCKER

Sphyrapicus varius **L.**

Emily Vasquez, Tulsa University

Description

The yellow-bellied sapsucker is a member of the woodpecker family (Picidae) and resembles woodpeckers in appearance. The identifying field markings of adult birds are a black crescent on the breast, pale yellow belly, longitudinal white stripe on the mostly black wings, and crimson red crown. Although it most closely resembles the hairy and downy woodpeckers and is between the two in size, it is the only woodpecker with a red forehead in combination with a black patch on the breast. In addition, the male has a crimson chin and throat that distinguish him from the female whose chin and throat are white.

Distribution

This pest is found across most of the U.S. and southern Canada, but its damage is best known in the eastern U.S. Damage has been reported in most of eastern and central Oklahoma and to some extent in the southwestern part of the state.

Life Cycle

Although the yellow-bellied sapsucker is a member of the woodpecker family, it has a short brush tongue in contrast to that of true woodpeckers, which have long tongues equipped with barbed tips for preying upon woodboring grubs. The sapsucker's staple diet is the living cambium layer, inner bark, and sap that flows from the pecked wounds. After settling in a locality, each bird pecks many trees but then selects a few trees for most of its feeding. Pecked holes are revisited several times daily to drink sap oozing from the wounds and to eat small insects attracted to the sap. On favored trees, holes are often enlarged as the sapsucker feeds on the cambium to freshen the wound and stimulate sap flow.

The yellow-bellied sapsucker is a migratory bird that spends its summers and nests primarily in the northern states and southern Canada. In the fall it migrates southward, sometimes as far as the Gulf Coast. It can be found in Oklahoma year round. They nest in dead or dying trees 15 to 60 feet above ground, in cavities excavated by others or in hollows they construct. The female lays four to seven white eggs and rears one clutch of eggs per year.

Hosts

This bird is known to attack more than 250 species of trees and shrubs.

Damage

The yellow-bellied sapsucker pecks small holes in tree bark, causing injuries that are often mistaken for exit holes of woodboring insects. As portions of the bark and cambium are removed by numerous pecked holes, the vitality of the tree decreases. When the injury is extensive, individual branches or the entire tree may be completely ringed or girdled and killed. Sapsucker pecking disfigures ornamental trees and gives rise to holes, to sap spots, and subsequently to gnarled bark deformities that ruin the aesthetic appearance of the trees. Pathogens and woodboring insects often become established at sapsucker wounds.

Inspection and Control

Sapsuckers peck a series of small holes about $^1/_4$ inch in diameter in a symmetrical pattern in the bark. Generally, the holes are made in horizontal rings (full or partial) around the trunk or branches. The holes extend through the bark to the cambium, sometimes penetrating the sapwood to a depth of $^1/_8$ inch. Occasionally, the holes in a series are gradually enlarged until they girdle or partially girdle the stem.

Control is difficult, but several remedies have been used with some success on high-value trees. Trunks of individual trees may be wrapped with burlap or some other material to prevent attacks. Painting damaged trees with tree-wound paint will sometimes discourage the birds. Commercially available repellents have been used successfully in repelling sapsuckers. Spraying the trunk periodically with a soap solution has reportedly helped to discourage attacks. Often only a single bird is responsible for damage to a shade or ornamental tree; thus, if it can be discouraged or eliminated, the problem is solved.

Appreciation is expressed to Peter Loy who, as a student in the Horticultural Insects Course in 1991, developed much of this information.

Notes

Notes

BLACK LOCUST PESTS IN OKLAHOMA

Locust borer [*Megacyllene robiniae* (Forster)] - Coleoptera

This longhorned woodborer is the most serious pest of black locust in Oklahoma. Larvae bore within the trunk and limbs, physically weakening them and making the trees susceptible to breakage from wind and ice. The adult is a black and yellow beetle that measures about $^{3}/_{4}$ inch long. It is active mostly in October in Oklahoma. It is often found on goldenrod flowers in the morning and on the trunks of black locust trees in the afternoon and evening. Eggs are placed in bark crevices. There is one generation per year. Silvicultural methods of control can be helpful in preventing locust borer damage. These include thinning to promote vigorous growth, mulching, use of mixed tree species in plantings, planting superior varieties of black locust, and not planting on poor sites. See OSU Extension Fact Sheet EPP-7315 for more details.

Carpenterworm [*Prionoxystus robiniae* (Peck)] - Lepidoptera

This species attacks black locust as well as many other shade and ornamental trees. The larva is a large greenish white caterpillar with a dark head and bores in the trunk of the tree. The adult is a large, mottled gray moth which is active in late spring and early summer. Eggs are laid in groups of two to six in bark crevices or near wounds or scars on the trunk. One generation is complete in two or three years. Control is difficult, but heavily infested trees can be removed and stands can be thinned to promote more vigorous growth. See OSU Extension Fact Sheet EPP-7315.

Locust twig borer [*Ecdytolopha insiticiana* Zeller] - Lepidoptera

The reddish to straw yellow larvae bore in the stems and twigs of black locust and cause the formation of elongate galls measuring up to 3 inches long. The adult moth has dark, ashy brown wings with large, dull, pinkish white patches on the outer margin and several small, blackish spots near the middle of each of the patches. There are two generations per year. Seedling mortality and twig damage may be high in heavily infested areas, but the species is not very common in Oklahoma.

Locust leafminer [*Odontota dorsalis* (Thunberg)] - Coleoptera

This species is a flattened, orange beetle with a black head and a black stripe down the middle of the back. Larvae mine the leaves of black locust, often killing them. Overwintered adults emerge in the spring and feed for a short time on the leaves. Eggs are laid on the lower surface of leaves in groups of three to five. Larval development and pupation occur in mines in the leaves. There is one generation per year. Heavy outbreaks can defoliate black locust trees but damage is usually not serious in Oklahoma.

Leaf beetle [*Anomoea laticlavia* (Forster)] - Coleoptera

This is a small, robust, orange beetle that feeds on the leaves of black locust and other plants in the spring. It usually has three black stripes on the wing covers. The head is orange and the body is not flattened. They are sometimes fairly common but are not serious pests.

Walkingstick [*Diapheromera femorata* (Say)] - Orthoptera

This is a long, slender insect with long legs, long antennae, and no wings. It is best known for defoliating oaks but is also very fond of black locusts, which are often defoliated in areas where walkingsticks are common. Winter is spent as eggs on the ground. Small nymphs hatch in the spring and feed on shrubs at first, later moving to trees. Adults are present by August and defoliation may occur in late August or September. The trees are not usually heavily damaged by defoliation, especially when it occurs late in the season.

Sawflies [*Nematus abbotti* (Kirby) & *N. tibialis* Newman] - Hymenoptera

Adult sawflies are wasp-like insects. *Nematus abbotti* is bluish black and about $^{1}/_{2}$ inch long while *N. tibialis* is yellowish, marked with black, and about $^{1}/_{4}$ inch long. Larvae of both species are light greenish with numerous small black spots on the body. They feed on black locust leaves in late April and early May. They may cause partial defoliation when numerous, but they are usually not serious pests.

Bagworm [*Thyridopteryx ephemeraeformis* (Haworth)] - Lepidoptera

This is a very general feeder on many species of evergreen and deciduous trees and shrubs. It is usually not a serious pest of black locust but will feed on it. The larva is a dark brown caterpillar which lives in a case made of silk and bits of the host plant's leaves. They are active from May to August.

Silverspotted skipper [*Epargyreus clarus* (Cramer)] - Lepidoptera

The adult is butterfly-like and brown except for yellow and white triangular spots on the front wings. Larvae have green bodies marked with five black rings. The head is large and dull red except for two yellow spots on the lower part of the face. They feed within nests made by tying several leaves together with silk. There are two generations per year. They are seldom common in Oklahoma.

Io moth [*Automeris io* (Fabricius)] - Lepidoptera

This species attacks a wide variety of trees including black locust. The larva is green with numerous branching, black-tipped spines on the body. There is a broad reddish brown stripe on each side of the body. Larvae are usually not serious tree pests but may become important in urban areas due to their stinging spines.

Crinkled flannel moth [*Lagoa crispata* (Packard)] - Lepidoptera

This is another species which feeds on a wide variety of plants and may be important because it has stinging spines. The larva is covered with long, silky, brownish hairs which hide the poisonous spines. It is often called a puss caterpillar. They are sometimes common in the fall in Oklahoma.

Lesser cornstalk borer [*Elasmopalpus lignosellus* (Zeller)] - Lepidoptera

This is a small bluish green caterpillar with brownish stripes down the body. It is a well-known pest of peanuts and several other field and vegetable crops. It has been known to damage black locust seedlings in nurseries by feeding on the stems at or just below ground level. Gall-like growths develop at the point of injury causing the stems to die or break off at the ground line.

Threecornered alfalfa hopper [*Spissistilus festinus* (Say)] - Homoptera

This small, green, triangular insect is known as a pest of alfalfa and soybeans. It occasionally damages black locust seedlings in nurseries by feeding on the stems, usually 1 or 2 inches above the ground. Gall-like swellings or calluses which develop just above the feeding punctures can kill the seedling. Others are lost when they break at these points.

Cowpea aphid [*Aphis craccivora* Koch] - Homoptera

This is a small insect usually found in groups on black locust seedlings or the tips of branches of larger trees in spring. Adults are shiny black with white markings on the legs and antennae. Nymphs are slate gray. They feed by sucking sap from the stems. Damage is not serious on older trees, but might possibly be serious on seedlings if heavy numbers are present.

Schoene spider mite [*Tetranychus schoenei* McGregor] - Acari

This species is most common on elms but also attacks black locust and several other trees. They are very small, pale , and have eight legs as adults. They produce considerable webbing on infested leaves and their feeding causes discoloration and sometimes death of the leaves. Heavy infestations can cause defoliation. They are most common in hot, dry weather and can have as many as nine generations per year.

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Notes

EASTERN REDCEDAR PESTS IN OKLAHOMA

Bagworm [*Thyridopteryx ephemeraeformis* (Haworth)] - Lepidoptera

This is the most serious, widespread pest of redcedar in Oklahoma. They overwinter as eggs in bags, in which the female lived the previous summer. Larvae hatch in April or May, spin a silken bag, and begin feeding on the foliage of the host plant. The bag expands as the larva grows and adds bits of foliage to it. The dark brown, hairless caterpillar measures 1 to 1 $^{1}/_{4}$ inches long at maturity in August. They pupate in the bag. The female is wingless and does not leave its bag. The male emerges as a clear-winged moth with a black, hairy body and engages in a mating flight in search of females. After mating, the female lays her eggs in the bag, falls to the ground, and dies. There is one generation per year. Control is by hand picking during the fall, winter, or spring or by treating with insecticides shortly after the larvae have hatched. See OSU Extension Fact Sheet EPP-7306.

Webworm [*Choristoneura houstonana* (Grote)] - Lepidoptera

The adult is a mottled yellowish tan moth that flies in June and July. Young larvae mine the shoots from July to September, overwinter in the shoots, and resume feeding in the spring. Older larvae web the foliage together and feed in silken tunnels in the webbing. There is one generation per year. This insect can cause considerable damage to ornamental plants in western Oklahoma.

Sawfly [*Monoctenus* sp.] - Hymenoptera

Mature larvae are dull green, measure about $^{3}/_{4}$ inch long, and have eight pairs of abdominal prolegs. The head is light brown and the body is marked with three dark longitudinal stripes. Adults are wasp-like insects which are active in May. Larvae feed on redcedar in June and July. They are widespread in Oklahoma but are rarely found in large numbers. There is one generation per year.

Bark beetle [*Phloeosinus dentatus* (Say)] - Coleoptera

The adult is a small, dark brown or black beetle, and clothed with rather abundant short, gray hairs. Adult females excavate galleries under the bark in which they lay eggs. Larvae feed between the bark and wood of redcedars. Infestations are usually found in cut, broken, or fire-damaged trees. This beetle is found occasionally in western Oklahoma.

May beetle [*Phyllophaga koehleriana* Saylor] - Coleoptera

A rather small, pale species of May beetle that emerges in June and feeds primarily on redcedars. It is only known to occur in Cimarron County but is very numerous there in some years. Many native cedars are partially or completely defoliated when the beetles are numerous.

Strawberry root weevil [*Otiorhynchus ovatus* (Linnaeus)] - Coleoptera

The adult is a large black weevil that feeds on the foliage of redcedar and many other plants. Larvae feed on the roots of a variety of plants. It is not native to Oklahoma, but was accidentally shipped to a nursery in Logan County on one occasion.

Pales weevil [*Hylobius pales* (Herbst)] - Coleoptera

This large dark brown to black, mottled weevil is a well known pest of pine reproduction in both the adult and larval stages. It will occasionally damage redcedar seedlings but only occurs in the southeast corner of Oklahoma.

Longhorned woodborers [*Callidium juniperi* Fisher, *Callidium texanum* Schaeffer, *Semanotus ligneus* (Fabricius), and *Oeme rigida* (Say)] - Coleoptera

These four species of woodborers occur in Oklahoma and are reported to develop in redcedar. They most commonly attack dying, dead, or recently cut trees and are seldom important in live, healthy trees.

Juniper scale [*Carulaspis juniperi* (Bouche)] - Homoptera

This armored scale has a circular, convex, grayish white covering with an off-center yellowish nipple. It is found on the needles of redcedar and other evergreens where it feeds by sucking sap from the plant. This species is relatively common on ornamental redcedars in Oklahoma and can do considerable damage, sometimes killing branches or entire trees. There are probably two generations per year.

Minute cypress scale [*Carulaspis minima* (Targioni)] - Homoptera

This species is very similar to juniper scale. It prefers other species of evergreens and is only rarely found on redcedar.

Redwood scale [*Aonidia shastae* (Coleman)] - Homoptera

The small, cone-shaped adult female scale resembles a droplet of hardened pitch on the foliage of redcedar and other evergreens. It is occasionally found in Oklahoma but does very little damage.

Fletcher scale [*Parthenolecanium fletcheri* (Cockerell)] - Homoptera

This is a soft scale. The newly formed adult females are flattened and have a mottled appearance, but as they mature they become more hemispherical and turn a uniform brown. They suck sap from the small stems of the host plant. They are rather common on ornamental redcedars but seldom do serious damage.

Juniper mealybug [*Spilococcus juniperi* (Ehrhorn)] - Homoptera

The adult female is dark purple, covered with a smooth gray wax, and has two bare areas forming longitudinal stripes on the dorsal part of the body. The body margin has several short, partially coalesced filaments. They are found in both native habitats and ornamental plantings and can be a serious pest of redcedar. The foliage of heavily infested trees turns brown and drops, beginning on the lower and inner branches of the host. Entire trees are sometimes defoliated.

Grasshopper [*Melanoplus splendidus* Hebard] - Orthoptera

This species is a dark brownish grasshopper with black and dark yellow markings and with the lower, inner edge of the hind femora blood red. It feeds almost exclusively on redcedars, and has only been collected in Blaine and Cimarron Counties in Oklahoma.

Spruce spider mite [*Oligonychus ununguis* (Jacobi)] - Acari

This is a common pest of redcedar and other conifers throughout the world and it should occur in Oklahoma. Infested trees may become brownish gray and appear unhealthy, or they may drop all of their needles. Periods of drought appear to be most favorable for population buildups.

Conifer spider mite [*Oligonychus coniferarum* (McGregor) - Acari

A species closely related to the spruce spider mite, the conifer spider mite has been reported to cause serious damage to redcedar in some areas of Oklahoma.

Twospotted spider mite [*Tetranychus urticae* Koch] - Acari

This is the common reddish or green spider mite that attacks a very wide variety of plants. It is occasionally found on redcedar.

Notes

Seasonal Appearance of Some Ornamental and Shade Tree Pests in Oklahoma

January and February

Few insects active, but during these months one can apply dormant oils for control of scale insects, e.g. on oak, elm, fruit trees, etc.

