Integrated Pest Management

INSECT AND MITE PESTS OF APPLES

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INSECT AND MITE PESTS OF APPLES

In the United States there are about 100 insect and mite species known to feed on apple, but only about 5–10 of these species require control on a regular basis. Arthropods that infest tree fruits can be broadly categorized as either direct pests, those attacking the fruit directly through feeding or oviposition activities, or indirect pests, those that primarily damage the foliage, twigs, trunks, and roots. In many cases, a species can be considered both a direct and an indirect pest.

Inadequate knowledge of a pest's biology, such as the damaging stage(s) and its seasonal occurrence, and a lack of damage recognition are some of the main reasons preventing the effective use of conventional and alternative control tactics in orchard pest management. This illustrated guide was prepared to provide information on the damage symptoms and signs caused by many insect and mite pests commonly encountered in commercial as well as backyard apple orchards in the Midwest.

FRUIT-DAMAGING PESTS

Codling moth

The codling moth is a serious tree fruit pest that prefers apples and pears. Adult moths begin to emerge around the bloom or petal-fall stage of apple development (Table 1). They are about 9–12 mm long. The wings are gray in color with indistinct dark/light wavy lines that are bronze-colored at the tips (Figure 1). Eggs are laid primarily on leaf surfaces near the fruit. After the eggs hatch, the larvae bore into the fruit and begin chewing their way to the core, where they feed on the seeds (Figure 2), and they push their waste material (frass) out the entrance and exit holes. This type of damage is often referred to as *deep entries* (Figures 3, 4). Sometimes a larva will bore into the fruit a short distance and then either die or move

Figure 1. Adult codling moths.

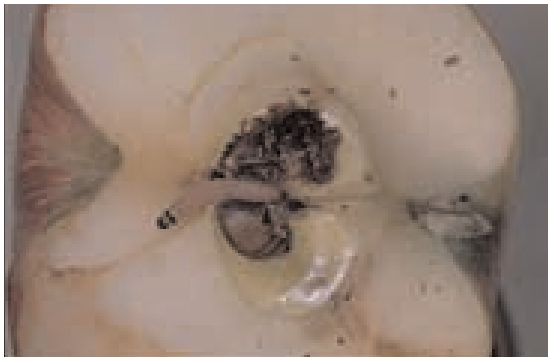

Figure 2. Mature codling moth larva at the apple core.

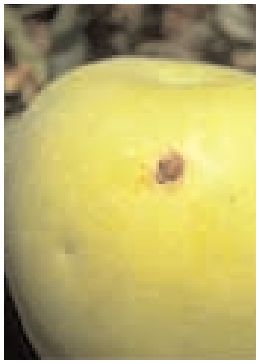

Figure 3. Frass at codling moth entry site on side of apple.

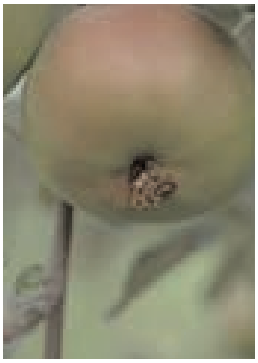

Figure 4. Codling moth damage at calyx end of apple.

Figure 5. Overwintering codling moth larva and its thick silken cocoon (cut away to expose larva) found underneath bark.

to another location to feed, leaving a little shallow hole called a *sting*. Small amounts of frass may or may not be present at sting sites. Mature larvae are about 13 mm long and pinkish white in color with a brown head. After feeding they leave the apple and seek out a protective site to pupate. During the warm summer months, developmental time from egg to adult is about 6 weeks. The codling moth overwinters as a mature larva in a dense silken cocoon found under loose bark or in debris underneath the tree (Figure 5). They can also overwinter in picking crates left in the orchard, in bins of culled fruit, and in other protected sites in and around packing sheds. There are three adult flights of codling moth in Missouri.

Oriental fruit moth

The Oriental fruit moth is often considered a primary pest of peaches but it can also be a serious pest of apples, and it damages apples in a similar manner as codling moth. The Oriental fruit moth is about 5 mm long and has indistinct dark/light wavy lines on its wings (Figure 6). In central Missouri, the adult moths emerge 4–5 weeks earlier in the spring than the codling moth (Table 1) and lay eggs near the terminal parts of rapidly growing apple shoots, often at the base of a leaf stem. The boring larva causes the stem to become wilted (Figure 7), and the larva's frass is often visible at the entry site (Figure 8). A larva may complete its development within the shoot. It has been observed that wilted shoots are most common during the first half of the season. When feeding on the fruit, the Oriental fruit moth larva does not appear to burrow to the core (as does the codling moth) but feeds primarily in the fleshy areas of the apple, sometimes just underneath the fruit's surface (Figure 9). Mature larvae are about 11 mm long, pinkish white in color with a black-brown head. The larvae do not appear to always push their frass out of the fruit entry site like the codling moth. The difference in visible fruit damage between Oriental fruit moth and codling moth, while unique in some regards, can be too similar in most cases and should not be used as the sole diagnostic characteristic. Since the larvae of both moths are similar, the only sure way to distinguish between them is to examine a mature larva with a hand lens (20X) for the presence (in Oriental fruit moth) or absence (in codling moth) of an anal comb on the ventral side of the last abdominal segment (Figure 10). There are three to four flights of Oriental fruit moth in Missouri.

