INSECTS THAT FEED ON COLORADO TREES AND SHRUBS[1]

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Colorado State University Cooperative Extension

DEFOLIATORS

LEAF FEEDING CATERPILLARS

Caterpillars are the immature stages of moths or butterflies and belong to the order Lepidoptera. They are typical of insects that develop in a pattern known as complete metamorphosis, involving the egg, larva, pupa, and adult stages. Each developmental stage is separated by a molt, and there are typically four to six molts during the larval stage.

Caterpillars feed by chewing plants. Most common are those that consume leaves and needles. However, many trees and shrubs support species that tunnel leaves or needles (see Leaf and Needle-miners), bore into cones or fruit (see the section Insects that Feed on Fruit, Seeds, and Cones), or tunnel into branches and trunks (see the section Borers of Trunks and Larger Branches).

Although a great many caterpillars feed on Colorado trees and shrubs, most occur chronically in low numbers and are rarely damaging. Consecutive annual problems are not common except for a few serious outbreak species such as Douglas-fir tussock moth and certain budworms.

Because caterpillars eat most of their food volume during the latest (i.e., largest) larval stages, defoliation may appear to occur very suddenly. Often, problems are not detected until feeding is nearly over and treatments are no longer of benefit. Detection of incipient problems can be made by watching for small larvae and the early phases of leaf or needle feeding. In some situations the pelleted caterpillar excrement (frass) on the ground can indicate a possible infestation within a tree.

For most caterpillars on shade trees and shrubs Pyrenone, Tempo, Talstar, Orthene, Tame, and Sevin are highly effective insecticides for control. Also, Bacillus thuringiensis (e.g., Dipel, Thuricide, MVP, Steward), the active ingredient in a group of microbial insecticides with exceptional safety characteristics, is also effective against most caterpillars if it is applied in a manner that allows ingestion by the insect larvae.

Insecticide applications made against caterpillars that produce protective structures (fall webworm, leafrollers, etc.) must be made shortly after eggs hatch. Treatments made later will generally fail to contact the insect. The addition of a wetting agent, such as soap, can improve coverage and is particularly useful for additional control of hairy caterpillars.

Specific recommendations for these insects appear in the supplement on insect control recommendations. Sections in the supplement which deal with leaf feeding caterpillars include: **Leaf feeding caterpillars, Douglas-fir tussock moth, Budworms, Fall webworm, and Leafrollers.**

CECROPIA MOTH

Hyalophora cecropia (L.)
Family: Saturniidae

Appearance: **Adults** - Large and colorful moths with a wingspan of five and one half to six and one half inches. Brownish-gray wings with white crescent-shaped eye-spots, a dark spot near the tip of each forewing and red bordered crossbands. The body is thick and red, crossed with white lines. **Larvae** - Large, sluggish green caterpillars, from 3 to 4 inches long, with bright blue lateral tubercles and yellow dorsal tubercles which turn bright red near the head.

Late instar larva of a crecopia moth. Photograph by D.A. Leatherman.

Hosts: At least 50 species of deciduous trees and shrubs are hosts of larvae of the cecropia moth. Lilac, elder, ash, and various species of viburnum are among the more common local landascape plants on which it feeds.

Damage: The larvae chew leaves and mature caterpillars consume very large amounts of foliage in a short period of time. However, defoliation occurs late

in the season. Because injury is late and large numbers of larvae rarely occur damage is minimal, although it commonly attracts attention.

Life History and Habits: Pupae overwinter in large double-walled cocoons fastened to branches. The adults (which have no mouthparts) emerge in the spring, mate, lay eggs and die. Eggs are laid in small groups on twigs and larvae hatch and feed from June through September. When full grown the larvae wander from the plant in search for a pupation site. There is one generation per year.

Cocoon of a crecopia moth. Photograph by W.S. Cranshaw.

Related Species: A closely related species, *Hyalophora gloveri gloveri*, which occurs at higher elevations in Colorado. It most always is found on *Rhus trilobata* but is reported to feed on maple, willow and many other trees and shrubs.

Miscellaneous Notes: The cecropia moth and the polyphemus moth are the two largest moths found commonly in Colorado yards. Both may be attracted to lights in spring and can be easily collected.

Control: Defoliation occurs late in the season and is rarely extensive. Controls are not recommended.

POLYPHEMUS MOTH

Antheraea polyphemus (Cramer)
Family: Saturniidae

Appearance: **Adults** - Large tan moths with a wingspan of 4 to 5 inches. Circular, translucent eyespots appear on each wing; the hind wing spots are distinctively rimmed with yellow, blue and black. **Larvae** - Large, sluggish apple-green caterpillars, up to three and one half inches long at maturity, with six rows of even-sized orange or golden tubercles arising from red spots.

Hosts: Many deciduous trees and shrubs. Dogwood shrubs and plum are among the more common hosts in Colorado.

Damage: Mature larvae chew leaves of a variety of plants and feed very heavily for a short time in late summer as they near maturity. However the time of injury and infrequency of outbreaks makes this insect primarily a curiosity.

Late instar caterpillar of the polyphemus moth. Photograph by J.L. Capinera.

Life History and Habits: The polyphemus moth overwinters as a pupa in broadly oval cocoons found on the ground or suspended on branches. In the spring, adults emerge, mate, and lay eggs on twigs. Larvae spend the summer feeding and pupate early in the fall. There is one generation per year.

Control: Defoliation occurs late in the season and is rarely extensive. Controls are not recommended.

NEVADA BUCK MOTH

Hemileuca nevadensis Stretch
Family: Saturniidae

Appearance: **Adults** - Wingspan of the moth is about three inches. Each wing is dark with a white transverse band containing a small eyespot marking. The abdomen has a reddish tuft. **Larvae** - Caterpillars are black when young, turning yellow as they mature. Older caterpillars have red heads and branched, black and white lateral spines, plus two rows of yellow dorsal spines.

Hosts: Cottonwood, poplars and willow, occasionally aspen

Damage: Larvae feed on foliage and during outbreaks can defoliate trees. The spines can cause skin irritation.

Life History and Habits: Egg masses that ring the twigs are the overwintering stage. These hatch in late April or early May. Larvae first feed gregariously, later dispersing. They grow and molt five times before dropping to the ground to pupate. Most adults emerge in fall, although some may overwinter as pupae. The name "buck moth" was given because adults can be observed during fall deer hunting season.

Mature caterpillar of the Nevada buck moth. Photograph by D.A. Leatherman.

Related Species: Several *Hemileuca* species also may occur in the region. These include *H. diana* Packard, on gambel oak; *H. magnifica* (Rotger) on *Artemisia tridentata*; *H. eglanterina annulata* Ferguson on many plants including *Amelanchier*, rose, *Prunus*, *Purshia tridentata*, and *Symphoricarpos*; *H. nuttalli nuttalli* (Strecker) which primarily feeds on Antelope bitterbrush (*P. tridentata*) and snowberry; and *H. neumoegeni* Hy. Edwards which feeds on desert almond, skunkbrush, sumac and Apache plume. None of these species are reported to cause significant injury.

Control: This species is regularly attacked by numerous natural enemies (tachinid flies, parasitic wasps) and rarely requires control. Applied controls involve standard caterpillar insecticide sprays. Young stages are much more susceptible to insecticides than are mature larvae.

PANDORA MOTH
Coloradia pandora (Blake)
Family: Saturniidae

Appearance: **Adults** - Gray, thick-bodied moths with a wingspan of three to five and one half inches. Forewings are brownish gray, hind wings pinkish gray, with black dot and dark wavy line on each wing. **Larvae** - From two and one half to three inches long, a gray caterpillar with white stripe down the back. A few stout, branched spines appear on each segment.