Early March

Host	*Pest*
crabapple	San Jose scale

Mid March

Host	*Pest*
cotoneaster	tent caterpillars
dogwood	
flowering peach	
hawthorn	
pecan	
pyracantha	
trifoliate orange	
wild plum	

Late March

Host	*Pest*

Early April

Host	*Pest*
elm	elm leaf beetle (adults)
hackberry	gall psyllids (adults)
hickory	painted hickory borer (adults)
oak	gall wasps (adults)
pine	pine tortoise scale
	Nantucket pine tip moth (adults)
redbud	redbud aphid

Mid April

Host	*Pest*
ash	redheaded ash borer
black locust	cowpea aphid
black walnut	European fruit lecanium
elm	European fruit lecanium
	elm calligrapha (adults)
	elm bud sawfly (larvae)
hackberry	European fruit lecanium
lilac	harlequin bug (adults)
mulberry	European fruit lecanium
oak	obscure scale
pecan	obsure scale
	European lecanium
pine	Ips beetles (adults) (SE Okla. only)
	southern pine beetle (adults) (SE Okla. only)
	pine needle aphids
	Nantucket pine tip moth (larvae)
redbud	European fruit lecanium
willow	willow leaf beetle

Late April

Host	*Pest*
arborvitae	juniper scale
crabapple	woolly apple aphid
	spring cankerworm
crape myrtle	crape myrtle aphid
elm	May beetles (adults)
spring cankerworm	
elm leaf aphid	
	woolly elm aphid
	smaller European elm bark beetle (adults)
flowering peach	spring cankerworm
hackberry	spring cankerworm
hickory	giant bark aphid
	hickory bark beetle
juniper	juniper scale
oak	spring cankerworm
	forest tent caterpillar
	May beetles (adults)
giant bark aphid	
	oak leaf aphids
pecan	May beetles (adults)
	giant bark aphid
	phylloxera
sumac	sumac leaf beetle
sycamore	giant bark aphid
wild plum	rusty plum aphid
	spring cankerworm

Early May

Host	*Pest*
arborvitas	spider mites
ash	sawfly (larvae)
birch	oystershell scale
black locust	sawfly (larvae)
boxelder	boxelder aphid
bald cypress	bagworm (larvae)
crabapple	Forbes scale
elm	elm lace bug

Mid May

Host	*Pest*
ash	ash leafcurl aphid
	ash borer (adults)
	carpenterworm
black locust	carpenterworm
boxelder	carpenterworm
cottonwood	carpenterworm
Eastern redcedar	Fletcher scale

Late May

Host	*Pest*
arborvitae	bagworm (larvae)
cottonwood	cottonwood twig borer (adults)
crabapple	spirea aphid
Eastern redcedar	bagworm (larvae)
	sawfly (larvae)
spider mites	
flowering quince	melon aphid

Early June	
Host	*Pest*
crabapple	flatheaded appletree borer (adults)
dogwood	flatheaded appletree borer (adults)
elm	flatheaded appletree borer (adults)
flowering peach	peachtree borer (adults)
goldenrain tree	boxelder bug
hawthorn	hawthorn lace bug
hickory	flatheaded appletree borer (adults)
holly	leafminer (larvae)
Lombardy poplar	poplar borer (adults
maple	cottony maple scale
oak	flatheaded appletree borer (adults)
pecan	flatheaded appletree borer (adults)
persimmon	false cottony maple scale
pyracantha	hawthorn lace bug
redbud	flatheaded appletree borer (adults)
sycamore	flatheaded appletree borer (adults)
willow	black willow aphid

Mid June	
Host	*Pest*
Eastern redcedar	minute cypress scale
hickory	fall webworm
Lombardy poplar	cottonwood borer (adults)
oak	oak grasshopper
pecan	fall webworm
pine	pine needle scale
	southern pine sawyer
sumac	sumac aphid
sweetgum	sweetgum pit scale
willow	cottonwood borer (adults)

Late June	
Host	*Pest*

Early July	
Host	*Pest*
Eastern redcedar	spider mites
juniper	spider mites
sycamore	sycamore tussock moth (larvae)
willow	black willow aphid

Mid July	
Host	*Pest*
black walnut	American walnut aphid
holly	grasshoppers
oak	oak eriococcus
	spider mites
privet	hornworms

Late July	
Host	*Pest*
privet	spider mites

Early August	
Host	*Pest*
ash	lace bugs
euonymus	spider mites
mulberry	spider mites

Mid August	
Host	*Pest*

Late August	
Host	*Pest*
elm	spider mites

Early September	
Host	*Pest*
black locust	walkingstick
honey locust	walkingstick
oak	walkingstick

Mid September	
Host	*Pest*
black walnut	twig girdler (adults)
elm	twig girdler (adults)
hickory	twig girdler (adults)
oak	yellownecked caterpillar
	variable oakleaf caterpillar
pecan	twig girdler (adults)
persimmon	twig girdler (adults)

Late September	
Host	*Pest*
ash	fall ash borer (adults)
	ash bark beetle (adults)
dogwood	whitebanded dogwood aphid

Early October	
Host	*Pest*
black locust	locust borer (adults)
pine	pine bark aphids

Mid October	
Host	*Pest*
arborvitae	arborvitae aphid

Late October	
Host	*Pest*
pine	spider mites
spruce	spider mites

November and December	
Host	*Pest*
pine	Nantucket pine tip moth

Notes

TURFGRASS INSECTS

Notes

ARMYWORM
(or True Armyworm)

Pseudaletia unipuncta **(Haworth)**

Frank Peairs, Colorado State University, www.insectimages.org

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

Description

The adult moth is uniformly pale brown to grayish brown with a wingspan of about 1 $^{1}/_{2}$ inches. There is a characteristic small, white spot near the center of each front wing. Eggs are greenish white and spherical and are laid in masses. Mature larvae are about 1 $^{1}/_{2}$ inches long with a yellowish or grayish ground color, and more or less tinged with pink. The dorsum is greenish brown to black with a narrow, broken, light median stripe. A dark stripe on each side includes the black spiracles in its lower edge. The sub-spiracular stripe is pale orange, mottled, and edged with white.

Life Cycle

Armyworms overwinter as pupae or as mature larvae that pupate in the spring. Moths emerge in the spring, mate, and lay eggs in masses on host plants (mostly in the grass family). Larvae feed for about four weeks, doing most of their damage during the last ten days of this period. They then pupate in cells in the soil. A new generation of moths emerges about one week later. There are four generations per year in Oklahoma.

Hosts

All common turfgrasses are susceptible but are less likely to be attacked than small grains, such as corn, timothy, millet, and some legumes.

Damage

Young caterpillars skeletonize the surface of leaf blades and the inner surface of the sheaths. Older larvae begin feeding from the leaf edges and consume entire leaves. Extensive feeding can cause bare areas in lawns. Armyworms often invade grasses in wet areas and may become most abundant after flooding has occurred. Plants that have lodged to make a dense canopy are often infested with the highest numbers. This species is a true armyworm; the larvae may migrate en masse from a decimated area to enter an area of abundant food supply.

Damage to lawns is normally found only in years when this species is especially abundant in wheat and other small grains. Only the first generation (during May) and the fourth generation (during September) are likely to damage turfgrasses in Oklahoma. In years when the first generation of larvae have been present in wheat, homeowners often will find the adult moths ("millers") in large numbers hiding in shrubs and trees in early summer.

Inspection and Control

Armyworm larvae can be detected in lawns by spraying a mixture of 1 tablespoon of dish detergent in 1 gallon of water per square yard. The caterpillars will surface within a few minutes and can be found by separating the blades of grass. Especially examine areas of heavy grass cover that show signs of feeding damage. Treatment may be needed if five or more armyworms are found per square yard.

A variety of chemicals can be used for armyworm control, including the bacterial insecticide, *Bacillus thuringiensis* var. *kurstaki*. See the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) for specific recommendations.

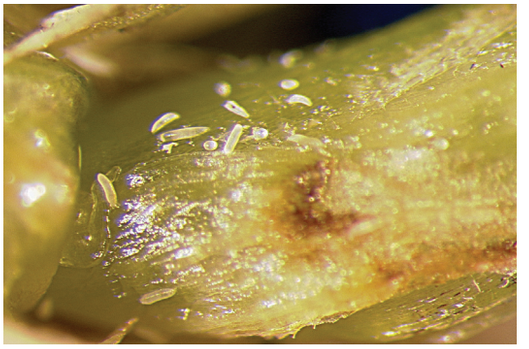
BERMUDAGRASS MITE

Aceria (Eriophyes) cynodoniensis **(Sayed)**

AND

ZOYSIAGRASS MITE

Aceria (Eriophyes) zoysiae **Baker, Kono, and O'Neill**



David Shetlar, The Ohio State University

David Shetlar, The Ohio State University

Description

These very small mites, approximately $^{1}/_{100}$ inch long, cannot be seen with the naked eye. With magnification, they are worm-like or sausage-like and creamy white. Since they are eriophyid mites, they have only two pairs of legs in both nymphal and adult stages.

Life Cycle

Adult mites infest protected tissues of the grass plant (primarily under the leaf sheaths). Eggs are deposited in these areas. The life cycle (egg to adult) can be completed in five to seven days and there can be many generations per year. Both species are active primarily in late spring and summer.

Hosts

Bermudagrass is the only known host of bermudagrass mite and zoysiagrass is the only known host of zoysiagrass mite.

Damage

Bermudagrass mite: Damage may be first noticed in early spring as bermudagrass breaks dormancy, although injury may become more severe later in the growing season. Injured grass has extremely shortened internodes, which produces a typical rosetting and tufted growth, or a witch's-broom effect. With severe infestations there is almost no green regrowth, and the turf is a mass of large knots which often die, leaving brown areas in the lawn. Grass in infested lawns usually thins, allowing weed development. Well-fertilized lawns appear to be more attractive to mites than starved grass, and injury is more pronounced during dry weather when grass is under stress.

Zoysiagrass mite: Zoysiagrass mite is more damaging to its host than is bermudagrass mite because zoysiagrass is slower growing. The appearance and life history of zoysiagrass mite are similar to bermudagrass mite. Damage occurs once grass breaks dormancy. Infested leaves have pale white or yellow streaks and plants are stunted. The upper leaf surface is "rolled up" and becomes caught within the older twisted leaves, creating an arch which is termed "buggy whipping."

Inspection and Control

Look for plants with a stunted, rosetted, or tufted appearance. Pull leaf sheaths away from the stems and examine the exposed area with a 10x to 20x hand lens or a dissecting microscope. Look for mites and spherical, transparent eggs.

Most varieties of common bermudagrass (*Cynodon dactylon*) are highly susceptible to bermudagrass mite damage, but varieties such as "Midiron," "Tifdwarf," "Tifgreen," and "Tifway" with African bermudagrass (*Cynodon transvaalensis*) parentage are highly resistant to the mite. Of these, "Midiron" is highly recommended for use in Oklahoma and "Tifgreen" and "Tifway" can be used in some areas.

Zoysiagrass varieties differ widely in susceptibility to zoysiagrass mite. The variety "Meyer," which is widely planted in Oklahoma, is one of the most susceptible to attack by zoysiagrass mite. The varieties "Royal" and "Emerald" are highly resistant, and "El Toro" has intermediate resistance.

Management practices appear to have an important influence upon the severity of mite infestations. Bermudagrass turf that has been "over-

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seeded" with a winter grass is more severely damaged in spring and early summer than turf that is not over-seeded. Other factors such as the amount of thatch, irrigation, soil fertility, summer temperatures, and shade appear to affect the extent of mite damage at different times during the growing season.

Chemical control measures are not always dependable and repeat applications may be necessary. Treatment combined with nitrogen fertilizer in spring may give both a significant reduction in injury caused by the mites and an increase in the green appearance of the grass. Treatment in fall sometimes gives a distinct reduction in the amount of mite-infested grass the following spring. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

BILLBUG

Sphenophorus **spp.**

Description

Billbugs belong to a group of beetles called weevils or snout beetles. Several species of billbugs attack turf. In Oklahoma, the bluegrass (*Sphenophorus parvulus* Gyllenhal) and hunting (*Sphenophorus venatus vestitus* Chittenden) billbugs are most damaging to turf. Adult billbugs are gray, black or brown, and measure $^{3}/_{8}$ inch long. They have a beak-like snout and the snout, head, and thorax are about as long as the wing covers. Billbug grubs are white and legless with a somewhat curved body and measure about $^{3}/_{8}$ inch long when fully grown. Grubs have a brown head capsule and can usually be found in grass stems or thatch.

Life Cycle

Billbugs overwinter primarily as adults, but some larvae also overwinter. Adult billbugs overwinter in thatch, soil crevices, under bark mulch or leaf litter, or other sheltered places. Adults become active in spring and wander to find suitable host plants where they mate and begin to lay eggs. Females lay from two to five eggs per day, placed singly in small, chewed cavities of grass stems. Most egg laying is complete by mid July, but some eggs are probably laid continuously all summer.

Hosts

The bluegrass billbug prefers to feed on Kentucky bluegrass, but will also feed on perennial ryegrass and fine-leaf fescue. Hunting billbugs infest zoysiagrass and hybrid bermudagrass but will also feed on bahiagrass, centipedegrass, and St. Augustinegrass.

Damage

Adult billbugs chew holes in grass stems, usually just above the crown to create an egg-laying site. Larvae begin to tunnel within the stem upon hatching, then burrow into the crown or exit and infest another stem. Older larvae will feed on the crown and can kill plants. Injury symptoms are often mistaken for disease (spring dead spot) or winter kill.

Inspection and Control

Billbug activity is often mistaken for a disease or winter kill because small patches are dead. The dead turf will not respond to watering and can be pulled easily from the soil. Closer inspection will reveal signs of billbug feeding, including hollowed out stems and sawdust. Larvae may also be found if the stems and crowns are split with a knife and examined. In spring, billbug adults become active in infested areas and can be seen crawling over paved areas that are near infested turf. Billbug infestations are often more associated with highly maintained lawns or sod farms. Bermudagrass seems to be less susceptible to severe injury from hunting billbug, but zoysiagrass can be susceptible. Texas researchers report that varieties of *Zoysia japonica*, which includes "Meyer," are very susceptible to billbug infestation. Varieties of *Zoysia matrella*, which includes "Royal" and "Diamond," are somewhat tolerant.

For specific recommendations see the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

Notes

CICADA KILLER

Sphecius speciosus **(Drury)**

Description

This large wasp has a rusty red head and thorax, russet colored wings, and a black and yellow striped abdomen. A length of 1 $^{1}/_{2}$ inches is not uncommon. Larvae are legless, white grubs and are found in burrows in the soil.

Life Cycle

The cicada killer wasp overwinters as a larva within a cocoon in a burrow in the soil. Pupation occurs in spring. Adults begin emerging in June and emergence continues throughout the summer. The adult female feeds, mates, and digs burrows for several weeks before preying on cicadas. A vertical or slightly angled burrow is excavated 6 to 10 inches deep and about 1/2 inch in diameter with broadly oval cells perpendicular to the main tunnel. The excess soil thrown out of the burrow forms a regular, U-shaped mound at the entrance.

Once cells have been constructed, the search for cicadas begins. Canvassing tree trunks and lower limbs, the female wasp stings her prey, turns the victim on its back, straddles it, and drags it or glides with it to the burrow. Each cell is furnished with at least one cicada (sometimes two or three) and a single egg before being sealed off. The egg hatches two or three days later and the larva feeds four to ten days, until only the cicada's outer shell remains. During fall, the larva spins a silken case and prepares to overwinter. Only one generation occurs each year.

Hosts

Cicada killers do not feed on plants. Larvae feed primarily on paralyzed cicadas, while adult wasps feed on flower nectar.

Damage

In spite of its formidable size and burrowing habit, this wasp is unusually docile and harmless. Although capable of inflicting a painful sting, the female cicada killer wasp is usually difficult to provoke. Mating males are aggressive and more easily disturbed, but cannot sting.

An unsightly mound of soil surrounds the burrow of each cicada killer. Since colonies of burrows are common, infested lawns usually contain several mounds that can smother the grass. However, since cicada killers prefer to nest in areas of sparse vegetation, it is likely that infested turf was already unthrifty when the wasps arrived. They rarely burrow in thick, vigorous turf. Burrows are most commonly found in ornamental beds or under trees or tall foliage plants where there are areas of bare soil. Wasps also preferentially construct burrows in sandy soils such as around playground equipment or in golf course bunkers.

Inspection and Control

Cultural controls can prevent or eliminate the establishment of cicada killer colonies. Adequate lime and fertilizer applications accompanied by frequent watering can usually eliminate an infestation in one or two seasons. In case of a severe infestation, chemical control may be necessary to prevent danger from stinging wasps. Specific recommendations can be found in the turf section of the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

CLOVER MITE

Bryobia praetiosa **Koch**

Rayanne Lehman, Pennsylvania Department of Agriculture, www.insectimages.org

Description

Clover mites are very small (about $^{1}/_{30}$ inch long) and red or brown. They have eight legs and are not insects (they are close relatives of ticks and spiders). They can be identified by the flattened, scale-like hairs on the top of the body and the long front pair of legs that extend forward, often giving the appearance of antennae. There is some controversy about whether this is one species or a complex of closely related species. If the house-invading clover mite is considered a separate species, it will be named *B. borealis* Oudemans.

Distribution

The clover mite (or clover mite complex) occurs in many parts of the world and should be found in all areas of Oklahoma.

Life Cycle

Adult females lay small, round, red eggs in bark crevices at the bases of trees or in the cracks and crevices of buildings. Most eggs are laid in spring before temperatures reach 85° F. Adults then die and the eggs remain dormant during the summer. Eggs begin to hatch in fall as temperatures drop below 85° F. Optimum egg hatch occurs at 65° to 70° F and with high humidity. The mites feed and develop during fall, warm periods in winter, and in spring when temperatures are above 45° F. Males are unknkown in this species, which means females reproduce via parthenogenesis, producing clones of themselves. Some populations (or species) have one generation per year while others have several.

Hosts

The clover mite is a plant feeder with a long list of known hosts. These include legumes (such as alfalfa, peas, and clovers), various weed species found in lawns, lawn grasses, certain ornamental plants and shrubs, and trees.

Damage

Clover mites seldom cause much damage to plants, but high numbers can cause a "silvered" appearance due to the loss of chlorophyll. They become a problem when they invade homes or other buildings. This happens most commonly in March and April in Oklahoma but has also occurred during fall and early winter months. They do not feed on anything in the home but can leave a reddish orange stain if they are crushed on curtains, bedspreads, furniture, walls, or carpets.

Inspection and Control

Mites enter buildings through small cracks and crevices around doors and windows or along baseboards while searching for food or protected locations. Sealing these crevices will help prevent entrance. The most effective prevention is removing grass and weeds 18 to 24 inches around the foundation of the building. This area does not have to be left bare. Ornamental plantings such as zinnias, salvia, roses, marigolds, petunias, chrysanthemums, junipers, spruce, arborvitae, and yew can be used in beds since they are not attractive to clover mites.

Border treatments starting from the foundation through ornamental beds and 15 to 20 feet out into the lawn help prevent mites from migrating into a home. Mites can also be treated inside the home with ready-to-use sprays or aerosols. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheets EPP-7306 and EPP-7312.

CUTWORMS
Family Noctuidae

University of Georgia Archive, University of Georgia, www.insectimages.org

University of Georgia Archive, University of Georgia, www.insectimages.org

Ian Kimber, www.insectimages.org

Tony Davison, www.insectimages.org

Description

Cutworm adults are medium-sized moths with a wingspan of 1 to 2 inches. Most species are brownish or grayish with various darker or lighter markings on the front wings. Larvae are black, gray, or brown caterpillars that are about $1\ ^{1}/_{2}$ inches long at maturity. Some species have darker or lighter spots or stripes on the body. At least eight species are known to damage turf in Oklahoma. The black cutworm [*Agrotis ipsilon* (Hufnagel)] is the most commonly reported. The species that occasionally cause problems in turf include the bronzed cutworm [*Nephelodes minians* Guenee], variegated cutworm [*Peridroma saucia* (Hubner)], and bristly cutworm [*Lacinipolia renigera* (Stephens)]. The granulate cutworm [*Agrotis subterranea* (Fab.)], army cutworm [*Euxoa auxiliaris* (Grote)], dusky cutworm [*Agrotis venerabilis* Walker], and claybacked cutworm [*Agrotis gladiaria* Morrison] may damage turf in years when they are abundant.

Lacy L. Hyche, Auburn University, www.insectimages.org

Life Cycle

Cutworms overwinter as eggs, larvae, or pupae, depending on the species. Damage to turf can occur from late February to early October. Army cutworms overwinter as larvae, feed in early spring, and have one generation per year. Damage in February and March is most likely to be caused by this species. Claybacked and dusky cutworms also overwinter as larvae and have one generation per year, but larvae develop later in spring. They and the bristly cutworm are most likely to cause damage in April and May. Bronzed cutworms overwinter as eggs and have one generation per year. Damage is most likely in May. Variegated and black cutworms overwinter as pupae and have several generations per year. Variegated cutworm damage is most likely in May, while black cutworm damage is usually reported in late summer or fall (August and September). Local populations of some species are augmented by migration of moths. Black cutworms migrate north in spring

and army cutworms migrate from the mountains of Colorado in fall.