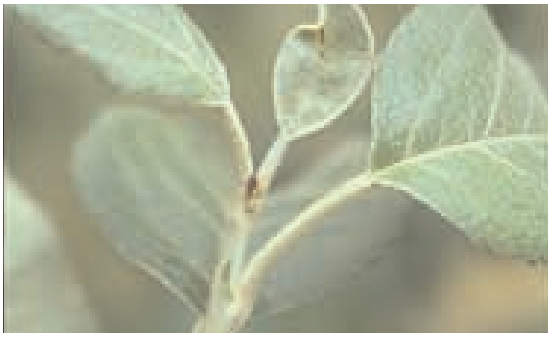

Figure 8. Small pile of larval frass at base of leaf petiole, entry site for Oriental fruit moth larva.

Figure 9. Irregular shallow tunnels caused by Oriental fruit moth larva.

Figure 6. Adult Oriental fruit moth.

Figure 7. Wilted apple shoot tip caused by burrowing Oriental fruit moth larva.

Figure 10. Oriental fruit moth larvae have an anal comb found on the ventral side of the last abdominal segment (left) whereas codling moth larvae do not (right).

Plum curculio

The plum curculio is a snout beetle about 4–6 mm long and colored with mottled patches of black, brown, and gray-white (Figure 11). The wing covers have four pairs of distinctive humps, with one pair being quite prominent. Adult beetles begin to migrate into apple orchards from their overwintering sites each spring during the bloom and petal-fall periods (Table 1). Early-season adult feeding damage on apples consists of small round holes about 3 mm deep (Figure 12). Oviposition damage is made as eggs are laid underneath a crescent-shaped chewed flap of the fruit's skin. The developing larva tunnels into the fruit flesh to feed. The larva is 6–9 mm long, white with a brown head, and legless. After 2–3 weeks in the fruit, the larva leaves and burrows into the ground to complete development. Fruit infested early in the season typically falls to the ground in June or later. But if the egg fails to hatch or the larva dies, the fruit may not drop and the oviposition scar at harvest appears as a corky, bumpy area resembling the letter "D" (Figure 13). Fruit that is severely in the spring is misshapen and scarred at harvest (Figure 14). The adult beetles resulting from eggs laid in the spring begin emerging from the soil in mid- to late summer and return to the trees to feed on maturing apples. When cold weather arrives, the beetles seek out hibernation sites under fallen leaves and debris in woodland and fencerows near the orchard.

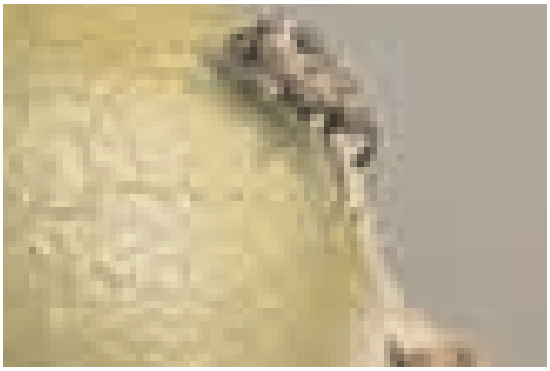

Figure 11. Adult plum curculio.

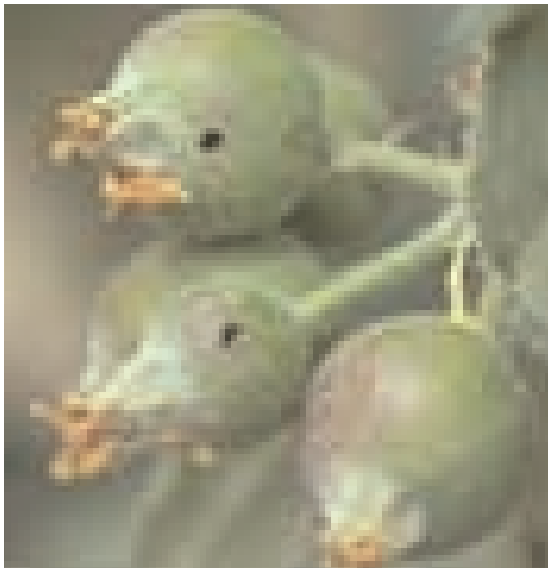

Figure 12. Early-season feeding damage by adult plum curculio.

Figure 13. Plum curculio oviposition scar at harvest.

Figure 14 . Plum curculio feeding and oviposition activity in the spring can result in misshapen fruit at harvest. Note the late-season feeding holes on the fruit too.

Figure 15. Adult tarnished plant bug.