Hosts: Lodgepole pine, ponderosa pine

Damage: Larvae feed on older foliage, leaving the tree with a tufted appearance. Infested trees have reddish tops with foliage only at branch tips. Heavy damage is not common and usually occurs only where soil is loose enough to allow caterpillars to burrow and pupate. The larvae are covered with stinging hairs. Because of the life history of the pandora moth, defoliation occurs in alternate year episodes during outbreaks.

Life History and Habits: Pandora moth most often has a two year life cycle. They spend the winter of the first year as young caterpillars on the tree and resume feeding with the return of warm weather. In June or July, mature larvae crawl down tree and pupate in loose soil. Pupation typically lasts for about a year, but may occasionally may extend up to four years. Adults emerge in June or July and mate. Females begin to produce eggs one to two days later, laying clusters on needles, bark, and occasionally in ground litter or brush. Eggs hatch in August, and young larvae feed on needles until fall, then overwinter.

Related Species: A related, uncommon species (*Coloradia* doris Barnes) feeds on ponderosa pine and has an annual life cycle.

IO MOTH
Automeris io (F.)
Family: Saturniidae

Appearance: **Adults** - Large moths with a wingspan of two and one half to three inches, the females with lightly patterned purplish-red wings, the males smaller with yellowish wings, both with a large circular black eyespot on the hind wings. **Larvae** -

Large pale green caterpillars with a lateral stripe of pink and creamy white down each side, covered with clusters of branching spines. About 3 inches long at maturity.

Hosts: Many varieties of deciduous trees and shrubs

Damage: The primary injury results from the stinging hairs on the larvae and pupae which can cause painful rashes. Larvae feed on leaves late in the summer but rarely cause noticeable defoliation to trees and shrubs. Most outbreaks have historically been around the Arkansas River Basin area (Fremont/El Paso counties).

Life History and Habits: Io moth spends the winter as a pupa, within a tough brown cocoon covered with bits of hair and debris, often on the ground in the vicinity of previously infested plants. Adults fly in the late spring and early summer and females lay eggs. Caterpillars are present from July to September. When full grown, they wander from the plant and search for a suitable site to pupate. There is one generation per year.

Larva of the io moth. These caterpillars possess urticating (stinging) hairs. Photograph by W.S. Cranshaw.

Control: This species is never abundant enough to seriously damage trees. However, control of outbreaks may be considered to limit injury by the stinging hairs of the caterpillars. Controls outlined under the section for **Leaf feeding caterpillars** in the control supplement should be effective.

FALL WEBWORM

Hyphantria cunea (Drury)

Family: Arctiidae

Appearance: **Adults** - Satiny-white moths sometimes with brown or black spots, wingspan of about one and one half inch. **Larvae** - Color of the caterpillars is pale but highly variable, yellow to brown, sometimes greenish. The body is covered with tufts of long, silky, gray hairs arising from black and orange tubercles. Caterpillars are about one inch long when mature.

Hosts: Cottonwood and chokecherry are the most common hosts, but over 100 species of hardwood trees may be eaten.

Damage: The larvae feed on leaves and build unsightly silken tents. Heavy infestations can defoliate trees. Wandering larvae are sometimes a serious nuisance. Fall webworm is the most common tent-making caterpillar in Colorado with outbreaks particularly common along parts of the West Slope and Platte River Valley.

Larvae and tent of the fall webworm. Photograph by W.S. Cranshaw.

Life History and Habits: The fall webworm spends the winter as a pupa within a light-colored cocoon on the ground or under bark. In late spring and early summer, adults emerge and egg laying takes place. Eggs are laid in masses on the leaves. The newly hatched larvae feed together and spin lightly woven webbed tents that enshroud the leaves on which they are feeding.

As the caterpillars grow, they continue to build tents which may reach several feet in diameter by late summer. The larvae mature in the late summer and early fall. They wander from the plant and search for a protected location to pupate.

One generation per year is normal for this species in Colorado. However, egg laying occurs over an extended period of several weeks with tents being initiated from late June through July. A second generation may occur in warmer areas of the state.

An adult of the fall webworm. Photograph by W.S. Cranshaw.

Control: Although an abundant and highly conspicuous defoliator, fall webworm damage tends to occur late enough in the season to cause little effect on plants. Only in areas where repeated, heavy defoliation occurs, or where there is a severe nuisance problem associated with wandering caterpillars, is control warranted.

Fall webworm is attacked by a great many natural enemies including tachinid flies, parasitic wasps and various hunting wasps. Sustained outbreaks may be related to excessive use of area-wide spraying for mosquitoes, which is detrimental to natural enemies of the fall webworm.

Fall webworm is highly susceptible to many insecticides, particularly pyrethroids. Specific treatments are outlined in the control supplement under the section on **Fall Webworm**. However, control is made difficult due to the tents and to the large size of the trees which typically are attacked, which produce problems with providing sufficient coverage. If trees are to be sprayed, treatments are best applied when tents are small, particularly if an insecticide is used that must be eaten, such as *Bacillus thuringiensis*. The addition of a soap or some other surface-active material which can allow better wetting of the tent silk should improve control.

Tents of the fall webworm can be pulled out and destroyed. However, burning the tents and caterpillars while on the tree can easily do more damage than is caused by the insect.

TIGER MOTH

Lophocampa ingens (Edwards)
Family: Arctiidae

Appearance: **Adults** - Buff-colored moths with a wingspan of about three inches, forewings dark brown with large white ovals, hind wings white. **Larvae** - Black caterpillars covered with gold and black tufts of hairs. Mature larvae reach one and one half inches.

Hosts: Pinyon, ponderosa and lodgepole pine. A related species (*Lophocampa argentata subalpina*) feeds on pinyon and juniper.

Damage: Larvae feed on older needles, sometimes defoliating trees in early spring. The larvae feed as a group and produce a large tent enclosing the upper terminal growth. Defoliation historically been most common in the Black Forest region and in West Slope pinyon-juniper stands.

Typical tent of a tiger moth in the top of a ponderosa pine. Photograph by D.A. Leatherman.

Life History and Habits: Tiger moths spend the winter as caterpillars in groups within silken tents. The tents are constructed by binding needles together, usually in the top of the tree. The larvae continue to feed and develop throughout winter when warm weather permits and become full-grown in late spring. They pupate in early summer and adults emerge in July and August to mate and lay eggs. Newly hatched larvae feed for a short time, then build nests in which they overwinter. There is one generation produced per year.

Control: Tiger moth outbreaks are almost always restricted to native stands rather than landscape

plantings. Controls are therefore rarely needed and biological controls (e.g., parasitic wasps) typically cause outbreaks to collapse after one or two years. Tiger moth caterpillars should be susceptible to *Bacillus thuringiensis*, carbaryl (Sevin), and other insecticides used to control leaffeeding caterpillars.

AMERICAN DAGGER MOTH

Acronicta americana (Harris)
Family: Noctuidae

Appearance: **Adults** - Moderately large moths with a wingspan of about two inches. The wings are rather drab and brownish, with darker brown hind wings, and a dagger-like marking at the anal angle of the forewing. **Larvae** - The caterpillars are about one and one half inches long when mature, with a black head and greenish white body covered with dense, long yellow hairs. Two dark "hair-pencils" on the head and a similar one at the rear of the body are conspicuous.