In years when cutworms have been heavy, surrounding areas (e.g., shrubs, garages, outbuildings, etc.) may be used as hiding places for large numbers of adult moths ("millers"). Cutworms (larvae) pupate and the emerging moths often congregate before laying eggs or migrating. Those that remain in the area will eventually die off.

Hosts

Cutworms are general feeders and attack a wide range of plants. All common turfgrasses are susceptible to damage.

Damage

Larvae feed at night on the leaves and crown and may cut off plants near the soil line. During the day, they are found hiding in holes, under debris, or under thatch near the surface of the soil.

Inspection and Control

An infestation in the lawn can be detected by applying a mixture of 1 tablespoon of dish detergent in 1 gallon of water per square yard. The caterpillars will surface within a few minutes and can be found by separating the blades of grass. The lawn should be treated if five or more cutworms are found per square yard. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

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FALL ARMYWORM

Spodoptera frugiperda **(J. E. Smith)**

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Steve L. Brown, University of Georgia, www.insectimages.org

University of Georgia Archive, www.insectimages.org

Description

Male moths have dark gray front wings mottled with darker and lighter splotches. There is a prominent pale, diagonal marking near the center of the front half of each wing and a prominent white spot at the extreme tip. The front wings of female moths are dull gray brown with only small, inconspicuous markings. The hindwings of both sexes are white with a slight purplish sheen. The wingspan is about 1 $^{1}/_{2}$ inches. Eggs are pale gray, laid in masses, and covered with grayish, fuzzy scales from the body of the female moth. Mature larvae may be green, brown, or almost black and measure about 1 $^{1}/_{2}$ inches long. There are black and reddish brown stripes on each side of the body and four small, black spots on the dorsal side of each abdominal segment. The head capsule is mostly black and is marked with a pale, inverted "Y" on the front.

Life Cycle

The fall armyworm does not overwinter in Oklahoma, and we are reinfested each year by moths that migrate northward from Texas or Mexico. Migrating populations usually reach Oklahoma by late June. Each female lays about 1,000 eggs in masses of fifty to several hundred. Larvae are present by early July. After feeding for two to three weeks, larvae dig into the soil to pupate. A new generation of moths emerges about two weeks later. There are several overlapping generations extending into October or even November in some years.

Hosts

This species will feed on a very wide variety of plants but prefers grasses. Most turf and pasture grasses are subject to infestation.

Damage

Fall armyworms are potential turf and pasture pests in late summer and fall. Large numbers can consume all above-ground plant parts, and they are capable of killing or severely retarding the growth of grasses. This species may migrate in large numbers in search of new areas in which to feed. Moths are attracted to lights and may lay masses of eggs on non-host plants, walls, clothes on lines, etc.

Inspection and Control

Larvae infesting a lawn can be detected by applying a mixture of 1 tablespoon of dish detergent in 1 gallon of water per square yard. The caterpillars will surface within a few minutes and can be found by separating the blades of grass. Treatment may be needed when five or more larvae are found per square yard. See the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) for specific recommendations.

FIELD CRICKETS

Gryllus **spp.**

Description

Field crickets are black or dark brown insects measuring about 1 inch long as adults. They have large hind legs (for jumping) and most have well-developed wings. Nymphs resemble adults but are smaller and lack wings. Both have long, slender antennae.

Distribution

Various species of field crickets occur over most of the U.S. and all of Oklahoma. There are probably five species in eastern Oklahoma and at least two of these occur in the western part of the state.

Life Cycle

Eggs are usually laid in the soil. The newly hatched nymphs burrow to the surface. They will molt eight to ten times over a period of two to three months before becoming adults. One species overwinters as nymphs and the adults are present in spring and early summer. Others overwinter as eggs and adults are present during summer and fall.

In certain years, field crickets appear in very large numbers during August and September. These outbreaks seem to occur after periods of prolonged dry weather in spring and early summer followed by rainfall in July and August. Extensive soil cracking may be an important factor. Good sites for egg deposition, an abundance of favorable food, vegetation for shelter, and a scarcity of parasites and predators may also be involved.

Hosts

Field crickets will feed on almost anything. They occasionally damage cultivated crops such as alfalfa, cotton, and strawberries. They can also damage vegetables and ornamentals when they are numerous.

Damage

Their major importance is as a nuisance pest when they come to lights in homes and urban areas during periods of high abundance. Their chirping or mere presence is a nuisance to some. Also, they will sometimes damage fabrics, especially if soiled, and may chew on wood, plastic, rubber, or leather goods.

The most serious outbreak in recent years occurred in 1953 when large numbers of crickets invaded cities and towns in many parts of Oklahoma and surrounding states. One report stated, "During warm nights, the streets beneath bright lights were black with crickets, sides of buildings were completely covered with tremendous numbers of the pests, and some streets were hazardous for driving due to the slippery conditions caused by the crushed crickets."

Inspection and Control

Crickets commonly spend the daylight hours hiding in dark, damp areas. Eliminating piles of bricks, stones, wood, or other debris around the home will help reduce numbers. Weeds and dense vegetation around the foundations of homes are other good hiding places. Nearby trash dumps, which provide both food and shelter should be cleaned out. Since crickets are attracted to lights, the elimination of light sources at night will reduce the numbers attracted to the home area. Measures such as caulking, weather stripping, and making sure all screens and doors are tight fitting will help reduce the numbers that can enter your home or business.

Adult crickets can be difficult to control. Inside homes or buildings, ready-to-use sprays or aerosols applied to baseboards, door thresholds, and cracks and crevices where crickets hide will normally control them. Also, it is frequently helpful to spray outside around the foundation, in ornamental beds, the patio, the area surrounding stacked firewood, etc. The outside treatment will help prevent crickets from moving into a building. Chemical recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832) and OSU Extension Fact Sheet EPP-7312.

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GROUND PEARLS

Margarodes **spp.**

David Shetlar, The Ohio State University

David Shetlar, The Ohio State University

Description

The adult female is a pinkish, soft-bodied scale insect with well-developed legs and antennae; the front legs are especially well developed. Adult males are small, gnat-like insects and are only rarely found. Eggs are pinkish white and are laid in clusters enclosed in a white, waxy sac. Nymphs (the ground pearl stage) have a hard, globular, yellowish shell and range from $^1/_{16}$ to $^1/_8$ inch in diameter. The sucking mouthparts extend through the wall of the cyst and are inserted into grass roots.

Life Cycle

Overwintering takes place in the ground pearl stage (nymphs). Females mature in late spring and emerge from their cysts. After a short period of mobility, they settle 2 to 3 inches below the soil surface and secrete a waxy coat. Each female deposits approximately 100 eggs (without mating) inside the waxy coat during the early summer. Nymphs hatch in mid-summer and infest small grass roots. They develop the familiar globular appearance soon after they begin feeding. There is usually one generation per year, but if conditions are not favorable for emergence, female nymphs may remain in the ground pearl stage for two or three years.

Hosts

Ground pearls infest the roots of grasses. Bermuda, St. Augustine, zoysia, and centipede grasses are most commonly found infested.

Damage

The nymphs suck sap from underground plant parts. During summer dry spells, irregularly shaped patches of grass begin to turn yellow. The grass in these spots eventually turns brown and usually dies by fall. Cysts are present in larger numbers at the interface between damaged and healthy grass and may be found as deep as 10 inches in the soil.

Inspection and Control

Examine the soil around grass roots, especially in the edges of damaged areas. Look for the round, yellowish cysts, which is the only stage commonly found during most of the year.

Insecticides have not been effective against ground pearls, partly because they can be found as deep as 10 inches below ground. Good cultural practices such as watering and fertilization may help lawn grasses recover from injury, but such beneficial effects may be only temporary.

MOLE CRICKETS

Family Gryllotalpidae

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

Description

Mole crickets are large, brownish insects. They are rather cricket-like in shape but their front legs are mole-like and used for digging. Adults have wings and many are powerful, though clumsy, fliers. The body is covered with short, dense hairs. Some species have darker or lighter markings on the thorax.

Northern mole cricket [*Neocurtilla hexadactyla* (Perty)]. The front tibia has four claws and the hind femur is longer than the pronotum. The front femur bears a short, nearly semi-circular process armed with stout setae (hairs). Length: 1 to 1 $^{3}/_{8}$ inches.

Prairie mole cricket [*Gryllotalpa major* Saussure]. The front tibia has four claws and the hind femur is longer than the pronotum. The front femur bears a knife-shaped, curved, acute process. Length 1 $^{1}/_{2}$ to 1 $^{3}/_{4}$ inches.

Southern mole cricket [*Scapteriscus acletus* Rehn & Hebard]. The front tibia has two claws that are separated by a space that is almost as great as the width of the claw and is "U" shaped. The hind femur is shorter than the pronotum. There is no process on the front femur. Length: 1 to 1 $^{1}/_{4}$ inches. This species has been reported from either Cherokee, Oklahoma, or Cherokee County but is not known to be established here. It was introduced into the southeastern U.S. in the early 1900s, and now occurs along the coast from Texas to North Carolina. It might eventually reach southeastern Oklahoma and specimens from this area should be examined with this possibility in mind.

Tawny mole cricket [*Scapteriscus vicinus* Scudder] The front tibia has two claws that are separated by a space narrower than their width, and is "V" shaped. It was introduced into Brunswick, Georgia in approximately 1899 and is considered to be the most damaging mole cricket of turf in the southeastern U.S. This species has not been reported in Oklahoma.

Distribution

The two native Oklahoma species (Northern and prairie mole crickets) are found mostly in the eastern two-thirds of the state. These and other native species are found throughout the eastern U.S. The southern and tawny mole crickets are found along the Gulf and Atlantic coasts. Along with the short-winged cricket, they were accidentally introduced into the U.S. from South America.

Historically, the prairie mole cricket was found in prairie areas in central and eastern Oklahoma, eastern Kansas, southwestern Missouri, northwestern Arkansas, and in small areas in Illinois and Mississippi. Recent Oklahoma records are from eight counties in the central and northeastern areas of the state. At one time, this species was being considered for threatened status under the Endangered Species Act, but it is not listed due to insufficient information about its distribution.

Life Cycle

Mole crickets spend most of the year burrowing just below the surface of the soil. They are active above ground in spring (April and May in Oklahoma) for mating and dispersal flights and to some extent in fall (September and October). Eggs are laid in burrows in the soil in the early summer. Southern mole crickets mature in about one year while the northern and prairie species probably have a two- or three-year life cycle.

Hosts

Depending on the species, mole crickets eat plant roots, insects, or decaying organic matter.

Damage

The northern mole cricket prefers damp areas along the margins of streams, lakes, ponds, or in low areas in grasslands. They can damage well-watered lawns, golf courses, etc. by dislodging plants or seedlings as they burrow beneath the soil surface. Dislodged plants become dry and soon die. Mole cricket burrows may be very evi-

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dent, especially in newly seeded or sprigged turf. Mounds of dirt are pushed above the turf and the damaged area is easily scalped.

The prairie mole cricket occurs in tall grass prairie and prefers drier areas. It does not survive plowing or heavy grazing and is now found mostly in hay meadows and other undisturbed areas. It does not cause economic damage in these areas.

Inspection and Control

Mole crickets in turf generally reveal their presence by surface tunneling, but tunnels of small immature crickets are inconspicuous and nearly formless. Once detected, mole crickets must be flushed from the soil if they are to be identified to species. Pyrethrins are the most effective flushing agents, but liquid dishwashing soaps (1 tablespoon per gallon of water) are cheap and available substitutes. The mixture is applied with a garden sprinkler can at a rate of about 1 quart per square foot and the treated area is watched for emerging crickets for several minutes. If crickets are in the area, they will normally come to the surface within 20 minutes.

Another method of collection is flotation. Select a large can such as a two-pound coffee can or one with a diameter of at least 6 inches, from which both ends are removed. Push the can into the turf, through the thatch, and into the soil surface in an area suspected of being infested. Then fill the cylinder with water. If the water recedes, more should be added. If mole crickets are present, they will soon float to the surface.

These methods are not likely to be effective in uncut grassland where prairie mole crickets are found. The most effective survey method for this species is listening for calling males during the mating period (April and May). Males call for about 50 minutes, beginning 5 or 10 minutes after sunset and ending rather abruptly once it is dark. Once a male is heard, the burrow can be located. This species should not be controlled and specimens should not be collected unless there appears to be a good population at the site.

The northern mole cricket only occasionally causes damage to turf in Oklahoma. The most serious problems have been reported on golf greens in the form of root damage, tunneling, and soil excavation (interfering with ball roll on the greens). The major control effort should be directed at the young (nymphal) stages. Because hatching may extend through June or July, treatments should be considered to reduce mole cricket populations (at the earlier, more vulnerable stage). It is generally best to apply insecticide late in the evening. In general, mid to late July treatments are best (repeated if necessary). In some highly maintained areas or in sod to be cut in spring, April treatments may reduce damage from overwintered mole crickets.

Turf that is well maintained recovers more quickly from mole cricket damage than poorly maintained grass. In some cases, it is possible to roll grass damaged by mole crickets and have the turf recovered because roots are pressed back in contact with the soil.

Specific recommendations for controlling mole crickets can be found in the turf section of the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

RED IMPORTED FIRE ANT

Solenopsis invicta **Buren**

April Noble, Antweb.org, www.insectimages.org

USDA APHIS PPQ Archive, www.insectimages.org

History

The red imported fire ant (RIFA) is native to the state of Mato Grosso in Brazil. It was introduced into the U.S. at Mobile, Alabama, in approximately 1940. The exact date and method of introduction is not known. It spread rapidly through the southeastern U.S. during the 1940s and 1950s, and is presently found in 11 states from southern North Carolina and Florida west to Texas and southern Oklahoma.

The first infestation found in Oklahoma was in the Waurika area of Jefferson County in July 1985. Surveys during the fall of 1985 found single colonies in Bryan, Marshall, and McCurtain Counties along the southeastern edge of the state.

The RIFA has continued to spread to the north and west. As of 2008, it has been found in 42 counties as far north as Garfield and Osage Counties and as far west as Jackson County. Many of these infestations are thought to be associated with movement of nursery stock and/or turf. Many of the northern infestations in the state are in small, isolated areas, usually in cities. Many of these have been treated and it is not known if all of these areas currently have active infestations. Some widespread, active infestations are present in the southeastern counties, especially from Love County to McCurtain County along the southern edge of the state.

Identification

The RIFA is a small ant with workers varying from $^1/_8$ to $^1/_4$ inch long. It is usually dark reddish brown in color and has two nodes on the petiole and a two-segmented antennal club. They are similar in appearance to many of our common house and field ants and are especially difficult to distinguish from the Southern fire ant (*Solenopsis xyloni* McCook), which is native to most areas of Oklahoma.

Life History

New colonies are formed by one (or more) winged, mated females (queens) following a mating flight. The mated queens find suitable nesting sites, shed their wings, and begin digging underground chambers in which to lay eggs. The first eggs and larvae are cared for by the queen. They emerge as small workers after three to four weeks. Thereafter, workers care for the queen and the brood, forage for food, and expand the nest.

An undisturbed colony can increase in size rapidly and may contain 10,000 or more workers after one year. Winged reproductives will also be produced sometime in the second half of the first year. A mature colony (three years old) may contain 100,000 to 500,000 workers and several hundred winged forms.

Mounds. As the workers extend the nest, the excavated soil is brought to the surface and a mound begins to develop. The mound may be small and inconspicuous for the first year or more, especially in sandy areas. In soils with considerable clay content, the mounds often reach 12 inches high and 12 or more inches across. Mounds in sandy soils are flatter and wider. The mounds are not denuded of vegetation and may have grass growing up through them. Each mound has several foraging tunnels that extend in all directions away from the mound just under the soil surface. These have openings to the surface at irregular intervals and may extend outward for 200 to 300 feet.

The RIFA will nest in almost any type of soil but mounds are not common in heavily wooded areas. They prefer open, sunny areas such as pastures, parks, lawns, meadows, and cultivated fields.

Spread. Imported fire ants spread naturally during their mating flights. This spread is usually one mile or less but flights of up to 12 miles have been recorded. Flights occur most commonly in spring or early summer, one or two days after a rain when the weather is warm and sunny and the wind is light. Ants can also float downstream in masses or on debris during floods.

The RIFA is also spread by human activities. Winged females appear to be attracted to shiny objects and will sometimes settle on cars, trucks, railroad cars, etc. in large numbers. These ants can be carried for long distances as the vehicles move from place to place. Ants can also be moved with

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nursery stock or grass sod and in soil on soil-moving equipment.

The spread of RIFA is likely to be limited by dry conditions to the west and by cold temperatures to the north. These factors may operate to cause this species to be only an intermittent problem in southern Oklahoma. However, there are some indications that it may be able to survive in most of the same areas as our native fire ant and the eventual limits of its distribution are uncertain at this time.

It seems likely that mounds of RIFA will be found along the southern tier of counties each year. Incidence and numbers will likely vary from year to year based on winter temperatures and spring/summer heat and moisture conditions. A cold winter followed by a drier than normal spring and a hot, dry summer would likely reduce ant survival.

Economic Importance

The most important problem with RIFA is its sting. Workers can sting repeatedly and attack anything that disturbs their mounds or food sources. Symptoms of the sting include burning and itching, followed by the development of a pustule that may take a week or more to heal. Scratching these pustules can lead to secondary bacterial infections and can leave permanent scars. As usual with insect stings, certain persons are hypersensitive to fire ant venom and may suffer chest pains or nausea or lapse into a coma from one sting.

Birds and small animals can be harmed, or occasionally killed, by fire ant stings. They will also sting poultry and domestic animals. The presence of fire ants in crops or gardens may prevent hand picking of fruits and vegetables because of the threat of stings. The presence of mounds may damage harvesting equipment.

In cities, fire ants sometimes nest in electrical circuitry, and they have been known to short out air conditioners, get in telephone junction boxes, traffic and light control boxes, and in transformers. They sometimes nest under sidewalks or highways and as the colony dies out, the area of the nest will sink and cause a pot hole.

Damage to plants occurs under some conditions. They will feed on germinating seeds, causing damage to corn and soybeans. They also feed on buds and developing fruits of crops such as beans, berries, okra, and citrus. They may girdle young trees in an attempt to find a source of water. Fire ants also feed on honeydew produced by aphids. They often tend aphids on plants and the aphids damage plants by their feeding activities.