Tarnished plant bug

A serious early-season pest of apples is the tarnished plant bug. The adults are about 6 mm long and 3 mm wide, and somewhat oval in shape and dorsoventrally flattened. Their color is mottled yellow and brown (Figure 15). Adults will overwinter in ground debris and become active early in the spring (Table 1). Their feeding on developing buds and flowers up to the tight cluster stage usually results in underdeveloped buds that fail to set fruit. Feeding activity on small, developing apples will result in deep depressions or dimples (catfacing) that are apparent at harvest (Figure 16). After the petal-fall stage, adults begin to migrate out of the trees to feed and lay eggs on other host plants (such as weeds).

Figure 16. Misshapen fruit (catfacing) caused by early-season feeding activity of the tarnished plant bug.

Figure 17. Adult stink bug.

Stinkbugs

Stinkbugs are another type of plant bug that can be damaging to apples. Stinkbugs are 12–18 mm long with a shield-shaped and somewhat dorsoventrally flattened body (Figure 17). Their color ranges from light brown to bright green. Adults overwinter in ground debris inside and outside of the orchard. From early to midseason, adults start to migrate into the orchard and begin feeding on the fruit (Table 1). Stinkbug feeding sites on mature apples appear sunken and dark in color, and beneath the skin the cells have a brown discoloration (Figure 18).

Figure 18. Stink bug feeding damage appears as sunken, dark areas on the fruit surface (left). Cells underneath the feeding sites have a brown discoloration (right).

Leafrollers

Several species of leafrollers can be serious apple pests in the Midwest. The larval stage of leafroller moths are caterpillars that spin silken threads to roll or connect leaves together to form a protective structure (Figure 19). If one pries apart a leaf shelter the larva will often squirm away rapidly, dropping to the ground or remaining suspended from a silk thread. Leafrollers become important pests when the larva attaches its leaf shelter to an apple where it then feeds on both leaf and fruit tissue (Figure 20), or when it lives and feeds within a cluster of apples (Figure 21). One of the most common species of leafroller occurring in apple orchards in Missouri and other parts of the Midwest is the **redbanded leafroller** (Figure 22). This species overwinters as a pupa on the ground or among plant debris under the trees. Soon after the green tip stage the adult moths emerge and begin laying egg masses

Figure 19. Leafroller leaf shelter.

on the twigs (Table 1). Adults of summer generations lay green egg masses on leaves. After hatching, the egg mass appears white (Figure 23). There are three generations of redbanded leafroller in Missouri.

Another common leafroller species in the Midwest is the **fruittree leafroller** (Figure 24). The overwintering stage is an egg mass attached to twigs or limbs (Figure 25). At about the time

Figure 20. Leaf shelter attached to apple (top) conceals surface feeding damage caused by leafroller larva (bottom).

Figure 21. Leafroller larva among fruit cluster.

Figure 22. Redbanded leafroller moth.

Figure 23. Redbanded leafroller egg mass (after hatch) on apple leaf.

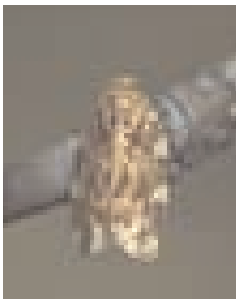

Figure 24. Fruittree leafroller moth.

Figure 25. Overwintering fruittree leafroller egg mass (after hatch) on apple twig.

Figure 26. Spring feeding by fruittree leafroller larvae causes fruit deformation at harvest.

apple buds are in the tight cluster stage, the larvae hatch and begin feeding on the opening buds (Table 1). Developing fruit fed upon by fruittree leafroller larvae will be badly scarred or lopsided at harvest (Figure 26). Maturing fruit that is attacked will have irregularly shaped feeding wounds that may be either shallow or deep. There appears to be only one generation of fruittree leafroller each year in Missouri. Depending on the species, leafroller larvae range in length from 16 to 30 mm. The body color of most species is light to dark green, but the head color may vary. The redbanded leafroller larva has a pale green head, but the fruittree leafroller has a black head.

Figure 27. Small apple branch heavily infested with San Jose scale.

San Jose scale

The San Jose scale feeds on plant sap with long needle-like mouthparts, and can be found on the twigs, branches, and fruit of apple trees. Twigs and branches heavily infested appear to be coated with wood ashes (Figure 27). On fruit, red spots develop around the scales (Figure 28). In high populations it can contribute to an overall decline in tree vigor, growth, and productivity. The San Jose scale is a tiny insect that spends most of its life underneath a waxy covering it secretes (hence the name of "scale"). In the spring, during the apple bloom and petal-fall periods, small, winged adult males begin to emerge from their waxy coverings and seek out females (Table 1). The mature female's round waxy covering is about 1.5 mm across, gray-brown in color with a tiny yellow-white dot in the center. The female's yellow body is legless and wingless. About 4–6 weeks after mating, immature scale nymphs called "crawlers" begin to emerge from underneath the female's covering and move about the tree looking for a suitable site to settle and begin feeding. Crawlers are yellow in color with short antennae and six legs. Crawlers can be distinguished from mites, which have four pairs of legs and no antennae. Once settled the crawler will insert its mouthparts into the tree or fruit and begin to feed. As the nymph grows it secretes its own waxy scale covering and loses its legs as it molts. A scale infestation can spread only during the crawler stage. There are two generations of San Jose scale in Missouri.