Hosts: Primarily silver maple but occasionally other maples including boxelder

Damage: Larvae feed on foliage and have the unique habit of clipping off partially eaten leaves in order to avoid detection by predatory birds. Leaves on the lawn with portions of the petioles attached are characteristic and indicate dagger moth feeding overhead.

Larvae of the dagger moth characteristically clip the leaf petiole. Photograph by D.A. Leatherman.

Life History and Habits: The adult moths fly in spring, laying eggs on foliage of host trees. The eggs hatch in late spring and larvae feed throughout the summer. In early fall they crawl down the tree trunk in search of pupation sites then spin a dense silken cocoon. American dagger moth spends the winter as a pupa under loose bark or other protected sites. There is one generation per year.

Related Species: Other dagger moths can be found in the region including the poplar dagger moth (*A. leporina* L.), found on poplar, willow and birch.

A dagger moth larva. Photograph by F.B. Peairs.

REDHUMPED CATERPILLAR

Schizura concinna (J.E. Smith)
Family: Notodontidae

Appearance: **Adults** - Wings are grayish brown with a narrow transverse brown band and white hind wings. Wingspan about one and 3/8 inch. **Larvae** - Caterpillars are about one and one half inches long when mature, bearing a double row of spines which are prominent near the head. The head and a hump on the first abdominal segment are both red. Body is dull yellow and streaked with black or reddish brown.

Hosts: Larvae feed on foliage of a wide variety of broadleaf trees, most commonly honeylocust, willow and various fruit trees such as crabapple, apple and plum.

Damage: Newly hatched caterpillars often feed in groups, first on the underside of leaves, later eating all leaf tissue except the veins. Serious defoliation is very rare, although individual branches may be stripped of leaves.

Life History and Habits: Moths emerge in midsummer and lay small, round, white eggs in clusters of 50 to 100 on the underside of leaves. Caterpillars hatch and feed as described above, spinning loose silken cocoons in late summer in the ground litter.

Redhumped caterpillars winter as pupae and have one generation per year.

Related Species: The unicorn caterpillar, Shizura unicornis (J.E. Smith) is an unusual brown and green caterpillar that feeds on many broadleaf trees and shrubs.

Control: This species is common, but rarely abundant enough to cause serious injury. It can be readily controlled by several insecticides including carbaryl (Sevin), *Bacillus thuringiensis* products, and pyrethroids. (See section in control supplement on **Leaf feeding caterpillars**.)

Larva of the redhumped caterpillar. Early stages typically feed in groups. Photograph by D.A. Leatherman.

ACHEMON SPHINX

Eumorpha achemon (Drury)

Family: Sphingidae

Appearance: **Adults** - Large, heavy-bodied sphinx ("hummingbird") moth, with marbled, brownish-gray wings with well-defined dark spots. Hind wings are rosy-pink. **Larvae** - A large green to reddish-purple caterpillar. This is a "hornless hornworm" but has a dark marking at the tip of the abdomen.

Hosts: Grape, Virginia creeper, woodbine

Larva of the achemon sphinx, a "hornless" hormworm associated with grape and Virginia creeper. Photograph by W.S. Cranshaw.

Damage: The caterpillars feed on foliage, occasionally causing significant defoliation. However, like most sphinx moths associated with trees and shrubs they are primarily a curiosity.

Table 1. Common sphinx moths (Hornworms) of Colorado.

Common name	Scientific name	Hosts
Elm sphinx	*Ceratomia amyntor* (Geyer)	Elm
Great ash sphinx	*Sphinx chersis* (Hubner)	Ash, lilac, privet
Wildcherry sphinx	*Sphinx drupiferarum* (J.E. Smith)	Plum, cherry, etc.
(no common name)	*Paonias myops* (J.E. Smith)	Cherries, serviceberry
Giant poplar sphinx	*Pachysphinx modesta* (Harris)	Poplars, willow
Columbia Basin sphinx	*Pachysphinx occidentalis* (H. Edwards)	Poplars, willow
Achemon sphinx	*Eumorpha achemon* (Drury)	Grape, virginia creeper
Common clearwing sphinx	*Hemaris thysbe* (F.)	Honeysuckle, viburnum, hawthorn, snowberry, cherry, plum
(no common name)	*Hyles gallaii* (Rottenburg)	Willow weed, woodruff, bedstraw
Whitelined sphinx	*Hyles lineata* (F.)	Portulaca, apple, primrose, four o'clock, peony, others
Twinspot sphinx	*Smerinthus jamaicensis* (Drury)	Poplar, birch, elm, willow, ash, apple
Tomato hornworm	*Manduca quinquemaculata* (Haworth)	Potato, tomato, tobacco family plants
Tobacco hornworm	*Manduca sexta* (L.)	Potato, tomato, tobacco family plants

Life History and Habits: The achemon sphinx spends the winter as a pupa in a chamber underground. The adult moths emerge in May and June and females lay eggs on the leaves of host plants. The larvae which first emerge are green with a long dark horn. However, the horn is lost after the first molt. They become full-grown in about 25 days, pupate and repeat the cycle. There are two generations produced per year.

Related Species: Several other hornworms feed on trees and shrubs in Colorado.

Larva of the cherry sphinx. Photograph by D.A. Leatherman.

DOUGLAS-FIR TUSSOCK MOTH

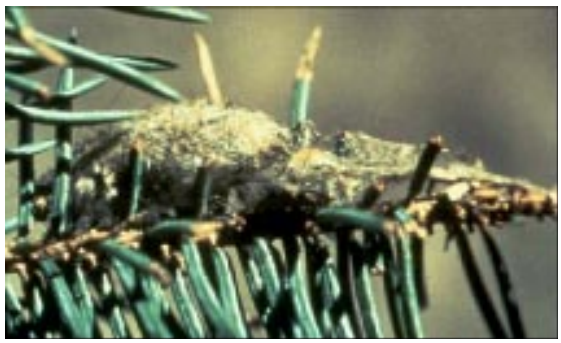
Orgyia pseudotsugata (McDunnough)
Family: Lymantriidae

Appearance: **Adults** - Males have rusty forewings and gray-brown hind wings, with a wing-span of about one inch. Females are thick-bodied and wingless. **Larvae** - Range from 3/4 to one inch long when mature. They are generally gray with distinctive tufts of hairs along the front of the back.

Larva of the Douglas-fir tussock moth. Photograph by D.A. Leatherman.

Hosts: Colorado blue spruce has been most commonly damaged, but Engelmann spruce, Douglas-fir and white (concolor) fir are less common hosts.

Damage: Larvae feed on the needles, typically defoliating the tree in a top-down pattern. Defoliation is rapid and tops may be killed, sometimes after only a single season of severe injury. Following repeated attacks over several seasons whole trees may die or succumb to attack by bark beetles. Douglas-fir tussock moth is one of the most serious pests of landscape trees along much of the Front Range. For reasons that are unknown, damage is most common in cities and it occurs infrequently as a forest pest in Colorado.



Egg mass of the Douglas-fir tussock moth. The female covers the mass with scales. Photograph by D.A. Leatherman.

The hairs of the caterpillars may cause skin irritations, particularly following repeated exposure.

Life History and Habits: Douglas-fir tussock moth spends the winter as eggs, laid within a mass covered with the hairs of the female. Eggs hatch in the spring, often in late May. The small, hairy caterpillars migrate to the new growth. There also tends to be a migration to the top of the tree and many newly emerged larvae may subsequently be dispersed by wind. Since the adult female moths do not fly, wind-blown movement of young larvae is an important means of initiating new infestations.