Control Measures

In general, nonchemical methods are ineffective against fire ants. Digging up or tilling mounds usually results in dispersal of ants or movement of nests; however, boiling water is reportedly a fairly effective treatment for individual ant mounds. Approximately 3 gallons of boiling water poured on a mound will eliminate nests about 60 percent of the time. Surviving nests would need retreatment. This method may work in certain situations, but care must be taken not to pour hot water on desired plants. Also, extreme care should be exercised when handling large volumes of hot water to avoid serious burns.

Best control has been achieved with chemical treatment of nests and surrounding areas. Usually, desirable levels of control are achieved if treatment is made within two or three hours after sunrise or within a couple of hours of sundown. Individual mounds can be treated using drenches, surface sprays, granules, or baits. Because these ants can make deep gallery systems, drenching usually achieves more reliable results than surface sprays.

An easy effective method to drench a mound is to use a liquid insecticide diluted in water (per label directions) and applied from a sprinkling can. Thoroughly wet the center of the mound with 2 to 3 quarts of drench. Allow a few minutes for this to soak into the soil then use 1 to 2 gallons of drench over the rest of the nest. After allowing this to soak in a few minutes, pour the remainder of the drench (1 to 2 quarts) in the center of the nest.

Insecticide granules can be sprinkled on the top of and around a mound. These should be applied at rates specified on the product label. Treatment should be followed by a gentle watering of the mound.

Several products contain insecticides or insect growth regulators (IGR's) on a bait of processed corn grits coated with soybean oil (or similar material). Insecticide or IGR baits can be applied around individual mounds (at labeled rates). Baits should be applied when worker ants are actively foraging. This can be determined by leaving some greasy food (e.g., tuna fish, peanut butter) near a mound and checking it for ant activity or observing ant trails around mounds. During hot summer days, the worker ants are inactive during the day and forage during the night. In most cases, baits should be applied in late afternoon or early evening.

To treat individual mounds with bait, sprinkle the recommended amount of product around, but not on the undisturbed mound. The bait should be sprinkled 1 to 3 feet away from the mound. Depending on the active ingredient, several days to several weeks may be required to eliminate the mound's ant population. Since soybean oil becomes rancid and less attractive to worker ants when stored improperly, a bait containing soybean oil should be used as soon as possible after opening the package. The bait should be stored in a cool, dry location away from sunlight. Moisture and rain will dissolve bait particles, so use baits only when grass and soil are dry and no rain is expected within several hours after treatment.

Whatever control method you use, it is important not to disturb the mound before or during treatment since this will cause ants to move away from the chemical. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

SHORTTAILED CRICKET

Anurogryllus arboreus **Walker**

Oklahoma State University

Description

These crickets are similar to field crickets except for the short ovipositor, from which their common name derives. They are light brown with a body length of about $^{3}/_{4}$ inch. They shed their hindwings soon after becoming adults and never fly. Nymphs are smaller than adults, light brown, and lack wings.

Life Cycle

Shorttailed crickets overwinter as nymphs in burrows in the soil. After several molts in early spring, they reach the adult stage. Mated females begin to lay eggs in late spring or early summer. Hatching takes place in a multi-chambered burrow constructed by the adult. For a short period of time, both eggs and nymphs may be found in the burrow. Between the fourth and sixth instars, nymphs leave the parent burrows and construct burrows of their own. At first the burrows are small, but as the crickets mature the burrows are enlarged and may reach depths of 12 to 20 inches. Only one cricket is found per burrow except when certain burrows contain eggs and nymphs. There is one generation per year.

Hosts

These crickets feed on grasses, weeds, and pine seedlings. Their damage to turfgrasses by feeding is apparently negligible.

Damage

In turf, burrows constructed by nymphs and adults result in unsightly mounds of small soil pellets, which may smother the surrounding grass. In Oklahoma, they are seldom noticed until the maturing nymphs begin to construct new burrows in late summer. This is usually sometime in August and activity continues through October and, in some years, through most of November. The burrows are rebuilt each time they are washed away by fall rains.

Inspection and Control

Look for mounds of small soil pellets or soil deposits similar to those constructed by crayfish. Treatment provides only partial control and is seldom needed unless large numbers of mounds are encountered. If treatment is attempted, chemicals suggested for white grubs and other soil insects could be used. These can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

Notes

Notes

SOD WEBWORMS

Crambus, *Parapediasia*, and *Surattha* spp.

Marlin Rice, Iowa State University

Jim Kalisch, University of Nebraska-Lincoln

Description

Sod webworm moths can be distinguished from most other moths by their appearance. When at rest, their long labial palpi extend snout-like in front of their heads. The moths also fold their wings partially around their bodies so that they appear very slender. Most species are brownish or dull ash gray with white or grayish hindwings. Many of the *Crambus* species have a white streak from the base to the outer margin on the front wings. Most species measure about $^{1}/_{2}$ inch in length and have a wingspan of about $^{3}/_{4}$ inch. Eggs are very small, oblong, and white to pale yellow. Larvae vary from pinkish white to yellowish to light brown with yellowish brown, brown, or black heads. They have thick bodies, coarse hairs, and paired dorsal and lateral dark spots on each segment. Most species are about 1 inch long when mature.

Life Cycle

Sod webworms overwinter as larvae in the thatch or soil. Some species do so as mature or nearly mature larvae, while others overwinter as small larvae. Larvae resume feeding or pupate in spring. Moths emerge during late spring or early summer, depending on species. Adult activity occurs most often during the early hours of night. After mating, females scatter their eggs indiscriminately as they fly over turfgrasses. Eggs hatch in seven to ten days and young larvae immediately begin to feed and construct silken tunnels in the soil. During hot weather, most feeding occurs at night or on cloudy days. Large larvae may cut off entire grass leaves and pull them into their silken tunnels. Some species have only one generation per year, but many have two or three per year with approximately six weeks elapsing between egg deposition and adult emergence.

Hosts

With rare exceptions, sod webworms feed primarily on plants of the grass family. Turfgrasses most commonly recorded as hosts include Kentucky bluegrass, perennial ryegrass, fine fescue, and bentgrass. Records of damage to warm-season grasses are relatively few, however some species will damage bermudagrass and zoysiagrass. The buffalograss webworm, *Surattha indentella* Kearfott, feeds almost exclusively on buffalograss.

Damage

Young larvae feed only on the surface layers of leaves and stems. The first evidence of damage to a normally growing lawn may be small patches of leaves that are yellow to brown during summer. Larger larvae cut off grass blades just above the thatch line and pull them into their tunnels to eat them. The injury appears as small brown patches of closely cropped grass. If many larvae are present, these patches run together to form large, irregular brown patches.

The presence of webworms under drought conditions constitutes the most serious situation for potentially heavy turfgrass damage. Not only can the dormancy of the grass restrict the manifestation of early feeding symptoms, but all too often the dead turf does not become evident until fall rains revitalize the turf.

Inspection and Control

Adult moths are often noted flying in erratic, zigzag patterns close to the turf surface at dusk; however, the presence of a large number of small moths flying over the lawn does not necessarily mean that a heavy larval infestation will occur. Nor does the presence of flocks of birds feeding on the lawn during the day signify a heavy infestation. These phenomena, however, should cause the presence of webworm larvae to be suspected and should not be ignored.

Since the presence of adults is not a positive indication of potentially damaging larval populations, larval abundance should be determined before a decision is made to apply an insecticide. Infestations in the lawn can be detected by applying 1 tablespoon of pyrethrin or dish detergent in 1 gallon of water per square yard. Caterpillars will surface within a few minutes and can be found by separating the blades of grass, particularly at the interface between living and dead areas of turf. Treat when 15 or more larvae are found per square yard. Preventative treatments are suggested for newly planted lawns. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

WHITE GRUBS

Phyllophaga **and** *Cyclocephala* **spp. and** *Popillia japonica* **(Neuman)**

Notes

Steven Katovich, USDA Forest Service, www.insectimages.org

Steven Katovich, USDA Forest Service, www.insectimages.org

Description

White grubs are the larval stage of several scarab beetles, including May or June beetles, masked chafers, and Japanese beetles. Adult May or June beetles (*Phyllophaga* spp.) are oblong, robust insects. There are many species in Oklahoma, but most are shiny, reddish brown or dark brown, and measure 3/4 to 1 1/4 inches in length. They are often incorrectly referred to as "Junebugs." Adult masked chafers (*Cyclocephala* spp.) resemble May beetles but are smaller and yellowish brown. White grub larvae are white, C-shaped grubs with distinct, brown heads and three pairs of legs near the front end. There are two rows of stout hairs (the radula) on the underside of the last abdominal segment of *Phyllophaga* spp. *Cyclocephala* spp. larvae (often called annual white grubs) have scattered, stout, hooked spines on the underside of the last abdominal segment. Adult Japanese beetles (*Popillia japonica*) are about the same size as masked chafers, but the body is metallic green with bronze wing covers. A row of five white tufts of hair are found along each side of the body next to the outer edges of the wing covers. The larva is a typical white grub with a brown head and three pairs of short legs and measures about 1 inch when fully grown. Hairs located on the underside of the last abdominal segment form a "V" when examined under magnification.

Life Cycle

May or June beetles have life cycles ranging from one to three years, depending on species and location. It appears that many species in Oklahoma have two-year life cycles. Adults emerge from the soil, some species as early as early April and others extending into mid September. Adults of most species are most common in May and June. After mating, females enter the soil and deposit about 50 eggs in small, earthen cells over a period of one to three weeks. Larvae hatch three to four weeks later and begin feeding on dead organic matter, later moving to the roots of plants. In fall, larvae move deeper into the soil for the winter. The following spring they move back to the root zone to feed; most of their damage occurs during this time. At maturity, they move deeper into the soil to pupate.

Masked chafers and Japanese beetles have one-year life cycles. They overwinter as third-instar larvae deep in the soil. Larvae migrate upward in March and April and resume feeding until May, doing most of their damage during this period. They then move deeper in the soil for pupation. Adults emerge during June and July and mate. Females enter the soil and lay 10 to 30 eggs, which hatch two to three weeks later.

Hosts

Annual white grubs are more likely to feed on dead organic matter than May or June beetle larvae and can develop on this diet alone. Japanese beetles feed on roots of turf as well as those of other plants. Adult May or June beetles feed on the young, tender leaves of a variety of deciduous trees. Japanese beetle adults feed on more than 300 different plant species. Masked chafers are reported not to feed as adults.

Damage

Above ground symptoms of white grub damage are browning and dying of the grass in localized spots or in large irregularly shaped areas. Where infestations are heavy, the grass roots may be entirely eaten away and the turf may be rolled back like a carpet. Damage may be severe in September and October when grubs are reaching maturity. White grubs are rarely a problem in bermudagrass but typically damage cool season grasses like bluegrass and fescue.

Inspection and Control

Examine the soil around the grass roots. Dig in brown areas near the edge of green, healthy areas of grass. If the soil is dry, you may need to dig

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6 to 10 inches deep to find larvae. The lawn should be treated if five or moreMay or June beetle larva per square foot are found. Golf fairways should probably be treated if examination reveals an average of three May or June beetle larvae per square foot. Higher numbers of annual white grubs and Japanese beetle grubs can be tolerated as they are smaller and more likely to feed on dead organic matter, especially in the third instar. Studies on annual white grubs in Kentucky have indicated it takes at least eight or nine larvae per square foot to damage moisture-stressed Kentucky bluegrass turf.

Chemical controls for all common root-feeding species of grubs should be applied in late summer or early fall (mid August through September) in Oklahoma (killing the newly hatched grubs from summer egg lay). Turf should be watered thoroughly before treatment unless adequate rainfall has provided soil moisture. One should also water thoroughly after treatment to help move the insecticide into the root zone where white grubs are found. Larger grubs found in the soil are more difficult to control with insecticides. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

PESTS IN AND AROUND THE HOME

BLACK FLIES - BUFFALO GNATS

Family Simuliidae

Oklahoma State University

Simuliidae is a small family of blood sucking flies commonly known as black flies or buffalo gnats. More than 100 species are known from North America and new ones are still being described. Recent studies have shown the existence of species groups in which two or more species can be distinguished only by studying the giant chromosomes of the salivary glands of the larvae. These species are known as cytospecies or sibling species. Even though they may appear to be identical, they often live in different habitats and do not interbreed.

Black flies have not been studied in Oklahoma, but it appears we should have perhaps a dozen species. Most of these are in the genus *Simulium*, but one species of *Cnephia* (*C. pecuarum*) has been reported here.

Biology

Egg laying habits vary with the species, but all lay their eggs in running water. Some lay in masses on plants trailing in the water, others drop the eggs singly into streams, while others lay their eggs in long strings. Each female will lay from 150 to 450 eggs. The eggs are white to orange when laid and darken before hatching. Hatching in species with several generations per year can take from four to 30 days depending on species and temperature. Species with one generation per year often enter diapause in the egg stage, so hatching can take as long as seven months.

Larvae occur only in running water. Some species are found in clear mountain streams, some in temporary streams, some in rivers, and some only around springs or reservoir outlets. Some species breed successfully in irrigation ditches. Larvae are usually brown, gray, or black in color with a light brown head. They are somewhat club shaped and have a prominent pair of mouth brushes with which they gather food. They feed on small organisms and detritus found in the water. Larvae attach to stones, vegetation, and other objects by means of a sucker-like disc at the end of the abdomen. The larval period may be as short as two weeks in late spring or may extend from October into early spring in species that overwinter as larvae, but larvae development only occurs when there is running water or sufficient movement to accelerate oxygenation of the water.

Pupation takes place on rocks or other objects in the water. Each larva spins a basket-shaped cocoon open at the downstream end in which to change to an adult. The pupal period lasts only two to six days in some species and up to three or four weeks in others.

When the adult emerges, it floats to the surface in a bubble of air and quickly flies away. Mating occurs in swarms in many species but on the ground near the emergence site in others. Both males and females feed on nectar and the females of most species also require a blood meal for development of the eggs. Some species feed mostly on birds while others prefer to feed on mammals.

Adults are often found several miles from the nearest known breeding area. They are commonly reported to move 7 to 15 miles and wind-aided migration of 90 to 150 miles have been reported in some cases.

The most common species in Oklahoma appears to have two generations per year. One generation begins in October, the larvae overwinter, and the adults emerge in the spring. The other generation occurs in April and May. Numbers depend on the availability of running water and on water temperature. Larval numbers are known to decline sharply when water temperatures reach 75° to 80° F.

Importance

Humans as well as domestic animals may be viciously attacked. The eyes, ears, nostrils, wrists, and all exposed parts of the body of man are subject to attack. The extreme pain, itching, and the resultant local swellings, together with occasional severe complications, indicate the presence of an active allergin. In some individuals, the face, arms, and other exposed parts may be greatly swollen as a result of the bites; in others, effects other than blood loss may scarcely be noticeable.

Livestock and poultry are sometimes killed by large numbers of black flies. Death seems, in most cases, to be the consequence of a toxemia caused by the bites or the result of an anaphylactic shock; although debility resulting from blood loss and suffocation brought about by inhalation of the flies is apparently a contributing cause. In addition, certain species are known to transmit leucocytozoon, microfilaria, and trypanosome infections in poultry.

Control

Under Oklahoma conditions, it is not practical or efficient to attempt chemical control. Some personal protection is provided with repellents (e.g. those containing DEET or Avon's Skin So Soft). Vanilla extract is also reported to repel black flies. In general, problems with black flies normally disappear by the end of May or early June with the completion of the late spring generation that occurs with running waters provided by spring rains).

CARPENTER ANTS

Family Formicidae

Carpenter ants are a nuisance when found in parts of the home such as the kitchen, bathroom, living room, or other areas. If only one or two large, wingless ants are found, they may simply be foraging for food with the nest located outside. However, if 20 to 25 large winged and/or wingless ants are found indoors in the daytime near one location, it is possible that the colony is well-established in the home and the nest may have been extended into sound wood, causing damage. These ants are second only to termites in damage caused to wooden structures.

Identification

Ants can be separated from termites by the presence of a narrow waist and elbowed antennae, and in winged forms, by the first pair of wings being larger than the second pair. Termites have a broad waist, straight antennae, and two pairs of wings that are similar in size.

Ants are separated from other families of Hymenoptera (bees and wasps) by the presence of a one or two segmented petiole (the narrow waist) between the thorax and the enlarged part of the abdomen (gaster).

Carpenter ants (genus *Camponotus*) can be recognized by their large size, one segmented petiole, circular ring of hairs around the anus, 12 segmented antennae, and evenly arched (convex) thorax (in side view).

Black carpenter ant [*C. pennsylvanicus* (DeGeer)]. The largest ant in Oklahoma; queens (with wings) being about $^3/_4$ inch long and the larger workers at least $^1/_2$ inch long. Color is usually entirely black, but some workers have varying amounts of brown on the thorax.

Two other species **[*C. caryae discolor* (Buckley) and *C. sayi* Emery]** can be found in homes in Oklahoma. Both have a reddish brown thorax and a dark brownish-black gaster. Queens are about $^1/_2$ inch long and the larger workers are about $^1/_4$ inch long. The species are difficult to separate.

At least eight other species of carpenter ants have been found in Oklahoma. Some nest in the soil or in hollow twigs or insect galls and none are very common. They will rarely, if ever, be found in homes.

Life Cycle and Habits

Winged male and female carpenter ants (swarmers) emerge from mature colonies in the spring (March to June). After mating, males die and newly fertilized females establish a new colony in a small cavity in wood, under bark, etc. and lay a small number of eggs. The queen cares for the first brood, feeding the larvae a secretion from her salivary glands. She does not feed during this period, but utilizes stored fat reserves and wing muscles for her nourishment. The few, small workers emerging from the first brood assume the duties of the colony by collecting food, excavating galleries to enlarge the nest, and tending the eggs, larvae, pupae, and queen. The queen has few remaining duties except to lay eggs.

In later generations, workers of various sizes are produced. All are sterile females. The larger (major) workers guard the nest, battle intruders, explore, and forage for food while the smaller (minor) workers expand the nest and care for the young and the queen. Workers, when disturbed, carry off the larvae and pupae, which must be fed and tended or they die. Carpenter ants **cannot sting** but have strong jaws and readily bite (a sharp pinch) when contacted. A black carpenter ant colony matures in three to six years and may contain 2,000 to 4,000 workers. At this time, winged males and females will be produced. Other species usually have smaller colonies, sometimes only a few hundred workers.