Figure 28. Fruit infested with San Jose scale.

Apple maggot

In the Midwest, the apple maggot is a serious pest in Michigan, Wisconsin, Minnesota and the northern areas of Iowa, Illinois, Indiana and Ohio. It is not common in Missouri. Adult apple maggot flies begin to emerge from the soil in June and July, and emergence may extend into September (Table 1). The dark-colored adults are about 6 mm long. They have dark cross-bands on the wings and a large white spot on the thorax (Figure 29). On the abdomen of females, there are four white transverse bands, whereas on the males, there are only three white bands. Females insert tiny, white, elongate eggs in the fruit flesh just underneath the apple skin. The hatching maggots (larvae) begin feeding on the apple flesh, leaving tiny, irregular brown winding tunnels that are visible externally, especially on the thin-skinned early varieties. These tunnels can extend from beneath the skin down to the core (Figure 30). The feeding maggots, along with associated bacteria, quickly begin to soften and decay the infested fruit, which will often drop to the ground. When mature, the white-colored maggots (6–7 mm long), leave the fruit and crawl into the soil to pupate. There is usually one generation per year.

Figure 29. Adult apple maggot fly.

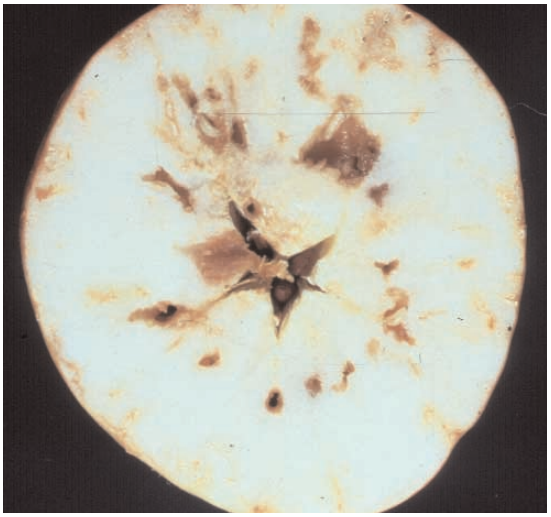

Figure 30. Apple maggot larvae (maggots) feeding inside apple.

FOLIAGE-DAMAGING PESTS

Mites

The two most important mite species found infesting apples in the Midwest are the European red mite and the twospotted spider mite. Both species have very fine needle-like mouthparts that withdraw plant fluids, including the chlorophyll, from leaf tissue. Individual feeding sites on leaves look like tiny white spots. Large mite populations cause infested leaves to become discolored with a yellowish brown hue, referred to as "bronzing" (Figure 31). Severe leaf bronzing causes premature defoliation and fruit with poor color and reduced size and quality. The adult **European red mite** female is about 0.35 mm long, oval in shape, dark red in color, and with stout white bristles on the back of the body. This mite species overwinters in egg clusters located in the bark crevices of twigs. The eggs begin to hatch in the spring during the apple tight cluster stage (Figure 32, Table 1), and most eggs will have hatched by the end of the bloom period. The **twospotted spider mite** female is about 0.40 mm long and oval in shape. She is yellow-green in color and has two distinctive dark spots on the back of her body. The adult female will overwinter in plant debris beneath the tree. This mite species becomes active in the spring during the half-inch green stage of apple leaf development but will often stay in the ground cover feeding and reproducing on weeds and grasses until midsummer (Table 1) when it begins moving up into the apple trees. During the fall most adults will leave the trees and overwinter in plant debris on the ground. There are several mite generations each year.

Figure 31. Apple leaves discolored (bronzed) by mite feeding. Note rich green uninfested foliage in bottom left.

Figure 32. European red mites infesting newly formed cluster.

Tentiform leafminers

The spotted tentiform leafminer and apple blotch leafminer are small moths (5 mm long) with bronze and white streaks on the forewings (Figure 33). These two species have similar life histories and are both found in Missouri apple orchards. They are referred to collectively as **tentiform leafminers**. The adult moths begin to emerge in the spring during the tight cluster and pink stages of development (Table 1). Eggs are laid on the underside of leaves, and the hatching larvae chew their way into the internal leaf tissue. These young larvae are referred to as sapfeeders. They are dorsoventrally flattened and lack legs (Figure 34). At first, the small developing sapfeeder feeds on the lower internal leaf tissue, forming a mine that is blotch-shaped and can be seen only on the underside of the leaf (Figure 34). As the larva grows, it develops legs and becomes caterpillar-like in appearance and is

Continued on page 12

Figure 33. Adult tentiform leafminer.

Figure 34. Young leafminer larvae are referred to as sapfeeders (left), and they produce mines that are visible only on the leaf's underside (right).