The caterpillars first feed solely on the newer foliage, and partially eaten needles may wilt and turn brown. Later, the older caterpillars will move to older needles as the more tender needles are eaten. During feeding, particularly when disturbed, larvae may drop from branch to branch on long silken strands. By mid-July or August, the larvae become full grown and many may migrate away from the

infested tree. They pupate in brownish spindle-shaped cocoons in the vicinity of the infested trees.

The adults emerge from late July through mid-August. The males are winged but the females have only minute, non-functional wings. Mating of the females occur in the immediate vicinity of the pupal case and they then lay characteristic masses of eggs covered with grayish hairs. There is one generation per year.

Control: Several natural controls affect Douglas-fir tussock moth populations. At least seven species of parasitic wasps and a tachinid fly have been identified as parasites that are locally present. Caterpillars may be killed by general predators, notably spiders. A nuclear polyhedrosis virus disease, known as the "wilt disease", also can be an important mortality agent during outbreaks. Perhaps most important are extreme winter and freezing temperatures during spring that kill eggs and newly emerged larvae.

Chemical controls can be effective but need to be applied thoroughly to the top of the tree. In addition, younger larvae are much more effectively controlled than older larvae, so treatment timing is best shortly after eggs have hatched. Pyrethroids (e.g., Tempo, Talstar, Mavrik, Tame) and pyrethrins (Pyrenone) are particularly effective against Douglas-fir tussock moth; carbaryl (Sevin, Sevimol) and Orthene are also effective. The addition of insecticidal soap or some other surfactant may assist in control of these hairy caterpillars. Young caterpillars are susceptible to *Bacillus thuringiensis* products (Thuricide, Dipel, etc.), but control during outbreaks has been erratic, perhaps due to difficulties in providing adequate coverage of the new growth on which the caterpillars primarily feed. Older caterpillars are somewhat less sensitive to Bt-products than are young larvae.

Outbreaks of Douglas-fir tussock moth are cyclical. Some estimate of outbreak potential can be made by surveying the site for the presence of egg masses in winter and early spring. Where egg masses can be easily found in the vicinity of the planting, a high risk exists for subsequent injury.

Related Species: Several other species of tussock moths can be found in Colorado include, although they are not considered economically important in the state. *Dasychira grisefacta* (Dyar) is occasionally abundant in forests, where it feeds on a wide range of conifers including pinyon, ponderosa pine, Douglas-fir, and spruce. A related species, *Dasychira vagans* (Barnes and McDunnough), feeds on birch, aspen, poplar, and willow, reportedly preferring the latter. The whitemarked tussock moth [*Orygia leucostigma* (J.E. Smith)] also is occasionally found in Colorado. This is an important pest species in the eastern United States and feeds on an extremely wide range of shrubs, fruit trees, shade trees and even conifers.

WESTERN SPRUCE BUDWORM

Choristoneura occidentalis (Freeman)
Family: Tortricidae

Appearance: **Adult** - Highly variable moths with mottled dark-brown to orange-brown forewings and tan hind wings. Wingspan of about one inch. **Larvae** - An olive-brown or reddish-brown caterpillar, one to one and one half inches long at maturity, with ivory-colored paired spots on each body segment and a chestnut-brown head and collar.

Hosts: Douglas-fir, spruce, and true firs.

Damage: Western spruce budworm is the most serious defoliator of Colorado forests. The larvae first mine old needles and buds, and later chew on new growth. Cones and seeds can also be destroyed. During outbreaks the entire tree may be defoliated. Repeated defoliation weakens and often kills trees. Defoliated trees are susceptible to attack by Douglas-fir beetles and other bark beetles.

Characteristic defoliation of the new growth by western spruce budworm. Photograph by D.A. Leatherman.

Life History and Habits: The western spruce budworm spends the winter as a minute larvae, pro-

tected within a silken hibernacula on the bark. In spring, they begin feeding and first mine old needles, buds, or developing cones. The larvae later move to swelling buds and after bud break consume the new growth.

Larvae mature 30 to 40 days after feeding begins in spring. Pupation occurs among foliage. Adults emerge in July and early August to mate and lay eggs. Eggs are laid in shingle-like masses on the underside of needles. Eggs hatch in about 10 days and the resulting larvae immediately spin small overwintering cocoons (hibernaculae) on the bark. There is one generation per year.

Related Species: Related species of *Choristoneura* include the pine budworm and large aspen tortrix, discussed below.

Western spruce budworm.

Control: Western spruce budworm is attacked by many natural enemies including parasitic insects, predators such as spiders and birds as well as suffering from adverse effects of late spring frosts. Several insecticides are also registered for western spruce budworm control, which are best applied shortly after the flush of new growth is produced in late spring. Specific controls for protection of landscape trees are included in the supplement under the heading **Leaf feeding caterpillars**. Sprays used in forest protection are more limited.

PINE BUDWORM (Sugar Pine Tortrix)
Choristoneura lambertiana (Busck)
Family: Tortricidae

Appearance: **Adult** - Moths have a wingspan of about 1 inch, with dull grayish-brown forewings and light tan hindwings. **Larvae** - Caterpillars are about 1 inch long when mature, with a dark head capsule and a smooth brown-green body with paired white spots on each body segment. They closely resemble the western spruce budworm.

Hosts: Ponderosa pine and occasionally other pines

Damage: Larvae feed on developing buds and newly produced needles. Buds are littered with frass and webbing. Repeated annual loss of new growth can leave branch ends sparse and reduce overall tree growth and vigor, although the trees are rarely killed. However, defoliated trees appear to be more susceptible to mountain pine beetle and other bark beetles.

Life History and Habits: Moths fly and mate in July and August, laying clusters of 25 to 50 eggs in shingle-like patches on young needles. Eggs hatch after two to three weeks and the larvae, without feeding, seek shelter and spin tiny cocoons, called hibernaculae, in which they spend the winter. In the spring, they emerge and begin feeding on the developing buds and needles. They later feed on older needles and pupate among the damaged foliage. There is one generation per year.

Related Species: Related species of *Choristoneura* include the western spruce budworm (above) and large aspen tortrix (below).

Old injury by the pine budworm. Photograph by D.A. Leatherman.

Control: Pine budworm populations are naturally regulated by a great many control agents, including parasitic insects, predation by birds, and effects of temperature extremes. Following sustained outbreaks starvation can also be important. Where chemical controls are necessary to prevent unacceptable injury, sprays should be timed for periods when larvae resume feeding in the spring. Typically this would be just after bud break.

LARGE ASPEN TORTRIX
Choristoneura conflictana (Walker)
Family: Tortricidae

Appearance: **Adults** - Dull, light gray moths with a wingspan of about one to one and 3/8 inch. **Larvae** - Olive-green to black caterpillars, one half to 3/4 inches long when mature. Head and first body segment are dark.

Hosts: Aspen and occasionally other Populus species

Damage: Outbreaks occasionally occur in Colorado that extensively defoliate local aspen stands, but this has had temporary effects and has rarely resulted in killed trees.

Leaf tying characteristic of (from left to right) the cottonwood leafroller, fruittree leafroller, and aspen tortrix. Photograph by D.A. Leatherman.

Life History and Habits: Large aspen tortrix spends the winter as a second instar larvae, usually in crevices of bark. In spring the larvae first feed on developing buds, later moving to newly-formed leaves. During feeding, they commonly tie together two leaves with the larvae feeding and later pupating within this structure.

The gray adult moths appear in late June and July and lay characteristic shingle-like egg masses on the leaves. Eggs hatch and larvae move to the tree trunk to overwinter. There is one generation per year.

Related Species: Related species of *Choristoneura* include the western spruce budworm and pine budworm, discussed above.