Nests are usually established in soft, moist (not wet), decayed wood, but occasionally they nest in existing wood cavities or voided areas in a structure that are perfectly dry. Workers cut galleries in the wood, expanding the nest size for the enlarging colony. Galleries are irregular, usually excavated with the wood grain into softer portions of the wood. The walls of the nest are smooth and clean (appearing as if sandpapered), and shredded sawdust-like wood fragments are carried from the nest and deposited outside. These piles of wood fragments, often found beneath special slit-like openings or nest entrances, may contain portions of insects, empty seed coats, etc.

Under natural conditions, carpenter ants nest in live and dead standing trees and in rotting logs and stumps, but they are also adapted to nesting

in homes and other buildings, telephone and telegraph poles, and in other wood or wood products used by man. During the warmer months of the year, workers may invade homes from outdoor nests Quite often the ants make conspicuous trails on the lawn or soil in passing to and from their nest. Infrequently the ants are accidentally brought into homes with firewood. It appears quite definite that homes in the vicinity of trees, logs, or stumps suffer more from carpenter ant attack than homes some distance from them, and that older homes are more frequently attacked than new ones because the woodwork in them may be in poorer condition. The ants seem to enter homes through faulty, decayed, or moist wood, and although their nest may begin there, it may extend into adjacent solid woodwork.

Carpenter ants do not eat wood; they only excavate galleries in which to rear their young. They feed on a great variety of plant and animal materials including plant juices, fresh fruits, insects (living or dead), meats, syrup, honey, jelly, sugar, grease, fat, and honeydew from aphids and other insects. They feed readily on termites and usually will not co-exist with them in a home. Workers are known to forage for food as far as 100 yards from their nest.

Control Measures

The most important and often the most difficult part of carpenter ant control is locating their nest or nests. Once the nest location is found, control is often rather simple. Sometimes more than one colony is present in the structure or on its grounds, so a thorough inspection is very important.

Interview. Often children and adults of the residence know where ants are seen, where large numbers are most prevalent, movement patterns, moisture in the structure, moisture problems of the past, if swarmers were seen, or location of sawdust-like material in piles, populations outdoors, etc. Children can sometimes lead you straight to the nest.

Inspection Indoors. Carpenter ants prefer to nest in wood with a considerable moisture content (more than 15 percent), often caused by rain, leaks, condensation, etc. Structural timber is about 12 to 15 percent moisture. A moisture meter can find wet spots to pinpoint possible nest locations. Check wood affected by moisture from contact with the soil such as steps, porch supports, and siding, seepage from plugged drain gutters, chimney flashing, wooden shingle roofs, hollow porch posts, columns, or curtain rods, leaking window and door frames, window boxes, crawl spaces, dish and clothes washers, pipes, refrigerator drip pans, poor pitch of porch roofs, flat deck porch roofs, under porches, attics, etc. Nests may also be found in dry environments, such as hollow veneer doors, small void areas between the door casing and ceiling, false beams, or under insulation in attics. Look for damaged timbers, swarmers in spider webs, indoor wood piles, piles of wood debris (pencil sharpener shaving-like) ejected from the colony, etc.

Flushing Agent. A household aerosol spray or space spray (e. g. one containing pyrethrins and piperonyl butoxide) applied directly into cracks, crevices, or holes, will excite the ants (repellent action) causing them to come running out and revealing the presence of their nest in some instances.

Inspection Outdoors. Look for ants traveling from a tree or stump to the structure. They may travel over tree branches or vines touching the roof, electrical and telephone wires, fences next to the house, piles of firewood, logs, or railroad ties nearby or hollow living trees with entrance knot holes, etc. They may also move into the home via wooden porch or patio supports/columns. Workers are most active at night, traveling from their nest to a food source following trails but no particular trail leading directly to the nest.

Sound Detection. An active colony may produce a distinct, dry rustling sound (sometimes loud), heard in a wall when standing in a room. A listening device, such as a stethoscope, may be useful when conditions are quite and outside noises are at a minimum. Tapping on an infested wall may cause an increase in the noise, which appears to be a form of communication, if the colony is disturbed.

Prevention. Homeowners should trim all trees and bushes so branches do not touch the house and correct moisture problems such as leaking roofs, leaking chimney flashing, leaking plumbing, poorly ventilated attics or crawl spaces, and blocked gutters. Replace rotted or water damaged wood and eliminate wood to soil contact, remove dead stumps within 50 feet of the house if practical, and repair trees with broken limbs or holes in the trunk. Be sure to store firewood off the ground and away from the house. Bring in only enough firewood to be used quickly. Consider non-organic mulches near the house in heavily ant infested areas. High moisture conditions must be eliminated to help control carpenter ants, prevent future attacks, and prevent wood decay fungus infection.

Treatment. The best control will be obtained if insecticide is applied to the nest and nest area. Dust formulations are particularly effective for treating the nest galleries. Spraying or dusting the infested area with residual insecticides without locating and treating the nest usually does not give complete control. Some of the foraging workers will contact the insecticide and die; however, some of the ants confine their activities to the inside of the nest and would survive this type of treatment. Also, the queen and developing larvae would not be affected. Considering that individual carpenter ants can live for well over six months without feeding, it becomes obvious that the galleries of the nest must be treated.

Thus, insecticides should be applied so as to reach as many as possible of the areas inhabited or traveled by the ants. It is often advisable to drill holes so that treatment can be made into hollow structures, wall voids, or similar hidden areas where ant nests are suspected.

CARPENTER / WOOD BEE

Xylocopa virginica **(L.)**

Oklahoma State University

Oklahoma State University

USDA Forest Service Archive, www.insectimages.org

Description

Carpenter bees are large, black and yellow insects about 1 inch long. They resemble bumble bees but the abdomen (rear end) is black and shiny and does not have the extensive yellow hairs found on bumble bee abdomens. The females can sting but rarely do so unless molested. The males cannot sting. Males have a yellow face, while females have a black face.

Life History

Adults overwinter in nest tunnels in wood. They emerge in the spring, usually in late April or early May, and mating occurs within a few weeks. The newly fertilized female establishes a nest by burrowing into wood at right angles to the grain for about an inch. The tunnel has clean-cut, sharp edges and is $^{3}/_{8}$ to $^{1}/_{2}$ inch wide. The entrance and tunnels may appear like they were made with a brace and bit. The female then makes a 90 degree turn and burrows with the grain, usually for 4 to 6 inches. When the nest is completed, she places a mixture of nectar and pollen at the end and lays an egg on it. This will be the food supply for the developing larva. She then seals off the cell with a partition of chewed wood pulp. This process is repeated until six or eight cells have been formed. The female may build a new nest by extending an old nest, and galleries up to 10 feet long have been formed in some cases. Larval development takes five or six weeks and new adults emerge during the summer and fall. These new adults store pollen in preparation for hibernation but do not mate and do little if any nest building. Carpenter bees frequently return to the nesting site(s) during following years.

Economic Importance

Wood chosen for nest building is usually a type that is soft and easy to work, such as redwood, cypress, cedar, or white pine. Other harder woods may be selected if they have been softened by exposure to the weather for extended periods of time. Structural damage by one or two carpenter bees is usually slight, but if subsequent generations extend the old burrows for a number of years, serious damage may result. There have been reports of collapse of structural timbers due to unchecked activity of carpenter bees through a number of years. Also, abandoned nests are often infested with secondary pests, especially dermestid beetles.

Control

Carpenter bees can generally be controlled with: Sevin® wettable powder mixed as a spray and applied to the opening of the nest or Sevin 5® percent dust blown into the tunnels with a duster. It is generally best to treat the nest (tunnels) at dusk or after dark when the temperature is cooler; thus, the bees are calmer. Repeated application 7 to 10 days later may be needed to obtain complete control. Also, it is helpful to plug the nest openings with pieces of dowel rod or corks about 24 hours after treatment. In hard to reach locations, broadcast treatment with Sevin directed at the bees and the nest opening will help reduce the population of bees. Frequently, this type treatment has to be repeated several times to obtain good control. It is reported that a spray mix of 2 tablespoons of liquid detergent per gallon of water will kill bees and wasps if the insects are directly hit (soaked) by the spray. Other recommendations for control are found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832). For more information on carpenter bees, honey bees, bumble bees, etc., see OSU Extension Facts EPP-7317.

CARPET BEETLES

Family Dermestidae

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Carpet beetles feed on animal and plant substances such as wool, fur, feathers, hair, hides, horns, silk, and bone as well as cereals, cake mixes, red pepper, rye meal, and flour. Other food sources include powdered milk, dog and cat food, leather, book bindings, dead insects, and even cotton, linen, and rayon when stained with spilled foods or animal excreta. The larvae cause the damage, crawling from room to room and living behind baseboards and moldings, and in air ducts, dresser drawers, carpets, clothing, and furniture. Adult beetles fly readily and may be found outdoors feeding on pollen, especially on plants with white or cream colored flowers.

Identification

Black carpet beetle [*Attagenus unicolor* (Brahm)]. Adults are oval and shiny black with brownish legs. They vary in length from $^{1}/_{8}$ to $^{3}/_{16}$ inch. Larvae are golden to dark brown and about $^{1}/_{2}$ inch long. The body is narrow and elongate and narrows toward the rear. There is a long brush of bristles at the end of the abdomen. This species is common in Oklahoma.

Varied carpet beetle [*Anthrenus verbasci* (L.)]. Adults are about $^{1}/_{10}$ to $^{1}/_{8}$ inch long and nearly round. The top surface is usually gray with a mixture of white, brown, and yellow scales and irregular black crossbands. The bottom surface has long, gray-yellow scales. Larvae are about $^{1}/_{4}$ inch long and light to dark brown in color. The body is wide and broader at the rear than the front. There are tufts of hair near the tail end. They are very common in Oklahoma.

Furniture carpet beetle [*Anthrenus flavipes* LeConte]. Adults are about $^{1}/_{16}$ to $^{1}/_{8}$ inch long, nearly round, and whitish checkered with black spots, each outlined with yellowish orange scales. The bottom surface is white and the legs have yellow scales. Larvae are about $^{1}/_{4}$ inch long, elongate-oval, and thickly covered with brownish hair. This species is not common in Oklahoma but has been found on a few occasions.

Common carpet beetle [*Anthrenus scrophulariae* (L.)]. Adults are about $^{1}/_{10}$ to $^{1}/_{8}$ inch long, nearly round, and gray to black. They have minute, whitish scales and a band of orange-red scales down the middle of the back and around the eyes. Larvae are similar to those of the varied and furniture carpet beetles. They are not common as far south as Oklahoma, but possibly could be found here.

Life Cycle and Habits

All carpet beetles pass through four stages: egg, larva, pupa, and adult. Adults fly readily and during warm sunny days feed outdoors on pollen of various flowers and shrubs, especially spirea and crepe myrtle. Depending on the species, each female may lay 40 to 90 white eggs which hatch in 8 to 15 days. Eggs laid indoors are found in lint accumulations near the food source, in air ducts, under heavy furniture, behind baseboards, etc.

After hatching, larvae begin their destructive feeding, avoiding light and molting several times as they develop. They may spend 60 days to a year or more in the larval stage, depending on species, type, and amount of food available, and temperature. When rooms are warm indoors, the life cycle is shorter than in an unheated portion of the house during the winter. In the spring, the pupal stage is followed by new adults. The black and varied carpet beetles usually have only one generation per year, but other species may have three or four generations per year.

Some infestations are started by adult carpet beetles that fly from house to house. Also, carpet beetles breed and feed outdoors in places such as bird and rodent nests. Some adult beetles are attracted to flowering plants close to homes and can easily enter through small openings.

Eggs and larvae may be carried into homes on articles containing wool or other animal fibers. The articles on which they hitchhike most commonly are secondhand clothing, upholstered furniture, and material such as woolen scraps (as for rug or quilt making).

Carpet Beetle Biology

Species	Longevity	Time to Sexual Maturity of Adults	No. of Eggs Laid
Black	6-12 months	30-60 days	90
Varied	8-12 months	14-44 days	40
Furniture	3-4 months	30-60 days	60
Common	2.5-3.5 months	20-30 days	60

Control Measures

Inspection. Locate the source of infestation before treatment. Carpet beetle larvae prefer to feed in dark, protected places. Check lint under baseboards, in and under upholstered furniture, in air ducts, stuffed animals, stored cereals or grain, abandoned bird or wasp nests, under eaves or in attics, in woolens, clothes closets, furs, etc. Also, check all boxes and suitcases in storage areas for the presence of beetles or damage. In all areas, cast skins may be more abundant than larvae. Adult beetles flying around windows may indicate the presence of an infestation.

Prevention. Good housekeeping is critical. Use a strong suction vacuum cleaner with proper attachments to remove lint, hair, and dust from floors, shelves, and drawers. Periodically brush, air outdoors, or dry clean furs, woolens, blankets, etc. Thoroughly and frequently clean rugs, carpets, draperies, furniture, baseboards, air vents, and moldings. Destroy untreated worthless animal skins, valueless insect or dried plant collections, old woolen rags, and old clothing. Clean pet bedding and remove bird and wasp nests and dead rodents from the premises. Cedar lined closets and chests do not provide 100 percent protection from carpet beetles. Fur storage in cold vaults is effective. Mothproofing when woolens are manufactured may be effective forever, whereas treatments at dry cleaners are less permanent and may need to be **renewed regularly.**

For home storage, be sure that all cloth goods are dry cleaned, washed, pressed with a hot iron, sunned, or brushed prior to storage. Use one pound of naphthalene flakes or balls or paradichlorobenzene (PDB) crystals per 100 cubic feet of closet space for best protection. Any tight box or bag that can be sealed is a good storage container. Place garments in container and add PDB or naphthalene interspaced between sheets of paper. Use one ounce per two cubic feet of container space. As these chemicals evaporate they produce a vapor that, in sufficient concentration, kills carpet beetles. The mere odor of the chemical does not repel the insects and is no indication that the concentration of vapor is sufficient to kill them. To be effective in holding the vapor, the container must be airtight. Even in an airtight closet, protection is lost if the door is opened frequently.

Treatment. Infested items can be sprayed with properly labeled products (these are often available as ready-to-use pressurized aerosols). All cracks and crevices in infested areas (e.g. around and behind baseboards, cabinets, etc.) should be treated.

If one encounters extremely large and/or heavy infestations of carpet beetles, you should consider hiring a pest control firm to treat the house. Besides interior treatments, the firm may need to treat attics and crawlspaces and exterior areas such as around windows, doorways, etc. Specific control recommendations for carpet beetles are listed in the *OSU Extension Agents Handbook of Insects, Plant Disease and Weed Control* (publication E-832).

CIGARETTE BEETLE - DRUGSTORE BEETLE

Lasioderma serricorne **(Fab.) -** *Stegobium paniceum* **(L.)**

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

Natasha Wright, Florida Department of Agriculture and Consumer Services, www.insectimages.org

Identification

Adult cigarette beetles are yellowish to reddish brown, oval-shaped, and about $^{1}/_{10}$ inch long. The head is bent downward sharply, giving the body a humpbacked appearance when viewed from the side. The wing covers (elytra) are smooth. The antennae are uniformly serrate (saw-like).

Adult drugstore beetles are reddish brown, more elongate, and about $^{1}/_{10}$ inch long. The head is bent downward but does not result in a distinct humpbacked appearance. The wing covers are striated (faint lines running lengthwise). The antennae have three enlarged segments at the tip.

Larvae of both species are C-shaped grubs about 3/16 inch long when mature. Cigarette beetle larvae are creamy white and covered with long, yellowish brown hairs. They have a brown head and legs. Drugstore beetle larvae are similar but do not have the fuzzy appearance.

Life History

Both beetles can live from two to four weeks, and during this time, females can lay 30 to 100 oval, whitish eggs in foodstuffs. The eggs hatch in 7 to 20 days. Larvae reach maturity in 30 to 50 days, and then pupate in a silken cocoon covered with bits of the material on which they fed. The pupal period is 8 to 10 days long. The life cycle can be completed in 40 to 50 days under ideal conditions. There are usually three to six generations of cigarette beetles and one to four generations of drugstore beetles each year. The beetles can fly but usually hitchhike in infested materials distributed by man.

Economic Importance

Cigarette beetles commonly infest dried tobacco and tobacco products. They also infest raisins, figs, dates, ginger, pepper, nutmeg, chili powder, curry powder, cayenne pepper, paprika, drugs, legume seeds, barley, cornmeal, flour, soybean meal, sunflower meal, wheat, wheat bran, rice meal, beans, cereals, fish meal, peanuts, dry yeast, dried flowers, leather, woolen cloth, and bamboo. They have been known to damage the leaves and bindings of books when feeding on the paste and overstuffed furniture when infesting the stuffing (hair, straw, etc.).

Drugstore beetles will feed on many drugs, including poisonous substances such as belladonna and strychnine. They infest almonds, peanuts, paprika, red pepper, alfalfa meal, cornmeal, flour, milo, wheat, wheat bran, wheat germ, dry dog food, bread, beans, coffee beans, fish meal, spaghetti, instant chocolate, powdered milk, books and manuscripts, dried flowers, and certain fillers and fabric coverings of furniture.

Control Measures

Prevention. At the time of purchase, examine foods such as cornmeal and macaroni for infestations, and check the packaging date to establish freshness. Purchase seldom-used foods in small quantities to prevent long storage periods of one month or more. Susceptible foods should be stored in insect-proof containers of glass, plastic or metal, or store in a refrigerator. Use older packages before new ones, avoid spillage in cabinets, and always keep food storage areas clean.

Inspection. Locate the source of the infestation by carefully examining all seldom-used foods and least-disturbed storage areas. Inspect packages of pancake flour, spices, cornmeal, raisins, dry dog and cat food, birdseed, etc. Dispose of heavily infested foods in heavy plastic bags in the garbage, or bury deep in the soil. Lightly infested foods or food products where there are questionable infestations can be heated in shallow pans in the oven at 130 to 150° F for 30 minutes (or use a preheat setting of 30 to 45 seconds in a microwave oven) or placed in a deep freezer at 0° F for seven to ten days. Sifting the food material will remove

most of the insect fragments and any remaining will not cause harm if consumed. Heat-treat dried fruits by placing in a cheesecloth bag and dipping in boiling water for about six seconds. Note: Seeds saved for planting may have the germination reduced by super heating or cooling.