Continued from page 9


Figure 35. Older leafminer larvae are referred to as tissuefeeders (left), and they produce mines that are visible from both the upper and lower leaf surfaces (right).

referred to as a tissuefeeder larva (Figure 35). These older larvae begin to feed on the upper internal leaf tissue, resulting in light-colored spots visible externally on the upper leaf surface. The tissuefeeder larva spins silken threads within the mine, causing the mine to arch, becoming tent-like in shape (Figure 35). High infestations can lead to early leaf drop, reduced fruit and terminal growth, and reduced fruit set the following year. There are three to four generations of both leafminer species each year in Missouri.

Figure 36. Leafhopper nymphs and cast skins.

White apple leafhopper

The white apple leafhopper is primarily an apple pest, but it can also occur on other tree fruits. Overwintering eggs, found just underneath the bark of twigs, begin to hatch during the apple pink to petal-fall stages of development (Table 1). The young nymphs move to the lower leaf surfaces and begin to feed. Their shed skins and tiny spots of black excrement are often visible (Figure 36). Leafhoppers, both nymphs and adults, have piercing-sucking mouthparts that remove plant sap and chlorophyll from the foliage tissue. The topsides of heavily infested leaves are covered with tiny white markings. The entire leaf may seem mottled or silvery in appearance (Figure 37) and, in high population densities, such damage may affect fruit set and size. Adults are about 3 mm long and readily jump and fly from the foliage when disturbed. At harvest, second-generation populations can build to such large numbers that the leafhoppers become a nuisance as they fly about the heads of pickers. The accumulation of leafhopper excrement on the fruit surface may also be a problem.

Figure 37. Apple leaf discolored by leafhopper feeding.

Figure 38. Leaf curl at petal fall due to aphid feeding.

Aphids

Aphids are small, soft-bodied insects that can be found, depending on the species, on almost any part of the apple tree. Aphids are about 3 mm long, winged or wingless, and vary in color from light-green, yellow-green, reddish brown to black. Three of the most common aphid species that infest apples are the **rosy apple aphid**, the **green apple aphid**, and the **woolly apple aphid**. Aphids have piercing-sucking mouthparts and consume large quantities of plant sap. Both the rosy apple aphid and the green apple aphid feed on the underside of leaves, causing the leaves to curl (Figures 38, 39). In high aphid infestations, the fruit will be small or distorted at harvest. In addition, large quantities of aphid "honeydew" (waste product) can be produced that can coat both the foliage and fruit and act as a medium for

Figure 39. Rosy apple aphids.

Figure 40. Clusters of overwintering aphid eggs on twig.

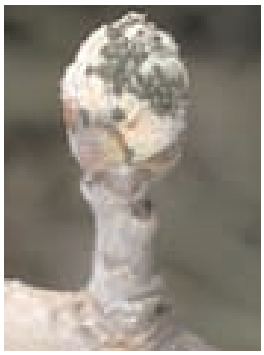

Figure 41. Newly hatched aphids feeding on bud.

Figure 42. Woolly apple aphid at base of shoot.

the growth of a black sooty mold. Both the rosy apple aphid and the green apple aphid overwinter as tiny black eggs on the bark of small twigs and branches (Figure 40) The eggs hatch in the spring at about the time of apple bud break (Table 1), and the immature aphids immediately start feeding on developing green plant tissue (Figure 41). The bodies of woolly apple aphids are covered by a white, cotton-like substance, and populations can be found infesting the root system as well as around leaf axils, new shoot growth, and on the trunk and branches (Figure 42).

Other foliage-feeding pests

- **Leafrollers** see pages 6–7
- **Japanese beetle** see page 8

TRUNK- AND TWIG-DAMAGING PESTS

Dogwood borer

In apple trees, the dogwood borer is frequently found infesting the burrknots or adventitious (aerial) roots that grow just below the exposed graft union on dwarf and semidwarf trees. Severe borer infestations can girdle and kill a tree, but lower persistent infestations over several years will contribute to a slow decline in the tree's vigor. The adult stage is a moth that looks wasp-like. It is about 13 mm long with a wingspan of 19 mm. Both pairs of wings are clear except for the veins and margins, which are fringed with steel-blue colored scales. The body is blue-black in color except for yellow bands on the abdomen and the legs are mostly yellow (Figure 43). The dogwood borer moth looks similar to the lesser peachtree borer moth but smaller. Adult moth emergence generally begins in early June and can continue at varying levels into September (Table 1). Eggs are usually laid on rough bark or around bark wounds. After hatching, the larvae begin to burrow into the tissue (Figure 44). A mature larva is about 15 mm long, white to cream colored with a pale brown head. As the larvae feed, reddish brown frass is pushed to the surface of the tunnel (Figure 45). A feeding tunnel may be as much as 19 mm deep. As the burrknot tissue is consumed, the larvae will move outward and begin to feed on the cambium layer of healthy bark. Overwintering is done in the larval stage in the feeding tunnel. In the spring, the larva resumes feeding. Before pupation the larva will construct a tough silken cocoon covered with bits of frass. After adult emergence the empty pupal casing often remains protruding from the surface of the burrknot (Figure 46). There is usually one generation per year.

Figure 43. Adult dogwood borer.