Control: Outbreaks are sporadic and aspen is quite tolerant of defoliation. In protection of ornamental aspen during outbreaks, insecticides recommended for control of **Leaf feeding caterpillars** in the supplement should be effective.

CANKERWORMS AND OTHER LOOPERS
Alsophila pometaria (Harris) (Fall cankerworm)
Erannia tiliaria (Harris) (Linden looper)
Coryphista meadii (Packard) (Barberry looper)
Lambdina punctata (Hulst)
Itame ribearia (Fitch) (Currant spanworm)
Paleacrita vernata (Walker) (Spring cankerworm)
and other species
Family: Geometridae

Appearance: **Larvae** - Caterpillars of the family Geometridae are often known as "inchworms", "measuringworms" or "loopers". This is because they lack most of the hind prolegs found on other species of caterpillars, possessing merely two hind pair. As a result they walk in a distinct "looping" manner. The species found on trees and shrubs vary widely in coloration and patterning.

A linden looper larva. Photograph by W.S. Cranshaw.

Hosts: Loopers can be found on most species of trees and shrubs. The fall cankerworm has a wide host range including fruit trees, elm, honeylocust, and maple. The linden looper similarly feeds on a variety of plants particularly linden and oak. The barberry looper limits feeding to mahonia; oaks are sometimes heavily infested by *Lamdina punctata*. A great many species of minor importance are associated with conifers.

Damage: Larvae chew leaves and occasionally occur in outbreak numbers to cause visible defoliation. However, sustained outbreaks are tend to be rare as existing natural control appear to suppress

populations of all the common "inchworms" found in the state sufficiently to prevent significant injury.

Life History and Habits: (See above)

Control: Inchworm caterpillars are easily controlled by *B. thuringiensis,* carbaryl, pyrethroid insecticides and other sprays used to control leaf-feeding caterpillars.

UGLYNEST CATERPILLAR

Archips cerasivorana (Fitch)
Family: Tortricidae

Appearance: **Adult** - A dull-orange colored moth with a wingspan of about one inch. **Larvae** - Olive green caterpillar with a black head, reaching about 3/4 inch long when mature. The larvae are almost invariably found within a 'nest' of tight webbing.

A colony of the uglynest caterpillar. Photograph by S. Krieg.

Hosts: Most common on chokecherry, but may also be found on other trees and shrubs

Damage: Larvae feed on leaves within shelters of webbing. Accumulations of frass and bits of leaves inside the webbing can cause an infested tree to become unsightly.

Life History and Habits: The uglynest caterpillar spends the winter in the egg stage on twigs. Eggs hatch in May or June and the larvae construct a tightly woven silk and leaf nest in which they feed. They become full-grown in four to six weeks and pupate around the nest. Adult moths appear from July to September, and eggs are laid in late summer or early fall. There is one generation per year.

Related species: The rabbitbrush webbing moth, *Synnoma lynosyrana* Walsingham, commonly creates dense tents on rabbitbrush and may cause serious defoliation. Life history is similar to that of the uglynest caterpillar, although the females of the rabbitbrush webbing moth do not fly. Other *Archips* species are leafrollers on a variety of trees and shrubs (see Fruittree leafroller, following).

Control: Although conspicuous, infestations of uglynest caterpillar typically occur on low-value plants for which treatment is not economical. In landscape settings, the tents can be easily removed by hand.

FRUITTREE LEAFROLLER

Archips argyrospila (Walker)
Family: Tortricidae

Appearance: **Adults** - Brown moths with yellow and dark markings and a wingspan of 3/4 to one

Table 2. A summary of the life history of common inchworms (Family Geometridae) developing on trees and shrubs in Colorado.

Species	Hosts	Number of generations	Overwintering stage (egg hatch)
Fall cankerworm	Elm, honeylocust, fruit trees, etc.	One	Eggs, sometimes pupa (early spring)
Spring cankerworm	Elm, other hardwoods	One	Pupa (early spring)
Linden looper	Linden, oak, maple, apple	One	Eggs (early spring)
Barberry looper	Mahonia	Three	Pupa (mid-spring, throughout summer)
Currant spanworm	Currant	One	Eggs
Filament bearer	Douglas-fir, some other conifers and hardwoods		
Lambdina punctata	Oak	One	Eggs (mid to late spring)

inch. **Larvae** - Green caterpillars are 3/4 inch when full grown, with black heads. They are almost always found within folded leaves and wriggle vigorously when disturbed.

Hosts: Almost all hardwoods may be infested with apple, crabapple and lindens among the more common hosts

Damage: Larvae chew leaves, causing significant defoliation during outbreaks. Developing fruits may also be chewed causing them to drop or grow in a distorted manner.

Larva of the fruittree leafroller, spinning. Photograph by W.S. Cranshaw.

Life History and Habits: The fruittree leafroller overwinters as eggs within a flat gray egg mass on twigs. Eggs hatch in spring shortly after leaves have emerged. Young larvae tie up leaves with webbing and feed inside this shelter. When mature, larvae pupate in the rolled leaf and adult moths appear two weeks later to lay eggs. There is one generation per year.

Related Species: The boxelder leafroller, *Archips negundana* (Dyar), commonly feeds on and rolls the leaves of boxelder. The species overwinters as eggs in bark cracks and has a single, early spring, generation of feeding larvae. Gambel oak is occasionally attacked by the oak leafroller, *Archips semiferana* (Walker). These species also have a single generation per year, with peak feeding injury in midspring through early summer.

Control: Leafroller outbreaks are often highly sporadic, and numerous natural controls usually prevent high, damaging populations. Supplemental controls are rarely needed for plant protection.

Fruittree leafroller can be controlled by most of the insecticides listed in the supplement under the heading **Leaf feeding caterpillars**. However, coverage can be difficult after leaves are curled and systemic insecticides are more likely to be effective in those situations.

Horticultural oils applied during the dormant season are effective at controlling overwintering egg stages of this insect. Applications should target the twigs, where egg masses are laid.

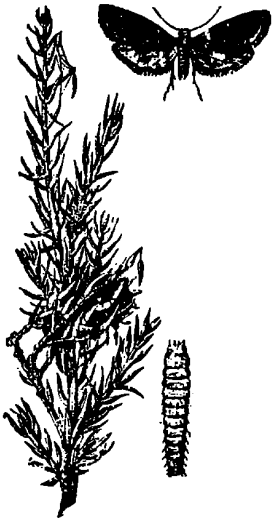
JUNIPER WEBWORM

Dichomeris marginella (F.)
Family: Gelechiidae

Appearance: **Adults** - A small (one half inch wingspan) moth with copper-colored wings bordered with white. **Larvae** - A brown caterpillar with indistinct stripes and a dark head, reaching about one half inch when full grown. Older larvae are almost always found in silken tubes they produce amongst the juniper foliage.

Hosts: Many juniper (*Juniperus*) species, including eastern redceder

Damage: The larvae feed on the needles of junipers during late summer, causing damage foliage to turn brown.



Juniper webworm, larvae and adults.

Life History and Habits: The juniper webworm spends the winter as a large larva within the webbed needles. They continue feeding in spring and later pupate. Adults emerge in June and July, mate and lay eggs. The tiny, newly hatched larvae first feed by tunneling needles. They later emerge and form silken tubes, becoming surface feeders. During outbreaks, silk production may be extensive and several larvae may feed together in "nests" on the foliage. There is one generation per year.

Control: Outbreaks of juniper webworm are very uncommon in the region and several predators and parasites are reported to attack this insect. During outbreaks systemic insecticides such as acephate

(Orthene) are likely to provide best control. The addition of a wetting agent, such as soap, can improve coverage and penetration of webbing.