Treatment. The use of insecticides should be supplementary to sanitation and proper food storage. Treatments are not effective on insects within the food packages. For control of beetles flying around windows and doors inside, use a household aerosol insecticide labeled for flying insects. For a treatment for cracks and crevices to control beetles, use a residual insecticide labeled for use in food storage/handling areas. Before treatment of cabinets and other storage areas, remove all food, food packages, utensils, dishes, and other food-related items. Cover these items to prevent accidental spray drift. Vacuum cabinets and shelves to pick up spilled and loose infested food, then scrub with soap and hot water. After drying, spray lightly, forcing spray into cracks and crevices, or apply with a paintbrush. After the spray has dried, cover shelves with clean paper or foil before replacing food and cooking utensils. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

Notes

CLOTHES MOTHS

Family Tineidae

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

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Clothes moth larvae feed on wool, feathers, fur, hair, leather, lint, dust, and paper. They may damage cotton or synthetic fabrics if they are mixed with wool or stained with such common substances as human sweat, tomato juice, milk, coffee, or beef gravy. Most damage is done to articles left undisturbed for a long time, such as carpets under heavy furniture and clothing in storage.

Identification

Adult casemaking clothes moths [*Tinea pellionella* (L.)] have a $^{1}/_{2}$ inch wingspan. The front wings are brownish buff in color and have three more or less distinct dark spots on each wing. Both pairs of wings are fringed with long hairs. The larvae are small, white caterpillars with brown heads. They live in a case made of silk and fibers of the material on which they are feeding.

Adult webbing clothes moths [*Tineola bisselliella* (Hummel)] are uniformly golden buff in color. The head has a tuft of upright, reddish gold scales. The larva may spin a feeding tunnel of silk, fibers, and excrement but does not make a case until it is ready to pupate.

Life Cycle and Habits

Clothes moths are seldom seen as they prefer darkness and are not attracted to lights. Males may be seen fluttering about the house in search of females. Females prefer to travel by walking or running and will attempt to hide when disturbed. The eggs are laid on or near a source of food for the larvae.

Female webbing clothes moths generally lay 40 to 50 eggs and seldom live longer than two weeks. The eggs hatch in 4 to 21 days and the life cycle can be completed in 65 to 90 days. There may be four or five generations per year.

Casemaking clothes moths live about 30 days and may lay 100 to 300 eggs. The larval stage lasts 50 or more days and they pupate in the larval case. They may occasionally be seen crawling over walls or ceilings in search of a pupation site. There are usually two generations per year.

Control Measures

Inspection. Locate the source of infestation before treatment. Examine closets and stored goods for larval cases, moths, and damage. Larvae prefer to feed in dark, undisturbed places. Check for woolen lint and hair under baseboards, in and under seldom moved upholstered furniture, in air ducts, in carpets at the corners of the room and along edges, in stored clothing, and in other places not readily accessible. Move furniture/household articles and check carpeting/pads under the articles as well as furniture fabric. Check furs or feathers such as stuffed birds or animal heads, antique feather beds, felts in pianos, woolen scrap piles, etc. Adult moths do not feed on fabrics but may be seen in darkened corners at night.

Prevention. Good housekeeping is critical in preventing or controlling clothes moth damage. Regular use of a strong suction vacuum cleaner with proper attachments to remove lint, hair, and dust from floor cracks, baseboards, air ducts, carpets, and upholstered furniture is necessary. Keep closets and dresser drawers clean. Regularly clean rugs where they fit close to the baseboards and under the quarter round. Launder or dry clean clothes or other items before storage as egg-laying moths are attracted to soiled articles. Brushing and exposure to bright, hot sunlight and wind will reduce larvae and damage. Constant illumination in a closet may discourage moths. Frequent use of woolens and other animal fiber articles almost assures no damage from clothes moth larvae. Cedar-lined chests or closets are not 100 percent effective. Fur storage in cold vaults is

effective. Mothproofing when woolens are manufactured may be effective forever, whereas treatments at dry cleaners are less permanent and may need to be renewed regularly.

For home storage, be sure that all cloth goods are dry-cleaned, washed, pressed with a hot iron, sunned, or brushed prior to storage. Use one pound of naphthalene flakes or balls or paradichlorobenzene (PDB) crystals per 100 cubic feet of closet space for best protection. Any tight box or bag that can be sealed is a good storage container. Place garments in container and add PDB or naphthalene interspaced between sheets of paper. Use one ounce per 2 cubic feet of container space. As these chemicals evaporate they produce a vapor that, in sufficient concentration, kills clothes moths. The mere odor of the chemical does not repel the insects and is no indication that the concentration of vapor is sufficient to kill them. To be effective in holding the vapor, the container must be airtight. Even in an airtight closet, protection is lost if the door is opened frequently.

Treatment. Cold storage has been used by department stores, wholesale dealers, warehouses, etc. to reduce problems with clothes moths. It is thought that it is not so much cold that kills, but rather the sudden change from cold to warmer temperatures and back to cold that provides the best results. One study showed the best results from clothes held refrigerated at 18ºF for several days, then suddenly exposed for a short time to 50º F, then returned to 18º F, and then held permanently at 40º F. During the winter, furniture or infested clothing may be placed out of doors (when around 0º F) for several hours with good results against clothes moths.

Some control of clothes moths has been reported from hanging infested articles in direct sun light. Indoors, clothes moths are killed when exposed to temperatures of 120ºF for 2 hours. To assist control effects indoors, one might consider the feasibility of raising the air temperature of the room (containing the infestation) to 125° to 130º F for about 12 hours.

Spray cracks and crevices of closets, storage areas, and chests labeled insecticides as per label directions. Spray closets and/or clothing with properly labeled products. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (E-832).

COCKROACHES

Families Blattidae and Blatellidae

Cockroaches feed on a wide variety of plant and animal products, including meat and grease, starchy foods, sweets, baked goods, and other unprotected kitchen goods. Some species seem to be especially fond of the dried residues of beer and soft drinks. They also feed on materials such as leather, wallpaper paste, and book binding and sizing. When starved, cockroaches will feed on substances such as wood, paper, dead insects, eyelashes, and finger nails.

Cockroaches are scavengers and are capable of spreading filth and contaminating far more food than they are able to eat. They have been incriminated as carriers of disease. In this regard, they can function to mechanically contaminate food and eating utensils by transporting filth or disease organisms on their legs or other appendages. They have been suspected of spreading dysentery, diarrhea, and food poisoning, and it is estimated that about 60 percent of the U. S. population have allergies associated with cockroaches. Bacteria contained in spoiled foods may be eaten by cockroaches and distributed in fecal droppings. These droppings may contaminate both food and utensils. Furthermore, cockroaches produce an extremely objectionable odor, which is very noticeable when they are present in high numbers.

Identification

American cockroach [*Periplaneta americana* (L.)]. This cockroach is dark reddish brown or mahogany in color with a tan or light yellow band on the thorax (the shield behind the head) and fully developed wings. This is the largest cockroach found in Oklahoma; adults are about 1 $^1/_2$ inches long. The egg cases (oothecae) are more than $^1/_3$ inch long, dark brown to black in color, and have 8 eggs on each side. They are usually almost three times as long as high. Newly hatched nymphs are grayish brown, gradually becoming reddish brown as they mature.

Oriental cockroach [*Blatta orientalis* L.]. This species is dark brown to nearly black in color and about 1 $^1/_4$ inches in length. Adult males have well developed wings but females have rudimentary wings which are reduced to short pads. The egg cases are very similar to those of the American cockroach but are only about twice as long as high. The nymphs are smaller, wingless versions of the adults.

German cockroach [*Blattella germanica* (L.)]. This is a small ($^1/_2$ inch long), tan to light brown species with two dark stripes that run lengthwise on the thorax. The egg case is about $^1/_3$ inch long and light brown. The top and bottom sides are parallel and there are 12 to 24 eggs on each side. Nymphs are light tan with two lengthwise dark stripes down most of the body. The wings cover the entire abdomen of adult females and all except the tip of the abdomen of males.

Brownbanded cockroach [*Supella longipalpa* (Fab.)]. This species is also light tan and about $^1/_2$ inch long but has a broad dark band across the thorax and two brownish yellow bands across the wings. The egg cases are about $^1/_4$ inch long, light brown, slightly curved on the top side, and have no more than nine eggs on each side. Nymphs are light brown with two or three dark bands across the body. The adult male is slender in appearance with its wings extending beyond the tip of the abdomen. Adult females have shorter wings that expose a considerable portion of their broad abdomens.

Wood cockroaches [*Parcoblatta* spp.]. The most common species of wood cockroach in Oklahoma is *P. pennsylvanica* (DeGeer). Adult males are chestnut brown in color with narrow

white margins on the thorax and the front part of the front wings. Females are light brown with dark brown abdomens and rudimentary wings. The egg cases are light brown, curved on both top and bottom sides, and have 16 eggs on each side. At least nine other species of *Parcoblatta* occur in Oklahoma. Most of these are smaller and paler than *P. pennsylvanica.*

Life Cycle and Habits

Cockroaches develop by gradual metamorphosis through three life stages: egg, nymph, and adult. Adult females produce small, bean-like capsules (oothecae) which contain the eggs. The female usually drops or glues egg cases to some surface soon after they are formed, but female German cockroaches carry the egg case protruding from the rear end of the body until the eggs are ready to hatch. Nymphs which hatch from the eggs and emerge from the oothecae resemble adults but are smaller and do not have wings. Their long, spiny legs and flattened bodies enable them to run rapidly and to squeeze into crevices and other hiding places. Nymphs molt several times until finally mature males and females appear. The time required to complete a life cycle varies from about two months to nearly three years, depending on the species and environmental conditions.

Cockroaches prefer warm, dark, and humid environments. Frequently they are secretive and feed at night. Although occasionally found in homes, American cockroaches are most often found in sewers, basements, alleyways, and steam tunnels. Oriental cockroaches prefer very moist conditions and are found in sewers, basements, crawl spaces and outdoors in flower beds and under leaf litter. German cockroaches are commonly found in homes, especially in kitchens and bathrooms where food and moisture are most likely to be available. Brownbanded cockroaches are found scattered throughout buildings, often high on walls or near the ceiling. Females, nymphs, and egg cases of the wood cockroaches are found outdoors in hollow trees, under logs or loose bark, and in wood piles. Adult males fly readily and are attracted to lights. They may enter homes but soon leave or die and do not breed indoors.

Control Measures

The key to successful cockroach control is the use of preventive measures. It is easier to prevent a cockroach invasion than to control an established population. However, the success of preventive measures requires care, planning, and continued effort. Cleanliness in the home and elimination of favorable breeding sites lessens the possibility of cockroach infestations and reduces the need for pesticides, but these practices will not always prevent invasions from outside sources.

Non-Chemical Control

Inspection. Prior to any cockroach control effort, cockroaches and their likely habitats should be identified. Because various cockroach species may live in the same building, it is essential to identify the species accurately and use control measures that take advantage of behavioral patterns and life requirements of the particular species. Also, frequent, thorough inspections will enable the homeowner to detect conditions which foster the development of infestations. In addition to examining all known or suspected cockroach hiding areas, incoming materials such as beverage cartons, groceries, dry cleaning, luggage, and used appliances or furniture should be inspected for hitchhiking cockroaches and/or their egg cases. Destroy any egg cases found.

Sanitation. Proper sanitation, both indoors and outdoors, effectively limits cockroach populations. Do not leave unwashed dishes, kitchen utensils, and uncovered food out overnight. Clean up all spilled liquids. Areas beneath cabinets, furniture, sinks, stoves, and refrigerators should be cleaned often, as should cupboards, pantry shelves, and storage bins where tiny particles of food frequently accumulate. Kitchen waste and excess refuse should be kept in cockroach-proof containers and disposed of as frequently as possible. Dry pet food should be stored away from the kitchen and other foods. If pets are fed indoors, leftover foods should not be allowed to remain in the feeding dish overnight. Outdoors, clean garbage cans frequently and any racks, platforms, or slabs on which they are kept.

Exclusion. Discourage cockroaches from entering the home by sealing any cracks of $^1/_8$ inch or more in the foundation and exterior walls. Check the seal or caulking around air conditioning units, windows, doors, pipes, or other openings into the home. Inside the home, eliminate all possible hiding areas and food sources. Repair cracks and holes in floors, walls, and ceilings. Seal openings around plumbing fixtures, furnace flues, electrical outlets, window sills, and walls and along baseboards and ceiling moldings. Leaky water faucets and pipes should be repaired.

Eliminate Hiding Places. Paper, cardboard, lumber, firewood, and other debris next to the home provide excellent refuge for several cockroach species. Keep yard trash and stacks of firewood away from the home or garage to minimize the chance of cockroach invasion.

Cockroach Traps. Cockroaches can be trapped both indoors and outdoors. Outdoor trapping can reduce cockroach populations and limit the number of cockroaches entering the home. Indoor trapping impedes indoor-breeding species such as German or brownbanded cockroaches. Trapping can also reveal the location and severity of infestations, help monitor the effectiveness of chemical controls, and detect population increases which

may require insecticide treatment. Trapping alone will not eliminate cockroach populations but must be used in conjunction with preventive measures for maximum effectiveness.

There are a number of cockroach traps available which are inexpensive, convenient to use, disposable, and contain no toxic insecticide. All are more or less box-shaped and coated on the inside with a very sticky adhesive. Some traps may also feature a slow release food attractant. Cockroaches enter the trap when detecting the food odor and become immobilized by the adhesive.

Traps should be placed where cockroaches are likely to travel to and from feeding and hiding areas. Reposition the traps if no cockroaches are caught after two or three nights. The number of traps required for a home or building will vary with the kind of cockroach present and the severity and location of the infestation.

Ultrasonic Devices. Although various types of ultrasonic (or sound) devices are widely advertised to control or repel cockroaches and other household pests, university research with these devices has shown that the devices tested to date have no effect on cockroaches.

Chemical Control

To effectively control cockroaches with insecticides, find their daytime shelters and thoroughly treat these areas. Regardless of the insecticide or formulation chosen, chemicals placed in or near regular hiding places provide much better control than those placed where cockroaches move only occasionally. Insecticides generally provide only temporary control within structures. Since some cockroach species invade homes and buildings from outside, they may reinfest dwellings once the insecticide dissipates. To solve this problem, outdoor populations must also be controlled.

To eliminate an established infestation in a home or building, first remove all routes of reinfestation, then thoroughly clean the home and apply an approved chemical. The type of chemical selected and the application method used will depend on the location and nature of the infestation. No one chemical handles all cockroach problems, but a combination of the various types available is effective. Select the appropriate combination of chemicals, formulations, and application techniques to provide the desired control.

Residual Sprays. These sprays are formulated as oil-based or water-based emulsions and water-based suspensions (wettable powders). They are available in ready-to-use pressurized containers or non-pressurized containers with built-in spray pumps. Residual sprays can also be purchased as concentrates to mix with water before applying with a compressed-air sprayer, plunger-type sprayer, or paint brush.

Exercise caution when using oil-based insecticides; they may stain, dull, or damage certain floor tiles, linoleum, painted surfaces, plaster, plastics, houseplants, carpets, and carpet backing. Oil-based sprays can create a fire hazard when used near an open flame (pilot lights, gas stoves, furnaces). Water emulsions may stain wallpaper, light-colored carpets, draperies, or other water-soluble materials. They can short out electrical circuits and are inferior to oil-based sprays on impervious surfaces such as glass or metal. Wettable powders must be frequently agitated in the spray tank, but they leave the most active residues, especially on porous surfaces such as unpainted wood, mortar, or concrete blocks.

Residual sprays are generally easy and fast to apply. The spray should wet or dampen the treated surface, but not to the point of puddling or running. When spraying cockroach shelters, pay attention to cracks and crevices. Exposed surfaces should usually not be treated with sprays, although it may be necessary to treat surfaces over which cockroaches crawl.

Dusts. Insecticide dust sometimes suffices as the total treatment for cockroaches, but it is most often a supplemental treatment. Dusts generally have longer residual action than sprays but are ineffective if they become damp. Dusts are useful in cockroach control because they can be placed deep in cracks, crevices, and wall voids; under refrigerators and furniture; around pipes, tunnels, and conduits; on very smooth or very rough surfaces; and in other places not treatable with other formulations. Do not use dusts for treating large surfaces because they leave unsightly deposits. Also, cockroaches avoid heavy deposits and will not walk through thick layers of the material. Use light pressure on the application device to minimize the dust particles in living areas. Apply dusts as light, even residues that are barely visible to the naked eye.

Baits. Several cockroach baits are sold in ready-to-use containers, or a combination of boric acid and certain foods may be used. The least important part of a bait is the insecticide. If cockroaches will not feed on the bait, the insecticide has no effect. Thus, it is important not to contaminate stored bait with organic solvents, other insecticides, fungicides, and fertilizers. Baits are usually long lasting and often work well in areas that can not be effectively sprayed or dusted. Baits are often most useful when used in conjunction with a residual spray or dust. Baits give best results in buildings where there is no food supply.

Aerosols. Aerosol insecticides may or may not have residual activity. A non-residual spray alone may not provide a high degree of control, but when used with a residual spray or dust, a high degree of control usually can be achieved. Non-residual aerosols are useful for finding the location and extent of cockroach infestations. Small amounts applied to hidden areas and shelters force cockroaches to evacuate and move across

previously treated surfaces. Residual aerosols should be used in the same manner as other types of residual sprays.

Inorganic Insecticides. Boric acid and silica aerogel powders are inorganic insecticides that can be used effectively for cockroach control in homes. Both are inexpensive, low in toxicity to humans and pets, and retain their effectiveness long after initial application. Usually, a longer period of time is required to achieve control, but retreatments are greatly reduced. Apply boric acid or silica aerogel in a light film to cracks and crevices and other cockroach hiding places. Avoid applications to moist or damp areas, especially when using silica aerogel.

Insect Growth Regulators. Synthetic compounds (IGR's) have been derived which mimic certain natural hormones found in insects. When applied to cockroaches during their early developmental stages, nymphs will develop into deformed adults which are reproductively sterile. IGR's have little or no human toxicity but long residual effectiveness. They must be applied along with residual insecticides to eliminate existing adults or other non-susceptible stages. Overall population reduction with IGR's usually takes several months.

Cockroach Control in Apartment Housing

The German cockroach is the most common insect pest for apartment dwellers in Oklahoma. While people in single family dwellings usually can control this cockroach for long periods on their first attempt, apartment dwellers usually find cockroach control to be a constant battle. Many urban Oklahomans even feel they must live with "a few roaches" most of the time. This does not have to be the case.

Cockroach control in multi-family housing requires that residents understand certain key factors in cockroach behavior. Effective control procedures then require that residents in most (or all) units of any structure increase their general sanitation and control efforts. Alternatively, if the apartment management or landlord takes responsibility for cockroach control, he/she should require all residents to participate in the program.