Figure 44. Exposed dogwood borer larva feeding beneath the bark surface.

Figure 45. Reddish-colored frass of dogwood borer collecting at surface of damaged area.

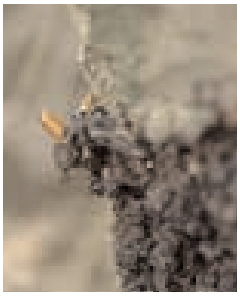

Figure 46. Pupal casing of dogwood borer protruding from damaged area.

Flatheaded appletree borer

The flatheaded appletree borer is a common borer of fruit trees. It is a particularly destructive pest to newly planted trees and trees stressed by drought or other factors. The adult beetle is about 13 mm long, oval-shaped and flattened, and has a dark metallic color. The body is blunt at the head, and tapers to a rounded point at the posterior end (Figure 47). Adults typically begin emerging in May, and egg-laying can continue from June to September; hence, larvae of varying sizes may be found throughout the summer (Table 1). Eggs are typically deposited under bark scales or in bark crevices on the south and west sides of the main trunk and larger branches. The larvae bore (tunnel) into the bark and feed on the phloem and outer sapwood. The bark tissue over infested areas are often dead and dark-colored. Young trees can be girdled and killed, whereas larger trees can be seriously injured through the loss of large portions of bark. Tunnels in trees can often be 7 cm long or more. As the larva feeds, it fills the tunnel with a powdery frass. Mature larvae are white, about 2.5 cm long, and slender, except for a broad, flat enlargement of the thoracic segments behind the head (Figure 48). During the fall the larva will bore deeper into the wood where it will spend the winter and pupate the following spring. There is one generation per year.

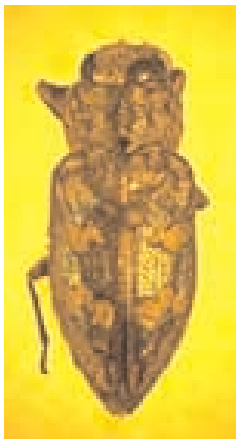

Figure 47. Adult flatheaded appletree borer.

Figure 48. Larva of flatheaded appletree borer in small apple trunk.

Other trunk- and twig-damaging pests

- **Oriental fruit moth** see pages 6–7
- **San Jose scale** see page 8

Roundheaded appletree borer

The roundheaded appletree borer is primarily a serious pest in neglected apple orchards. The presence of pigtail-shaped frass and wood cuttings on the bark surface or at the base of the tree, and darkened areas in the bark (due to sap flow), are evidence of borer attack. One or two borers may kill a young tree, and trees 5–10 years old may suddenly break off at the ground because of earlier borer infestations. The adult beetle is about 13–26 mm long with the antennae being about the same length. The body is entirely white except for three brown, longitudinal stripes extending the full length of the body (Figure 49). The borer has a two-year life cycle. Adult beetles usually appear during May and June with egg-laying continuing until late July (Table 1). Eggs are typically inserted into the bark of the trunk near the ground, although, eggs may occasionally be oviposited in tree crotches. The larva begins feeding within the bark and by September, larvae are found between the bark and sapwood. During this time the larvae eject wood cuttings and a rusty-brown frass from their tunnels. By winter the larvae have produced a tunnel about 7–10 cm long. The larva passes the winter in the sapwood. During the following spring, summer, and fall, the larva bores deeper into the wood (Figure 50). A mature larva is about 3 cm long, fleshy, thin-skinned, white or yellowish in color, cylindrically shaped, with a brown head and a rounded thickening of the body just behind the head. By fall of the second year, the larva excavates an overwintering and pupal chamber about 13 mm beneath the bark. In the following spring, the larva pupates and passes into the adult stage. The adult escapes from the pupal chamber by cutting away the bark cap (Figure 51). Adults will crawl over the surface of the tree and feed to some extent on the foliage and on the new twig growth before and during the mating period. Despite having well-developed wings, the adult beetle usually flies only short distances.

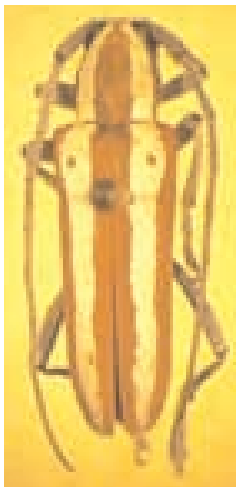

Figure 49. Adult roundheaded appletree borer.

Figure 50. Bark and wood removed exposing a roundheaded apple tree borer larva.

Figure 51. Dead adult roundheaded appletree borer removed from its pupal chamber (hole in trunk).