FOREST TENT CATERPILLAR

Malacosoma disstria (Hubner)
Family: Lasiocampidae

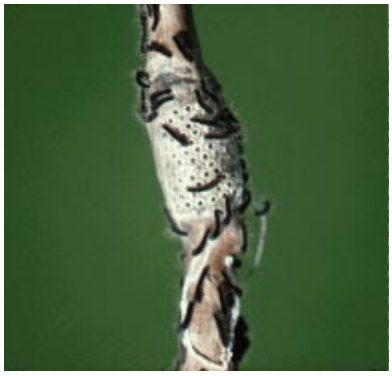
Appearance: **Adults** - Stout-bodied, light brown moths with a wingspan of about one inch. **Larvae** - Pale blue caterpillars about two inches long when mature, with buff-colored, keyhole-shaped spots on back and yellow stripes on back and sides. Light blue and black head is sparsely covered with fine hairs.

Larva of the forest tent caterpillar. Photograph by W.S. Cranshaw.

Hosts: Fruit trees, elm, aspen, and ash are common hosts, plus several other hardwoods.

Damage: Young larvae feed on opening buds. Mature larvae are foliage feeders, and defoliation is common.

Life History and Habits: The forest tent caterpillar overwinters as eggs, laid as a mass on twigs. Eggs typically hatch in early May and the larvae feed from mid-May to early June. The larvae usually feed together for most of their lives, often moving from branch to branch daily. During the day large numbers of the larvae may congregate on the trunk and branches, creating a thin resting pad of silk. As they become full-grown, the mature larvae then wander and pupate in protected locations either on or around the infested tree. Adults emerge in mid-July, mate, and the females then lay eggs in masses around twigs.



Egg mass of the forest tent caterpillar. Photograph by W.S. Cranshaw.

Despite this species being a true tent caterpillar (*Malacosoma* species) it never constructs a conspicuous tent of silk, only a silken resting mat.

Forest tent caterpillars massed on a tree trunk. Photograph by W.S. Cranshaw.

Control: Forest tent caterpillars are readily controlled by several insecticides, including *Bacillus thuringiensis* products. For specific recommendations see section in control supplement on **Leaf feeding Caterpillars**.

Horticultural oils applied during the dormant season are effective at controlling some of the overwintering eggs of this insect. Applications should target the twigs, where egg masses are laid.

SONORAN TENT CATERPILLAR

Malacosoma tigris (Dyar)
Family: Lasiocampidae

Appearance: **Adults** - Wings of the male moth are straw yellow, those of the female are reddish brown, with wingspans of one inch and one and 3/8 inch, respectively. Darker transverse bands mark the forewings. **Larvae** - Caterpillars are marked above with longitudinal black and orange stripes and crossed on each body segment by a blue line.

Hosts: Oak, especially Gambel oak

Damage: Areas of defoliation surround small silken tents on infested trees. Damaging outbreaks are uncommon.

Life History and Habits: Larvae emerge in early spring when the first young leaves appear. They feed in groups and together construct a small tent which is used for protection while molting. Pupation occurs in the leaf litter in chalky white cocoons. Adults appear in midsummer and lay masses of 150 to 200 eggs in spiral bands around slender twigs. Within two weeks the larvae are fully developed inside their eggs, but do not emerge until the following spring.

Control: Sonoran tent caterpillars are readily controlled by several insecticides, including Bacillus thuringiensis products. For specific recommendations see section in control supplement on **Leaf feeding caterpillars**.

WESTERN TENT CATERPILLAR

Malacosoma californicum (Packard)
Family: Lasiocampidae

Appearance: **Adults** - Variable, generally light brown moths with forewings divided into three bands by two white lines. Wingspan ranges from 1 to two inches. **Larvae** - A light brown, hairy caterpillar with powdery blue markings along the sides and a blue head. Much more hairy than the forest tent caterpillar. Full grown caterpillars may reach two inches in length.

Hosts: Aspen, mountain-mahogany, fruit trees, willow and some other hardwoods

Table 3. Tent-making caterpillars and sawflies of Colorado.

Several tree and shrub defoliators, particularly various caterpillars, feed together in groups and produce tents or other structures out of webbing. These tents can be very characteristic, and are useful for diagnosing the pest species. Some of the more common tent-making species are listed below.

Insect	Hosts	Description of tent
Fall webworm	Cottonwoods, poplars, fruit trees, etc.	Caterpillars construct a large, fairly loose tent that encloses much of the foliage that the caterpillars feed on. Tents may be produced from late June through early September.
Sonoran tent caterpillar	Oak	Tents are constructed of dense silk in the crotches of larger branches. Tents are formed in spring and abandoned in early summer.
Western tent caterpillar	Aspen, fruit trees, willow, etc.	Tents are constructed of dense silk in the crotches mountain-mahogany, of larger branches. Tents are formed in spring and abandoned by early summer.
Eastern tent caterpillar	Hawthorn, fruit trees,	Tents are constructed of dense silk in the crotches of larger branches. Tents are formed in spring and abandoned in early summer.
Tiger moth (*Lophocampa ingens*)	Pines, juniper, Douglas-fir, fir	Large tents are constructed in the tops of trees and include the leader. Caterpillar activity and tent building occurs during winter and early spring.
Tiger moth (*Lophocampa argentata*)	Pinyon, juniper	Large tents are constructed in the tops of trees and include the leader. Caterpillar activity and tent building occurs during winter and early spring.
Juniper webworm	Juniper	Individual larvae web together needles, but during outbreaks small "nests" may be formed when several caterpillars feed in close proximity. Webbing is produced during late summer and the caterpillars continue to feed in spring.
Uglynest caterpillar		Cherry, variousNests are tightly constructed forming a mat. Darkother shrubsfecal pellets are mixed with the silk. Nests are formed during late spring and early summer.
Rabbitbrush webbing moth	Rabbitbrush	Nests are constructed of a tight mat of webbing amongst the smaller twigs and branches during late spring and early summer.
Pine webworm (*Tetralopha* sp.)	Ponderosa pine	Larvae feed in groups and make a fairly tight tent in early summer. Old head capsules, cast skins and pellets remain in place. General appearance is similar to that of the web-spinning sawflies.
Web-spinning sawflies (*Acantholyda* spp., *Cephalcia* spp.)	Pines, spruce, plum	Silk is mixed with old skins and the pellet droppings the larvae produce. "Nests" are produced during late spring and early summer. Nests often persist.

Damage: Defoliation can be severe, especially if aspen is the host. Infestations reduce growth, and several consecutive years of severe defoliation may kill the tree or make it susceptible to canker fungi. In infestation cycles in early summer, trees are completely defoliated but refoliate in late summer. Tents are often considered unsightly and roving mature caterpillars can be a nuisance.

Life History and Habits: The western tent caterpillars overwinter as young larvae (first instar) inside eggs, laid in masses. Larvae emerge from the egg masses in May to feed and begin building tents in branch crotches. The tents serve as bases in which the colony of caterpillars rests, molts, and hides for protection during inclement weather. Larvae mature in 30 to 40 days at which time they become sluggish and move to the ground to pupate. Adults emerge 12 to 18 days later and egg laying occurs from mid-July to early August. Eggs are laid on live twigs that are less than 3/4 inch in diameter. Eggs develop for three to four weeks but do not hatch; young larvae overwinter in the eggs until spring. There is one generation per year.