German cockroaches frequently move around within infested apartments, and they even move between apartments where construction features permit. If individual units share common plumbing connections or other utility connections, cockroach movement between units can be significant. In this case, insecticide application causes cockroaches to move out of treated apartments into adjacent units. This is why apartment dwellers may continue to have cockroach problems despite their sanitation efforts and normally effective insecticide applications. Your neighbors, the apartment management, or the pest control service personnel should understand that control efforts must be coordinated to be effective. Rather than individuals treating their own apartments, pest control operators should inspect and treat apartments adjacent to those known to be infested. Residents should insist that the apartment manager and the pest control operator work together (and with your neighbors) to design and conduct an effective control program.

Apartment dwellers can caulk cracks and crevices which allow cockroaches access to wall voids. Wall voids which house plumbing systems may harbor many cockroaches but can be treated with insecticide dusts for long-term control. Also, openings where plumbing and electrical connections enter walls can be caulked or plugged with steel wool to exclude cockroaches. Along with these extra steps to prevent cockroach movement between apartments, thorough sanitation and careful insecticide application into the areas where cockroaches are hiding during the day should give effective control within any one unit. Careful, thorough insecticide applications cannot be made in only two or three minutes within any one apartment. If this is all the time a pest control service is spending, their efforts will fail. Residents should question their apartment manager about the quality of the pest control work and encourage him/her to place greater emphasis on this effort.

German cockroach problems may persist despite careful pest control efforts. Cockroaches may adapt to particular insecticides by developing resistance to them. Resistance is most likely to develop in apartments or commercial establishments since these types of buildings often receive routine insecticide treatments over extended periods. If you have difficulty controlling German cockroaches, consider changing insecticide products in order to use a different active ingredient. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (E-832).

Notes

FRUIT FLIES

Drosophila **spp.**

Nicolas Gompel, University of Wisconsin, www.news.wisc.edu/newsphotos/gompel.html

Jim Kalisch, University of Nebraska-Lincoln

Description

These flies are variously referred to as vinegar flies, pomace flies, banana flies, sour flies, vinegar gnats, and lesser fruit flies. There are several species which are similar in appearance. Adults may be dull yellowish, brownish yellow, or brownish black in color and range from $^1/_{10}$ to $^1/_5$ inch long. Most species have red eyes. Larvae are very small (ranging from $^1/_{10}$ to $^1/_5$ inch long), dirty white, and maggot-shaped. They can be recognized by the stalked posterior spiracles on the last abdominal segment.

Life History

Female fruit flies lay their eggs on the surface of rotting fruits and vegetables. Each female may lay as many as 500 eggs. These eggs hatch into larvae which molt twice before becoming fully grown. The larvae feed on the yeast organisms and fungi growing in infested material, and through their feeding efforts, they soon turn their food into a semi-liquid "mess." When the full-grown larvae are ready to pupate, they leave the food material for dryer areas. Complete development from egg to adult under summer conditions may be completed in 8 to 10 days. Mating takes place soon after adult emergence, usually within a few hours, and egg laying begins about 24 hours later.

Economic Importance

Fruit flies are of concern both as nuisance pests and as serious contaminators of food. Large populations of these flies can very quickly build up in restaurants, hotels, cafeterias, and similar food service establishments. Structures or areas in the vicinity of orchards, vineyards, truck crop acreages, etc., are frequently invaded.

The ability of the adults to appear from "nowhere" when fruits are exposed and the fact that they seem to be "everywhere" are sources of amazement for most homeowners and individuals in the food industry.

Food processing plants, including wineries, pickle plants, dehydrators, and canneries (especially tomato canneries), consider fruit flies to be a greater menace than any other insect pest. These flies cause a high percentage of the insect contamination of fruit and fruit products. Fruit flies are frequently cited as the contaminating agent in reports of food seizures made by the U. S. Food and Drug Administration.

Control

In warm weather, screen all openings to the outdoors with fine mesh screen or netting. Do not leave cut or spoiling fruit or vegetables, fruit salads, fruit juices, jams, jellies, pickles, etc., exposed in open containers. Do not keep whole raw fruit on hand in large quantities exposed to fruit fly infestations. Check vegetables such as potatoes and onions which are frequently stored in large quantities. There could be one rotten vegetable in the bottom of the bag which would be sufficient to support a sizable infestation. Whenever possible, keep susceptible foods in cold storage in order to retard development of larval fruit flies.

Should fruit flies become abundant, a careful search for the larval breeding areas should be made by the homeowner. Removal of any overripe fruit or vegetable material should alleviate any recurrence of these insects. Any lingering adults can be destroyed via the judicious use of pesticide aerosol space sprays or a fly swatter.

Breeding areas can sometimes be difficult to locate. Possible situations include a "forgotten" potato in a storage bin, an apple kicked under the shelves of a storeroom, improperly cleaned garbage cans or disposals, and endless similar examples of improper or lax sanitation practices. "Emptied" beer, soft drink, milk, or catsup bottles with small amounts remaining in the bottom have been reported as breeding media. Uncleaned mops and cleaning rags that have been left to sour may serve as breeding sites. Accumulations of food materials, usually small and hidden, may buildup in corners, under counters, under baseboards, in the cracks of or around drain boards, in cracks around sinks, etc. In addition, common sources of infestation in residences are "homemade" marmalade, preserves, chili sauce, mustard, pickles, etc. put up in jars. Wine, vinegar, sauerkraut, "homebrew," and cider are also common attractants.

HORSEHAIR WORMS

(other common names — cabbagehair, gordiid, or gordian worm)

Gordiacea (Nematomorphora)

Soni Cochran, University of Nebraska-Lincoln Extension, Lancaster County

These active, long, thread-like roundworms are occasionally found on sidewalks or patios, in water troughs and domestic water supplies, on cabbage plants and garden soil, and in the body cavities of various pest insects. Many homeowners wonder whether they are harmful to humans, domestic animals, or plants.

Identification

Horsehair worms are slender ($^1/_{25}$ to $^1/_8$ inch wide), very long (4 to 24 inches), and yellowish-tan to brownish-black. They often squirm and twist, knotting themselves into a loose, ball-like shape, resembling the so called "gordian knot," in freshwater pools. From this resemblance comes the scientific name of the group (Gordiacea). These worms may be found in masses of 100 or more, especially after rainfall. In water troughs and puddles, they resemble horsehairs actively moving in the water. Some people still believe that these worms develop from the long, thin hairs of a horse's mane or tail that fall into the water as a horse drinks.

Life Cycle and Habits

Horsehair worms are not harmful to humans, domestic animals, or plants. Adult worms are free-living and non-parasitic. Immature stages are internal parasites of grasshoppers, crickets, cockroaches, beetles, and other insects, and millipedes and centipedes.

The adult worms mate in fresh water or damp soil. The female lays up to several million eggs in water in long strings or slender broken cords. Eggs hatch in two weeks to three months, with the .01 inch larvae not resembling the adults. Some believe that within 24 hours after hatching, the larvae encyst on vegetation near the water's edge. After the water level drops, the exposed vegetation is eaten by a grasshopper or cricket. The cyst covering dissolves, permitting juvenile worms to bore through the gut wall and into the body cavity of the host. All nutrients are absorbed across the body wall of the worm, as no alimentary system is present.

As larvae develop fully or nearly so (several weeks or months), they break through the body wall of the host (in moist habitats) and become free-living. Other people believe that young worm larvae bore into or are swallowed by immature stages of water-inhabiting insects such as mayflies, dragon flies, or beetles. When the host emerges from the water as a free-flying adult, the mature horsehair worm breaks out of the body cavity. Grasshoppers, crickets, etc. may be a second host if they eat the dead, infested mayfly adults. It appears that the host must first come in contact with water to enable horsehair worms to escape the body cavity.

Horsehair worms are most commonly seen following rains in November and early December in Oklahoma. They have also been collected in the late winter and early spring (mid-January to March).

These worms are sometimes seen after crushing pests that have invaded the house. When crushed, worms are released and crawl indoors. Some are found in toilets where infested pests (e.g. crickets) have been discarded, in pet dishes where an infested insect has crawled, or in gardens on vegetable plants. Humans sometimes fear worms may have come from a household pet or children when found indoors.

Control Measures

No control measures are recommended because horsehair worms do not injure humans, domestic animals, or plants. Instead, they are considered beneficial because they kill many harmful pests such as grasshoppers, crickets, cockroaches, beetles, millipedes, and centipedes.

Control of horsehair worms in natural water is impractical. However, one can install a fine mesh filter or screen to keep out tangled masses of worms from a surface supply such as a farm pond or lake. Should the homeowner find nuisance worms in the wash water, bathtub, and sinks, domestic water supply systems can be filtered and chemically treated under supervision of the local health department. Remove and discard individual worms. Prevent nuisance insects from entering the house by caulking or sealing entry sites. An insecticide barrier around the house foundation might be helpful. Livestock water troughs can be kept free of horsehair worms by routine flushing.

INDIANMEAL MOTH

Plodia interpunctella **(Hubner)**

Description

Adult moths are about $^{3}/_{8}$ inch long when at rest and have a $^{3}/_{4}$ inch wingspread. The front wings are brick red on the outer two-thirds and light grayish brown on the inner one-third. The head and thorax are red brown and the hindwings are gray. Larvae are dirty white, often with a pinkish or greenish tint, and have brown heads. They are about $^{1}/_{2}$ inch long when mature.

Life History

Females begin to lay eggs on larval food materials about three days after emergence. Each female can lay 200 to 400 eggs over a period of 1 to 18 days. The eggs hatch in 2 to 14 days and the larvae begin building the silk and frass tunnels in which they live and feed. Food products often become matted with their silken webbing. Larvae mature in four to five weeks and often wander away from the food source in search of pupation sites. The pupal period is about two weeks. The entire life cycle can be completed in six to eight weeks under favorable conditions.

Economic Importance

The larvae infest a wide variety of food products, especially those of plant origin. They have been found in stored grains, flour, cornmeal, nuts, dried fruits, powdered milk, candy, chili pepper, fish food, dry dog and cat food, seeds, and chocolate.

Control Measures

Prevention. At the time of purchase, examine foods such as milled cereal products, flour, and dried fruits for infestations, and check the packaging date to establish freshness. Seldom-used foods should be purchased in small quantities to prevent long storage periods of one month or more. Susceptible foods should be stored in insect-proof containers of glass, plastic or metal, or in a refrigerator. Use older packages before new ones, avoid spillage in cabinets, and always keep food storage areas clean.

Inspection. Locate the source of the infestation by carefully examining all seldom-used foods and least disturbed storage areas. Inspect packages of pancake flour, cornmeal, raisins, dry dog and cat food, birdseed, etc. Dispose of heavily infested foods in heavy plastic bags in the garbage or bury deep in the soil. Lightly infested foods or food products where there are questionable infestations can be heated in shallow pans in the oven at 130° to 150° F for 30 minutes (or use a preheat setting of 30 to 45 seconds in a microwave oven) or placed in a deep freezer at 0° F for seven to ten days. Sifting the food material will remove most of the insect fragments and any remaining will not cause harm if consumed. Heat-treat dried fruits by placing in a cheesecloth bag and dipping in boiling water for about six seconds. Note: Seeds saved for planting may have the germination reduced by super heating or cooling.

Treatment. The use of insecticides should be supplementary to sanitation and proper food storage. Treatments are not effective on insects within the food packages. For control of moths flying around windows and doors inside, use a household aerosol insecticide labeled for flying insects. For a treatment for cracks and crevices to control moths and larvae, use a residual insecticide labeled for use in food storage/handling areas. Before treatment of cabinets and other storage areas, remove all food, food packages, utensils, dishes, and other food related items. Cover these items to prevent accidental spray drift. Vacuum cabinets and shelves to pick up spilled and loose infested food, then scrub with soap and hot water. After drying, spray lightly, forcing spray into cracks and crevices, or apply with a paintbrush. After the spray has dried, cover shelves with clean paper or foil before replacing food and cooking utensils. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (E-832).

MOTH FLIES

Psychoda **spp.**

Joseph Berger, www.insectimages.org

Description

Moth flies (also called drain flies or filter flies) are small, fuzzy, dark colored or grayish insects about $^{1}/_{12}$ to $^{1}/_{8}$ inch long. The body and wings are densely covered with hairs, and the wings are held roof-like over the body when at rest. They are weak fliers and often appear to be jumping or hopping. The larvae are legless and worm-like but are not maggot-shaped. Larvae are gray in color with both ends somewhat darker and are about $^{3}/_{8}$ inch long when mature.

Life History

Adult females lay their eggs in irregular masses of 10 to 200. They are laid on or in polluted shallow water, muck, or the gelatinous organic material which accumulates on the inner sides of drains and overflow pipes in homes, as well as in sewage disposal beds, septic tanks, and compost. The eggs must be kept moist to hatch. Hatching occurs within 14 to 48 hours. The larvae feed on decaying organic matter and the microscopic plants and animals that occur in such material. They are considered beneficial, as an essential part of the cycle that breaks down waste into water soluble compounds. Larvae develop through five instars and mature in 5 to 14 days, depending on the species and temperature. Pupae are found in or on the surface of the breeding media. The pupal stage lasts for 20 to 80 hours, after which new adults emerge. Under favorable conditions, some species can go through a generation in as little as one week, although two to three weeks is more typical.

Economic Importance

These flies do not bite and are of no economic importance. Even those which breed in sewage beds are not known to transmit human diseases. The adults can become a nuisance, however, in homes, sewage disposal plants, industrial plants, and food handling establishments.

Control

Insecticide-impregnated strips or household aerosol insecticides labeled for flying insect control provide some relief by killing adults. Infestations, however, can be eliminated only by removing the larval food source. In homes, the larvae usually breed in sink and bathroom drain traps and in floor drains. Thorough cleaning of drain traps with drain cleaners and long handled brushes will remove hair and trapped debris and greatly reduce larval numbers. A lye solution flushed down drains will help kill larvae. Specific recommendations for adult control can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (publication E-832).

Adults found in or around homes may be coming from outdoor sources. Determine the source of infestation by looking for concentrations of adult flies around potential larval habitats such as cooling towers, air conditioners, bird feeders, or other places containing standing water and decaying vegetation. Clean, remove, or treat the breeding area. Infestations can also be located in a neighbor's yard, shallow pools, or sewage treatment facilities, particularly those upwind from the nuisance area. In these cases, contact those people responsible for infested areas.

PAPER WASPS

Polistes **spp.**

Paper wasps have annual colonies and the only members of the colony to overwinter are fertilized females. These females spend the winter in protected locations such as under bark, in stumps, in hollow logs, or in buildings. They emerge during the first warm days of spring, select a nest site, and build a small paper nest in which they lay their eggs. When the eggs hatch, the female feeds the young larvae for two to three weeks. The larvae then pupate and later emerge as small, infertile females called workers. Once the first few workers appear, they help to rear and feed the brood. The colony expands rapidly and, depending on species, may total from 20 to 150 workers with a nest of 50 to 400 cells when maximum size is attained in August. About this time, reproductive cells are built and both males and females are produced. These emerge, mate, the males soon die, and the mated females seek sheltered locations in which to overwinter. The next year the cycle begins again.

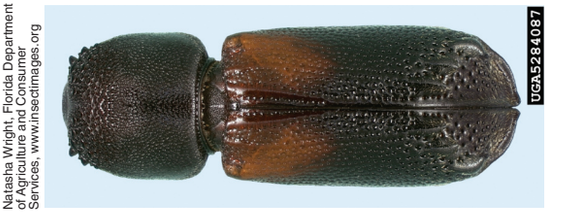
There are eight species of paper wasps in Oklahoma. They range from yellowish to reddish-brown to a mixture of black and reddish brown. All areas of the state have at least two species and all eight are found in some areas in south central Oklahoma. Their nests consist of a single comb of a paper-like substance and are commonly found suspended from eaves of structures or in sheltered sites such as sheds, barns, and garages. Some species seem to prefer man-made structures as nesting sites. Other species prefer more protected locations and will nest in attics, wall voids, hollow logs, etc. Nests can also be found in trees and shrubs and in such unusual places as bird houses, clothesline poles, unused barbecue grills, electrical breaker boxes, etc. These wasps are beneficial because they feed their young many insects, primarily caterpillars, that damage shade trees and crops.

For most people, the single outstanding feature of paper wasps is the ability of the females to inflict painful stings. Local reaction to a sting may involve intense burning at the site soon followed by swelling and itching; swelling may remain localized or develop to involve a greater area. For example, a sting on the finger tip can result in total swelling of the arm. Stings in the neck/head region are particularly dangerous since swelling could cause complications (e.g. suffocation). These are the principal after effects of stings to the majority of people; however, to a small percentage of people who are allergic to wasp or bee venom, a stinging episode may be more dangerous, possibly even life-threatening. Individuals aware that they have a severe reaction to wasp stings should visit a physician and explore the possibility of undergoing a desensitization program plus procuring an emergency sting kit.

The best control of paper wasps results from the destruction of individual colonies (preferably at night when the wasps are not likely to be active). Spraying the nests with insecticide spray bombs that are designed to propel the chemical as a stream up to a height of 9 to 10 ft. will normally control individual nests. Following treatment, dislodge the nest with a broom or similar article and destroy it. It is reported that a spray mix of 2 tablespoons of liquid detergent per gallon of water will kill wasps and bees if the insects are directly hit (soaked) by the spray. **NOTE:** Research reports indicate that insect repellents have not proven effective on paper wasps. More information on wasps is provided in OSU Extension Fact Sheet EPP-7305.

POWDERPOST BEETLES

Families Anobiidae, Bostrichidae, and Lyctidae



Powderpost beetles can be found in dead wood as well as dried and cured lumber. Damage occurs to many wood products such as rafters, joists, flooring, molding, paneling, crating, furniture, antiques, tool handles, gun stocks, fishing poles, baskets, and ornamental objects.

Beetles of three different families can cause similar damage. These include true powderpost beetles (family Lyctidae), false powderpost beetles (family Bostrichidae), and deathwatch beetles (family Anobiidae).

Identification

Larvae of all three families are similar in appearance — C-shaped and white to yellowish white with a dark head.

Adult anobiids have slender, red-brown to black cylindrical bodies measuring $^{1}/_{3}$ inch. In most species, the head is bent downward and the thorax is widest near the base. Damage by beetles of this family appears to be quite rare in Oklahoma.

Adult bostrichids are cylindrical, dark brown or black, and generally have a roughened thorax. The antennae end in a club of three or four distinct segments. The head is usually not visible when viewed from above. Damage by this family in Oklahoma is found mostly in bamboo or various hardwoods imported from other areas of the U.S.