MISCELLANEOUS APPLE PESTS

Japanese beetle

The Japanese beetle is a general herbivore that feeds on a wide variety of plant foliage, fruit, and flowers, and apple is one of its preferred hosts. Adults will feed on the upper surface of the leaves, eating the tissue between the veins. Damaged leaves have a lacey appearance and soon turn brown. Ripened fruit may also be attacked. Primary damage to plants comes when large numbers of feeding beetles congregate on a plant or fruit. The adults have a brilliant, metallic green color and are generally oval in shape and about 10 mm long and 7 mm wide. The wing covers are copper-brown in color and the abdomen has a row of five tufts of white hairs on each side (Figure 52). These white tufts are a diagnostic characteristic of Japanese beetle. Adult beetles emerge from the ground in early June through September, with peak emergence occurring in late-June/early-July (Table 1). Females will mate and lay eggs immediately upon emergence. Eggs are laid in moist soil. The developing larvae, a type of "white grub," feed on organic matter and roots and will reach a size of 3 cm long. The grubs will overwinter and continue their development in the spring. There is one generation of Japanese beetle each year.

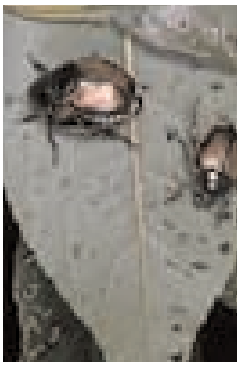

Figure 52. Japanese beetle adults.

Yellownecked caterpillar

The yellownecked caterpillar feeds on the foliage of many fruit trees, including apple, as well as shade and forest tree species. Infested trees can be completely defoliated by mid- to late summer with serious injury occurring primarily to single, isolated trees. Defoliation appears first on the periphery of the canopy. During midsummer, adult moths emerge from the soil and lay egg masses on the underside of leaves (Table 1). The larvae may consume the entire leaf tissue except the petiole. Full-grown larvae are about 5 cm long and moderately hairy. The head is black; the "neck" region is bright yellow-orange in color; and the body has alternating longitudinal black and yellow or white stripes (Figure 53). There is one generation per year.

Figure 53. Yellownecked caterpillar larvae.

Fall webworm

The fall webworm feeds on the foliage of many forest, shade, ornamental and fruit trees, including apple. Persistent infestations may cause branch and top-kill. Beginning in the spring and throughout the early summer, adult moths will emerge from the ground litter and lay hair-covered egg masses on the undersides of leaves. Newly hatched larvae immediately begin to spin webbing over the foliage they are feeding on. As the larvae grow, they enlarge the web nest to enclose more foliage (Figure 54). Larvae from the same egg mass generally stay together in the webbed nest until the last larval stage. Mature larvae are about 2.5 cm long. At the end of each generation, the webbed nests can be quite large and contain excrement, dried leaf fragments, and shed skins of the larvae. During high fall webworm populations, small to moderate-sized trees may be completely covered with webbing, which is most noticeable during the late-summer (Table 1).

Figure 54. Fall webworm damage on apple tree.

Shothole borer

The shothole borer is usually a problem of weak and declining fruit trees, and infestations frequently hasten tree or limb death. The bark of infested twigs, branches, and trunks are perforated with many small round holes about the size of a pencil lead (Figure 55). The adult beetle is dark brown to black in color, blunt on both ends, and about 2.5 mm long. The tips of the antennae and legs are reddish brown. The wing covers are striated with rows of shallow punctures. Adults emerge in May (Table 1). The female beetle will bore through the bark and begin excavating a gallery (tunnel) at the wood/bark interface that is about 5 cm long and runs parallel with the wood grain. Along the gallery the female will lay several eggs. The hatching larvae will then form their own galleries (Figure 56). A larva is about 3 mm long, legless, white with a brown-red head, and has a slight enlargement of the body just behind the head. It will feed on sapwood for about a month. The mature larva pupates within its tunnel and, as an adult, will chew a round hole through the bark and emerge. The small holes found in the bark can be either entrance or exit holes. After emerging, adult beetles can reinfest the tree or seek out new host trees. Adults are capable of flying long distances. There are usually two or more generations each year.

Figure 55. Entrance or exit holes of the shothole borer.

Figure 56. Galleries of the shothole borer beneath the bark.

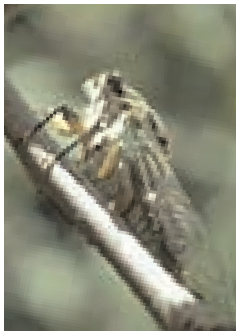

Figure 57. Adult annual cicada.

Cicadas

There are two common types of apple-infesting cicada in Missouri, the periodical cicada and the annual cicada (both with several species). Cicadas are heavy-bodied, wedge-shaped insects that have large compound eyes and membranous wings held rooflike over the body. **Annual cicadas** are larger than periodical cicadas. They are often dark green to blackish in color with green margins on the wings. There may be lighter markings on the thorax and abdomen (Figure 57). Their life cycle lasts 2–5 years, but because of overlapping generations, some adults appear every year, usually July through September (Table 1). **Periodical cicadas** are the most damaging species for apples. Adults are 19–38 mm in length. They have a brownish black body, unspotted from the top, and reddish colored eyes, legs and wing veins (Figure 58). There are six species of periodical cicadas, three with a 17-year life cycle and three with a 13-year life cycle. Broods of cicadas are groups of individuals that hatch and mature at about the same time. Table 2 provides the occurrence and state distribution of the five confirmed

Figure 58. Adult periodical cicada.