Related Species: The species *M. incurvatum discoloratum* (Neumogen) can be an important pest in parts of the West Slope, feeding on poplars and cottonwood along riverways. Eggs hatch very early, late March or early April, and feeding is completed by mid-May. There is one generation per year.

Nearly full-grown caterpillars of the western tent caterpillar resting on a tent. Photograph by D.A. Leatherman.

The eastern tent caterpillar, *Malacosoma americanum* (Fabricius), is an uncommon species within the region, confined to areas of northeastern Colorado. It is primarily associated with fruit trees and related species (e.g., hawthorn). This is the most common tent caterpillar in the midwestern United States.

Control: Western tent caterpillars are readily controlled by several insecticides, including *Bacillus thuringiensis* products. For specific recommendations see the section in the control supplement on **Leaf feeding caterpillars**.

Horticultural oils applied during the dormant season are effective at controlling overwintering eggs of tent caterpillars. Applications should target the twigs, where egg masses are laid.

SNAILCASE BAGWORM

Apterona helix (Siebold)
Family: Psychidae

Appearance: All stages of this insect take place within a coiled snail-like case. **Larvae** - Greenish or reddish-gray caterpillars with a black head. **Adults** - Wingless, nearly legless moths; the females mate while still within the silken case.

Hosts: Sagebrush, saltbush, rabbitbrush, willow, mountain-mahogany, various fruit trees

Damage: The snailcase bagworm is an unusual insect found commonly in parts of western Colorado and Utah. Although it can feed on a variety of plants, it is rarely damaging. However, it frequently attracts attention when the insects migrate to pupate on walls, fenceposts, mailboxes and other surfaces.

Life History and Habits: The snailcase bagworm is an introduced insect that has become established in many of the western states. This insect has one generation per year. Larvae become active in midspring and feed on the leaves of a wide variety of native and cultivated plants. The feeding injuries are characterized as having small areas progressively gouged out of the leaf surface.

As the larvae grow and develop they produce a snail-like case out of silk and soil particles. Later they push their fecal matter out of an opening in the center of the case, allowing it to pile up on top of the insect. The larval insects are mobile and can carry the case upright. As they become full-grown, typically in late spring and early summer, they migrate to high points, where they attached themselves to pupate.

Transition to the adult moth takes place in the pupal covering over a couple of weeks. The moths are wingless, nearly legless, and do not feed. Females only are produced, but they can fertilize eggs asexually. About one to dozen eggs are produced by the female and during midsummer these eggs hatch. The young larvae remain within the pupal covering throughout the winter until becoming active the following spring.

Control: For the most part this insect does not cause significant damage and is merely a curiosity. Controls are rarely, if ever, warranted.

Insecticidal controls have not been developed for this species. The insecticide Orthene is widely used for control of other bagworm species on ornamental plants.

SPINY ELM CATERPILLAR
(Mourning Cloak Butterfly)
Nymphalis antiopa (L.)
Family: Nymphalidae

Appearance: **Adults** - Large butterflies with yellow-bordered purplish-brown wings and a wingspan of two and 1/4 to three 1/4 inches. Just inside the yellow border is a row of purple spots. This butterfly is commonly known as the mourning cloak. **Larvae** - Velvety black caterpillar about two inches long at maturity, covered with several rows of fleshy spines and a row of red spots along the middle of the back.

A spiny elm caterpillar, larva of the mourning cloak butterfly. Photograph by S. Krieg.

Hosts: Aspen, willow, elm, hackberry, cottonwood and poplars.

Damage: Localized defoliation can occur on branches where larvae are feeding in groups. Their conspicuous appearance and early feeding period often attract attention.

Life History and Habits: The adult butterflies, known as the mourning cloak, are one of the few butterflies which spend the winter in the adult stage. They overwinter in protected areas and may be seen flying even during warm days in late winter.

In spring eggs are laid in masses around small twigs and branches as new growth first emerges. The newly-hatched larvae feed in groups stripping leaves from branches as they feed. Mature larvae then pupate and emerge as adults in late July or August. These butterflies lay eggs which produce a second late summer generation of caterpillars. The overwintering adults are produced from this generation.

Control: Significant defoliation is usually limited to isolated branches and spiny elm caterpillars are more a curiosity than a serious pest species.

For specific chemical controls see recommendations for **Leaf feeding caterpillars**.

HACKBERRY BUTTERFLY
Asterocampa celtis (Boisduval)
Family: Nymphalidae

Appearance: **Adults** - Butterflies with a wingspan of about two inches. Wings are patterned like a deer fawn, with a tan background and numerous white spots, pattern is repeated ventrally in lighter tones with the eyespots pronounced. **Larvae** - Caterpillars are lime green, striped with white and yellow. They are constricted in the middle, with tapering at each end. The tail segment is forked and the head bears a large pair of heavily barbed horns.

Host: Hackberry

Damage: Larvae feed on foliage and may occasionally strip branches of leaves. Outbreaks are very rare and the insect is primarily a curiosity.

Life History and Habits: The hackberry butterfly spends the winter as a partially grown caterpillar. They resume development in spring, pupate and the first generation butterflies appear in May or June. Adults are often seen flying high in the tree crown. After mating, females lay eggs singly or in clusters on leaves. Larvae hatch and the young caterpillars typically feed in groups. As they get older they

scatter throughout the tree. When full-grown they pupate within a chrysalis in or around the tree. A second and sometimes a third generation may be produced during a season. They hibernate as partially grown small larvae hiding in protected sites on the tree.

Control: For specific chemical controls see recommendations for **Leaf feeding caterpillars**.

Larva of the hackberry butterfly. Photograph by W.S. Cranshaw.

PINE BUTTERFLY

Neophasia menapia (Felder and Felder)
Family: Pieridae

Appearance: **Adults** - White butterfly with black wing markings and a wingspan of about one and 3/4 inches. The underside of the wing of the females has conspicuous red markings. They are generally similar in appearance to the common cabbage butterfly. **Larvae** - Young larvae are pale green with a black head. Mature larvae about one inch long, green caterpillars with a green head and a white lateral stripe on each side.

Hosts: Pines, usually ponderosa pine

Damage: Pine butterfly is one of the most serious defoliators of ponderosa pine, with periodic outbreaks occurring in many areas of the the state. Damage if restricted to the older needles, but repeated defoliation can weaken trees, making them more susceptible to attack by mountain pine beetle or other bark beetles.

Life History and Habits: Pine butterfly spends the winter as football-shaped green eggs on the needles. Eggs hatch in spring when new shoots are about two inches long. Larvae feed on old needles, usually consuming only the upper half of the needle. The mature larvae migrate to bark crevices, limbs, or twigs to pupate. Adults emerge 10 to 15 days later and mate, with adult flights peaking in mid-August. Eggs are laid within a few hours after mating. There is one generation per year.

Control: Populations are typically kept under sufficient natural control by birds, general predators such as spiders and various parasitic insects. Larvae can be killed by sprays of *Bacillus thuringiensis* and other insecticides listed in the supplement under **Leaf feeding caterpillars**.

Pine butterfly, female laying eggs. Photograph by D.A. Leatherman.

LEAF FEEDING BEETLES

Several leaf beetles (Family: Chrysomelidae) feed on trees and shrubs. Extensive larval feeding is usually preceded by small holes cut into leaves by adults or small areas of "skeletonized" feeding injuries made by adults or young larvae. By watching trees for these indications, the need to make an insecticide treatment can be anticipated before serious damage has occurred.