Adult lyctids are flattened, slender, reddish brown to black, and vary from $^{3}/_{32}$ to $^{7}/_{32}$ inch long. The antennae have a two-segmented club. The head extends forward and is visible from above. The most common species in Oklahoma is the southern lyctus beetle (*Lyctus planicollis* LeConte). The following discussion will apply mostly to this species; however, biology and control of most other species is quite similar.

Life Cycle and Habits

The southern lyctus beetle attacks only large-pore hardwoods. They are most commonly found in ash, hickory, and oak but have been known to damage dead and dried black walnut, elm, locust, maple, osage orange, persimmon, poplar, sycamore, sassafras, and wild cherry. They attack seasoned hardwood and sapwood timbers found in woodwork, flooring, structural wood, furniture, tool handles, and firewood. Adult beetles can emerge from wood stored in the home and infest structural wood or furniture. The most commonly reported infestation site in Oklahoma is in ash cabinets or trim around doors, windows, etc. in homes. Adult exit holes are round and $^{1}/_{32}$ to $^{1}/_{16}$ inch in diameter.

Larvae of lyctids and anobiids cause most of the damage while adult bostrichids contribute to damage. "Flour or talc-like" frass is packed in the larval galleries and falls out of exit holes and cracks. This fine sawdust is often found on the floor or counter tops in areas where infestations of powderpost beetles occur.

The length of the life cycle for lyctids is usually three months to one year, but this can be extended to several years depending on species, temperature, and starch content of the wood. It is not unusual to have infestations reported in newly constructed homes.

Newly emerged adults mate and the females lay eggs on or in the pores of wood. Lyctids and anobiids may reinfest the wood from which they emerged while bostrichids seldom do.

Control Measures

Most powderpost beetle infestations are in wood or wood products before the wood is purchased. Because development is slow and inconspicuous, the infestation may be several years old before they are discovered. There is no need for extreme haste in treatment.

Prevention. Carefully inspect wood at the lumbermill, lumberyard, or other storage area. Individuals remodeling or renovating old buildings and salvaging lumber from old wooden structures should be cautious. Farm-sawed lumber is often a source of infestation. Dust off the suspected wood surface and wait 24 hours to notice whether fresh dust appears around emergence holes. Live beetles or new exit holes indicate activity.

Wood no longer infested need not be treated, but weakened timbers may need to be replaced.

It may also be simpler to replace infested wood if only a small area of trim is involved. Most wood-infesting beetles will not reinfest wood that is painted, varnished, waxed, or shellacked. Larvae already in the wood at the time it is finished (varnished-lacquered) will develop and emerge. Wooden artifacts or furniture can be super cooled at 0º F for several weeks or super heated at 140° to 150º F for two to four hours to kill infestations.

For new construction, **use kiln dried lumber** (dried a minimum of eight hours at 130 to 140ºF and 80 percent relative humidity). Most beetles do not develop in wood with a moisture content below 10 to 15 percent. Also, wolmanized pressure-treated wood reportedly provides some protection from powderpost beetles.

Chemical Control. Infested wood can be treated with properly labeled products (apply according to label directions). Be sure to observe any precautions related to possible effects by the chemical on the wood finish. For extremely large, widespread, damaging infestations, one may have to hire a pest control firm to fumigate a building, furniture or other infested items (but this should be considered as a last resort). Also, a pest control firm can provide localized control by spraying, painting or injecting insecticide on or into infested wood.

SILVERFISH AND FIREBRATS

Order Thysanura

Silverfish are among the more common insect pests found in homes. They are elongate, flattened, wingless, and covered with small scales. There are two long antennae at the head end and three long, thin appendages (cerci) at the tail end. The body is broadest near the head end and tapers toward the rear. Silverfish are a primitive group of insects that develop without metamorphosis, and the immature stages look and act like the adults but are smaller in size. They are relatively long lived (for insects) and continue to molt even after the adult stage has been attained. They are nocturnal insects that avoid direct sunlight whenever possible. Silverfish become trapped in sinks and bathtubs because they are unable to climb slick porcelain or stainless steel surfaces. This has led to the erroneous belief that they are primarily found in kitchens and bathrooms or that they entered through the plumbing or sewer system. There are three species that may be found in homes and other buildings in Oklahoma.

Food Habits and Damage

A few silverfish in a home are mostly a nuisance and cause little damage; however, heavy infestations left untreated over long periods can damage fabric and paper goods. They feed on both carbohydrates and proteins and will travel quite far from their preferred living areas in search of food.

Silverfish feed more readily on paper that is glazed, but will feed on other types if deprived of other food. Cleansing tissue, onion skin, and cellophane are preferred while newsprint, cardboard, and brown wrapping paper are generally avoided. Wallpaper is commonly damaged by silverfish so they can feed on the paste used to apply the wall covering. They will feed on the sizing in book bindings and can be a major pest in libraries, used book stores, and museums. Books are especially prone to damage if they are stored in an area with high humidity or if surface fungi are allowed to grow on books and papers.

Fabrics also can be damaged. Artificial silk, rayon, cotton, and linen may be damaged, especially if starched, while natural wool and silk are usually not touched. Food products such as flour and cereals are often infested. They will also feed on glue, leather, and dried insects.

Silverfish—*Lepisma saccharina* L.

This species is uniformly silvery-gray, smooth, and has a metallic sheen. Both the antennae and the cerci are shorter than the body. Adults are about $^1/_2$ inch long. They are sensitive to dry conditions and prefer a relative humidity of 75 to 95 percent and temperatures between 70° and 80° F. All the nymphs die at or above 98° F. They are primarily an indoor insect, and are uncommon outdoors. They are often brought into new homes in cardboard cartons and books and papers that have come from infested places.

Silverfish may begin to reproduce at three or four months of age and may live (and continue to reproduce) for 2 to 3 $^1/_2$ years. They lay an average of about 100 eggs during their life, and infestations tend to build up slowly.

This silverfish is found most often (but not always) in the lower levels of a building, in basements, crawlspaces, at foundation walls, and near water or drain pipes. Sometimes they become a problem in new buildings with wet, green lumber and moist plaster or drywall, where fungus in the voids can support a large population.

Firebrat—*Thermobia domestica* (Packard)

This species is grayish, mottled with spots and bands of dark scales. The antennae are at least as long as the body and the cerci are about as long as the body. They reach about $^1/_2$ inch in length. The optimum temperature for this pest is from 90 to 106° F. Temperatures below 32° F and above 112° F readily kill the nymphs. This is a common indoor pest but can be found living outdoors in the southwestern U.S.

The firebrat can complete its life cycle in as little as two to four months and adults will live about 1 to 1 $^1/_2$ years. A female may lay as many as 195 eggs, but the average is only about 50. One batch of eggs is laid between each molt, and fertilization must take place for each batch.

Firebrats are found infesting ovens, boiler rooms, steam tunnels, fireplaces, furnaces, hot attics (just about anywhere with high temperatures).

Fourlined silverfish—*Ctenolepisma lineata pilifera* (Lucas)

This silverfish is grayish with four narrow, dark lines extending lengthwise on the body. The antennae and cerci are shorter than the body. They are slightly larger than our other species, reaching $^{5}/_{8}$ inch long when mature. They can be found living outdoors, especially in mulch in foundation plantings, and garages and sheds may be infested.

The fourlined silverfish does not seem to be as restricted by moisture or temperature as are other species. They can be found anywhere in a structure, from the basement to the attic. Large populations can live in the attics of homes, especially those with wooden shingles (perhaps because of increased humidity and fungus). The wide variety of suitable habitats can make this the most difficult species to control. In a 1944 laboratory study, it was noted that this species did more damage to fabrics than either of our other species.

Control Measures

Prevention. Sanitation is important but not entirely effective in reducing populations because these insects often reside between wall partitions, in insulation materials, in books and papers, among book shelves, and in other protected places. However, be sure to remove old stacks of newspapers, magazines, papers, books, and fabrics plus foodstuffs stored for long periods of time. Often reducing available water and **lowering the home's relative humidity** with dehumidifiers and fans is helpful. Repair leaking plumbing and eliminate moisture around laundry areas. Lighting a dark, sheltered area may force these insects to move to new sites where they can be controlled more easily. Once the infestation has been eliminated, sanitation will help prevent reinfestation.

Treatment. Spray treatments should be applied to floor and wall moldings, behind drawers, under furniture, and in all "cracks and crevices" throughout the building. Aerosols, space sprays, or dust formulations can be used in wall voids and in attics. Inspect for infestations outdoors. If specimens are found outdoors, treat eaves, mulched ornamental beds, storage sheds, etc.

Drione/silica gels have been reported to work well as attic treatments. Specific recommendations can be found in the *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* (E-832).

SUBTERRANEAN TERMITES

Reticulitermes **spp.**

Clemson University - USDA Cooperative Extension Slide Series, www.insectimages.org

USDA Forest Service Archive, USDA Forest Service, www.insectimages.org

USDA Forest Service Archive, USDA Forest Service, www.insectimages.org

Typical signs of termite infestations include swarming of winged adults in the spring and occasionally fall, mud tubes $^{1}/_{4}$ to $^{1}/_{2}$ inch wide constructed over the surface of foundation walls, mud protruding from cracks between boards and beams, and hollow sounds from infested wood when it is tapped or extreme softness when probed with a knife. Sometimes you will actually observe termite workers and/or soldiers when damaged wood is probed. Termites feed slowly and there is no need to panic.

Identification

Subterranean termites are social insects that live in nests or colonies in the soil. Each colony consists of three forms or castes: reproductives, workers and soldiers. Reproductives can be winged (primary) or wingless (secondary). The adults or reproductives do no direct damage to wooden structures. The primary reproductive (swarmer) is coal black to pale yellow-brown, about $^{1}/_{4}$ to $^{3}/_{8}$ inch long, with pale or smoke gray to brown wings. Secondary reproductives are white to cream-colored with short wing buds. Termite workers are wingless, white to grayish-white and about $^{1}/_{4}$ to $^{3}/_{8}$ inch long. Soldiers resemble workers, except they have large, well-developed brownish heads with strong mandibles. Adult swarmers have straight bead-like antennae and a thick waist, with both pairs of wings of similar size often easily detached. Adult ants differ in that they have elbowed antennae and constricted waists. The forewings are much larger than the rear wings and are not easily detached.

Life Cycle and Habits

In a typical termite colony, the king and queen are the only active reproductives; they perform no other function. They are fed by the other termites, and some have lived up to 25 years. A mature queen can lay thousands of eggs each year. During the two-week incubation period, eggs are tended to by the worker termites. The nymph hatches directly from the egg. Attendants feed nymphs regurgitated food for the first two weeks, enabling them through molting to become workers, soldiers, reproductives, or supplementary reproductives (depending on the needs of the colony). As the reproductive nymph matures, its body lengthens and sexual organs develop. The body turns black, eyes become functional, and wings extend twice its body length. Supplementary reproductives ensure the life of the colony should it lose the king and queen. They may start new colonies by migrating from the established colony.

The worker termite has no eyes and is sterile. Its main function is to provide the colony with food, usually obtained by eating the wood of building structures or other available cellulose sources (such as tree stumps, paper, etc.). It is the workers that do the actual damage to buildings. The soldier nymph develops a long, armored head and large jaws during its last molt. The sole purpose of the soldier is to defend the colony against enemies such as ants. All mature reproductives leave the colony at the same time (usually mid-morning to mid-afternoon) on warm spring and sometimes fall days (although in Oklahoma, swarmers have been recorded from every month of the year). Swarmers are poor fliers and when above ground usually flutter a few yards and fall. After falling to the ground, they chew or pry off their wings. Finding the discarded wings in window sills, air/heat ducts, or other areas around a structure is another indication of a possible termite infestation. Surviving males find compatible mates and construct a nest in wood, which is usually in contact with the soil to become king and queen. These termites live in nests underground and tunnel up for food, which may be in the wood structure of homes.

Termite Control

The primary nest of subterranean termites is in the soil. As such, the objective of termite control is to prevent, or stop (in the case of an existing home currently infested) the entry of termites

into the structure. This is primarily accomplished by placing a continuous barrier of an appropriate insecticide in the soil between the termite nest and the structure. To compliment this chemical barrier, it is important that the structure be properly constructed/repaired to prevent excessive moisture (no roof or plumbing leaks) or wood-to-ground contact (such as firewood stacked against the house which can serve as a bridge to allow termites to by-pass the chemical barrier).

Prevention (Pre-construction)

Before and during construction, never bury scrap wood or waste lumber in the backfill or near the building site. Make sure that roofs have an appropriate slope (pitch) to facilitate proper water flow and that flashing around chimneys and other obstructions on the roof are properly sealed. Also, make sure that gutters are properly installed and water drainage away from the building is proper. In crawl-space construction, avoid contacts between the soil and wooden portions of the building—an 18-inch or greater gap between the soil and wood is most desirable. Provide adequate ventilation in the crawlspace in unexcavated areas under the building. Ventilation openings in the foundation, at a rate of 2 square feet to 25 running feet of outside foundation wall, should provide adequate ventilation. The concrete foundation should be reinforced to prevent cracking. Use concrete or steel supports, steps, etc., when in contact with soil. It is very important, and in many ways more economical, to have the soil under and around the structure treated with an approved insecticide before the foundation is poured (referred to as a "pretreatment").

Corrective Treatment (Post Construction)

When termites are discovered infesting an existing structure, the first thing to do is not to panic. The goal of a termite treatment in this situation will be to re-establish a continuous insecticide barrier under and around the structure, leaving no untreated gaps to serve as avenues for termite entry from the soil. In addition, any existing moisture problems (leaky plumbing or roof) and other structural defects (wood-to-ground contact) should also be corrected at this time. Anything less, in time, can permit re-infestation by termites.

Selecting a Professional

When dealing with the construction of a new building or the treatment of an existing structure infested with termites, in most cases control measures are best accomplished by a professional pest control operator (PCO). They have the proper equipment and insecticides that will allow them to properly treat foundation voids, under slabs, in hollow openings of concrete blocks in foundation walls, around foundation walls and piers, and other critical areas to establish that continuous barrier between your house and the termite nests. Insecticides that are labeled and currently being used by PCO's are listed in OSU Extension Fact Sheet EPP-7312, "Household Pest Control."

You should only deal with a licensed PCO having an established place of business and a good professional reputation. Ideally, the PCO will belong to the Oklahoma Pest Control Association and/or the National Pest Control Association. It is a good idea to obtain more than one competitive estimate before signing a contract for control measures. You should ask for information on: (1) what labeled insecticide the PCO will use to do this job; (2) how much volume of finished spray the PCO plans to use to accomplish this treatment; and (3) what type of warranty is offered, if any?

In evaluating a very low PCO bid price (in relation to other prices quoted), always ask yourself, "How can one treat for less cost than chemical costs? Will applications be made less than according to label directions? Are corners being cut by using less solution than required to control all the termites?" In addition to chemical costs, there are several other expenses reflected in the PCO's bid. Among these are the purchase and maintenance of the PCO's business establishment, equipment, training, labor, and insurance premiums.

Do-It-Yourself Treatment

We do not recommend "do-it-yourself" treatments. Several products that were available to homeowners are no longer available. In the event that you would like to pre-treat or treat a structure (such as a small shed, dog house, etc.) check the latest version of E-832, *OSU Extension Agents Handbook of Insect, Plant Disease and Weed Control* for current recommendations.

Bait Stations/Termite Baits

Until 1996, we have relied primarily on chemical barriers in the soil to prevent termite damage. Research on alternative control measures has escalated during the last few years and one alternative is the use of baits. Typically, a bait stationconsists of a ground plastic bait stations that is baited with ideal food sources for termites. The stations are monitored initially on a monthly basis until termite workers are found in some of the stations. Then the food bait is replaced with a slow-acting toxin-ladened bait. This monitoring continues until no food bait and/or treated stations show signs of activity. After that, food bait stations can be monitored at longer periods to ensure no infestations return. DowElanco (now Dow AgroSciences) released their baiting system, called the Sentricon® system, to a select number of PCO's in Oklahoma in 1997. Since then, several other companies have developed similar bait station systems, including Firstline®, Exterra®, and Premise®, which are all available through pest control companies. There are several do-it-yourself bait stations available, but we generally don't recommend such do-it-yourself homeowner treatments.

TARANTULAS

Whitney Cranshaw, Colorado State University, www.insectimages.org

During the past few years, tarantulas have become popular as pets and are now widely sold, traded, and kept in houses, apartments, schools, and dormitories. However, those who fear spiders still panic when confronted by one of these large, hairy spiders. Actually, tarantulas are docile, non-aggressive, and rarely bite. Bites are not considered dangerous and cause little lasting pain. Some tarantulas have a dense covering of special hairs on the abdomen that cause skin irritation, which is mechanical rather than chemical in nature. Reportedly, the hairs on the abdomen are part of a defense mechanism whereby the spider, using the hind legs, can eject barbed hairs at a potential aggressor. These hairs have been found in the nose pads of dogs and various other mammals that have confronted a tarantula.

Identification

The largest tarantulas are tropical, with a body length of 3 $^1/_2$ inches and a leg span of 9 $^1/_2$ inches. The only species known to occur in Oklahoma, *Dugesiella hentzi* (Girard), has a body length of 2 inches and a leg span of about 6 inches. They are brown and black in color, stout-bodied, and covered with hollow, needle-like, barbed hairs, especially on the abdomen.

Life Cycle and Habits

Females are nocturnal for the most part, hiding during the day inside natural cavities in the ground, abandoned rodent tunnels, or burrows with the upper portion lined with silk. Mature males wander in search of females and are more likely to be seen during the day. They may be active any time from June to October but are most commonly seen in June and September. Females may live to be 15 to 20 years old and usually molt at yearly intervals.

Tarantulas will feed on any live animal they can catch and overpower. In Oklahoma, this is mostly the larger kinds of insects (e. g. crickets, grasshoppers, and beetles). They ignore small or dead insects. You will need live insects for food if you attempt to keep a tarantula as a pet. This may become a problem during the winter months. Some pet stores can supply live crickets or mealworms that would be acceptable food.

Bite Symptoms

While it is true that some of the South American tarantulas have a deadly bite, the bites of species found in the U.S. are considered to be no more harmful than a bee sting. The bite may feel like a pin-prick with mild pain, smarting, and soreness. The venom is only slightly toxic to mammals. There is very little chance of being bitten unless the spider is handled roughly. There can be a risk of developing a hypersensitive or allergic response to their body hairs. Anyone handling a pet tarantula should recognize this potential hazard.

Notes

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert E. Whitson, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of $17,611.24 for 1,200 copies. 1208 GH. This document was printed at CareerTech Printing Services, Stillwater, Oklahoma.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