Figure 59. Oviposition damage of the periodical cicada on an apple twig.

Figure 60. Mass of periodical cicadas in apple tree.

Figure 61. A periodical cicada shed exoskeleton attached to an apple leaf.

Table 2. Occurrence of periodical cicada broods in Missouri.

Year	Race	State distribution
1997	17-year	northern
1998	13-year	eastern
1998	17-year	west central
2002	13-year	south-east
2006	17-year	central
2011	13-year	eastern
2014	17-year	northern
2015	17-year	west-central

broods of periodical cicada found in Missouri. During infestation years, the adult periodical cicada begins to emerge in mid-May (Table 1). The female cicada uses a sawlike ovipositor to cut through the bark of small twigs and branches, and forms a pocket in the wood where she inserts eggs. She then will move forward, cutting a new pocket, and laying more eggs. This process may be repeated several times and may produce a continuous slit along the length of the twig (Figure 59). Leaves of the attacked branch can wither and turn brown, and smaller infested branches may break off the following year. Such damage can be serious to young transplanted trees especially during an outbreak (Figure 60). After hatching the nymphs drop from the twigs to the ground, enter the soil, and begin feeding on sap from the roots. Nymphs will remain underground at a depth of 5–45 cm until they are ready for their last molt (13 or 17 years after hatching from eggs). Before its final molt to the adult stage, the pupa will emerge from the ground and climb up the trunk of a tree, fence post, or side of a house and attach itself with its claws. The exoskeleton will split down the middle of the back and the adult will gradually pull itself free, leaving the cast skin of the pupal stage still attached to the substrate (Figure 61). The adults can live 5–6 weeks.

Grasshoppers

The occurrence of grasshoppers at damaging levels in commercial apple orchards is not too common primarily because of the regular use of insecticide sprays in such orchards. However, in the "backyard" orchard where sprays are usually not applied as frequently, and coupled with a hot, dry season, grasshopper populations can rise to levels that may cause severe damage. Large populations of grasshoppers can skeletonize the leaves (Figure 62) and eventually strip the lower branches of all foliage. They may also cause surface feeding damage on developing fruit and scar the bark. Grasshoppers lay their eggs in the ground as deep as 3 inches. In late spring, the young "hoppers" hatch as soon as the soil becomes warm.

Figure 62. Young grasshoppers feeding on foliage (left) and fruit (right).

Table 1. Seasonal timeline of apple pest occurrence in central Missouri.

Pest	Developmental stages of apple								May	June	July	August	September	October	Pest
	Dormant	Green tip (late March to early April)	1/2-in. green (late March to early April)	Tight cluster (early to mid-April)	Pink (early to mid-April)	Bloom (mid- to late April)	Petal fall (late April to early May)								
Redbanded leafroller		adult emergence	•	•	•	•	•		•	•	•	•	•	•	Redbanded leafroller
Oriental fruit moth			adult emergence	•	•	•	•		•	•	•	•	•	•	Oriental fruit moth
Green apple aphid			egg hatch	•	•	•	•		•	•	•	•			Green apple aphid
Rosy apple aphid			egg hatch	•	•	•	•		•						Rosy apple aphic
Fruittree leafroller				egg hatch	•	•	•		•	•	•				Fruittree leafroller
European red mite				egg hatch	•	•	•		•	•	•	•	•		European red mite
Tentiform leafminers				adult emergence	•	•	•		•	•	•	•	•	•	Tentiform leafminers
Tarnished plant bug					adult emergence	•	•		•						Tarnished plant bug
San Jose scale						adult male emergence	•		•	crawler emergence					San Jose scale
White apple leafhopper						egg hatch	•		•	•	•	•	•		White apple leafhopper
Plum curculio							adult emergence		•	•	•	•	•		Plum curculio
Codling moth							adult emergence		•	•	•	•	•	•	Codling moth
Woolly apple aphid							egg hatch		•	•	•	•	•		Woolly apple aphid
Stink bugs									adult emergence	•	•	•	•		Stink bugs
Roundheaded appletree borer									adult emergence	•	•				Roundheaded appletree borer
Periodical cicada									adult emergence	•	•				Periodical cicada
Flatheaded appletree borer									adult emergence	•	•	•	•		Flatheaded appletree borer
Shothole borer									adult emergence	•	•	•	•		Shothole borer
Apple maggot										adult emergence	•	•	•		Apple maggot
Dogwood borer										adult emergence	•	•	•		Dogwood borer
Japanese beetle										adult emergence	•	•	•		Japanese beetle
Twospotted spider mite											adults enter trees	•	•		Twospotted spider mite
Yellownecked caterpillar											larvae feeding in tree	•			Yellownecked caterpillar
Annual cicada											adult emergence	•	•		Annual cicada
Fall webworm											larvae feeding in tree	•	•		Fall webworm

This timeline shows approximate times and apple life stages when apple pests become active (based on data from central Missouri orchards). Bulleted areas (•) indicate subsequent occurrence of damaging adult or immature stages of pests.

For further information

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