In addition to the leaf beetles, a few other types of beetles are associated leaf chewing injuries to Colorado trees and shrubs. Black vine weevil (Family: Curculionidae) is becoming increasingly important in the region due not only to leaf injuries by the adult but also root injury by larvae. Periodically, masses of blister beetles (Family: Meloidae) may consume leaves.

Foliar applications of carbaryl (Sevin, Sevimol) have been the long-time standard for leaf beetle con-

trol. Leaf beetles are also highly susceptible to pyrethroid insecticides (e.g., Talstar, Tempo, Samurai, Mavrik) as well as Dursban and Orthene. Recently new strains of *Bacillus thuringiensis (tenebrionis* strain) have also been developed which are effective stomach poisons for control of younger larvae of most leaf beetles. Also, larvae and egg stages of some leaf beetle species are susceptible to neem-derived insecticides.

Root weevils are considerably more difficult to control since much of their life cycle is spent underground or off the leaves. Adult controls include pyrethroids and Orthene; larvae may be controlled with drenches of Turcam/Ficam or insect parasitic nematodes.

Specific recommendations for these insects appear in the supplement on insect control recommendations. Sections in the supplement which deal with leaf feeding beetles include **Elm Leaf Beetle** and **Black Vine Weevil**.

RABBITBRUSH BEETLE
Trirhabda nitidicollis LeConte
Family: Chrysomelidae

Appearance: **Adult** - Wings striped with yellow and dark markings, and three blue-green spots on the pronotum. Beetles are about one-quarter to 3/8 inch long. **Larva** - Conspicuously metallic blue-green grubs that chew the foliage.

Hosts: Rubber rabbitbrush

Damage: Adults and larvae both chew foliage, although larval feeding is much more significant. Sporadic outbreaks occur which can completely defoliate plants and occasionally kill rabbitbrush.

Rabbitbrush beetle larva. Photograph by W.S. Cranshaw.

Because the plants on which it feeds are sometimes considered rangeland weeds, the insect has been considered for biological weed control.

Life History and Habits: The rabbitbrush beetle spends the winter as eggs in small masses under ground. Eggs begin to hatch in April and appear stimulated to hatch by spring rains. The larvae crawl up the plant to feed on the new foliage.

Larvae are present primarily in May and June, with emergence often scattered over a period of several weeks resulting in a range of larval stages. Pupa-tion occurs in the soil and adults are present in June and July. The adult beetles feed on the leaves at this time but cause little defoliation. Eggs are laid from July through September.

Related Insects: Several other species of *Trirhabda* occur in the Rocky Mountain region, with sagebrush being among the more common host plants. *T. lewisii* Crotch also feeds on rabbitbrush and often is as common as *T. nitidicollis.*

Control: Several natural controls have been observed to feed on larvae, including lady beetles and predatory stink bugs.

Applied controls include sprays of insecticides effective against other leaf beetles, such as carbaryl (Sevin) and *Bacillus thuringiensis* var. *tenebrionis.*

COTTONWOOD LEAF BEETLE
Chrysomela scripta (F.)
Family: Chrysomelidae

Appearance: **Adults** - Light tan, oval beetles marked with black spots, about 3/8 inch long. **Larvae** - Young larvae are nearly completely black. As they get older they become gray with black dots and often are found feeding in groups. **Eggs** - Yellow to yellow-orange, football-shaped, and clustered on the lower leaf surface.

Life History and Habits: The cottonwood leaf beetle overwinters as an adult in protected locations. Shortly after leaf emergence adults begin to appear on trees and begin to feed and mate. Eggs are deposited in clusters on the under surface of leaves and are yellow or reddish in color. Eggs hatch 1 to two weeks after being laid and the small black larvae which emerge often first feed as a group. Older larvae then scatter. Feeding by all larval stages is

typical of leaf beetles in that they skeletonize the leaves, feeding on the lower leaf surface.

Hosts: Cottonwood primarily, but other *Populus* species and willow are occasional hosts

Cottonwood leaf beetle larvae. Photograph by W.S. Cranshaw.

Damage: Larvae chew on leaves, occasionally causing severe defoliation. Succulent growth tends to be most heavily infested. Adults feed on tender twigs and also skeletonize leaves, but do much less damage than the larvae. Damage in Colorado has primarily been along the Platte River Valley in the northeastern part of the state and the Arkansas River Valley east of I-25.

When full grown they pupate, attached to the leaves and somewhat resemble the pupae of lady beetles. Adults emerge in about two weeks and feed by chewing holes in leaves, but cause little damage.

In northern Colorado two generations are annually produced; three generations may occur in the warmer, southern areas of the state. Cool temperatures can reduce the numbers that will reproduce during the current season.

Control: Cottonwood leaf beetle is generally much less common in Colorado than is elm leaf beetle and rarely reaches levels that would get benefit from controls. (It is much more damaging in the region just east of Colorado.) Cottonwood leaf beetle is susceptible to the same insecticides as is elm leaf beetle, including beetle-active *Bacillus thuringiensis* strains (e.g., 'san diego' strain, 'tenebrionis' strain.

Related Species: A related species, *Chrysomela aeneicollis* (Schaeffer), feeds on willow.

ELM LEAF BEETLE

Xanthogaleruca luteola (Muller)

Family: Chrysomelidae

Appearance: **Adults** - Yellowish-tan to green beetles, oval, about 1/4 inch long, with two dark stripes down the back. **Larvae** - Yellow with two black stripes down the back, about one half inch long when mature. Eggs are yellow-orange and clustered on the lower leaf surface.

Hosts: Elm, particularly Siberian, Rock, and English elm, but often American elm

Damage: Both the adult and larval stages chew leaves often causing serious defoliation. Feeding damage is primarily produced by larvae which skeletonize leaves, feeding on the leaf underside. Adults chew circular holes in leaves and rarely cause much injury.

Larva of elm leaf beetle. Note the characteristic skeletonizing injury to the leaf. Photograph by W.S. Cranshaw.

In many areas the most important damage is caused by the movement of overwintering adult beetles in nuisance numbers into nearby homes. It rivals the boxelder bug as the most important nuisance insect invader of homes in the region.

Note: This insect does not transmit the Dutch elm disease fungus, which is transmitted instead by the smaller European elm bark beetle, discussed later.

Life History and Habits: Adult beetles over-winter in protected areas and in buildings. In late April and early May the beetles emerge and move to elm trees to feed and mate. After a period of several weeks they begin to lay masses of eggs, typically attached to veins on the lower leaves. Larvae hatch after about 10 to 14 days and feed for about three weeks, undergoing three larval instars. They then

crawl down the tree trunk in search of pupation sites. Most pupate at the base of the tree, but some may rest in folds of bark furrows.

Adults emerge in 10 to 15 days and most then mate and reproduce to begin a second generation. However, some may go into diapause and move to winter shelter without reproducing, particularly during cool seasons. A partial third generation may occur in some of the warmer areas of the state. All beetles at the end of the summer move to winter shelter where they remain semi-dormant until the following season.

Egg mass of the elm leaf beetle. Photograph by W.S. Cranshaw.

Control: Elm leaf beetle is under several important natural controls. Extreme winter temperatures kill many overwintering beetles, particularly if they have not found good winter shelter. Also very important are late spring frosts, which kill beetles that have already emerged and moved to the trees. Earwigs and predatory stink bugs are among the more important biological controls.

The elm leaf beetle is readily controlled with several insecticides, sprayed on the foliage. Standard applications usually involve use of carbaryl (Sevin), but the larvae are extremely susceptible to most pyrethroids. Effective applications for first generation beetle larvae usually suppress populations sufficiently so that they do not be retreated later in the summer.

Soil-applied systemic insecticides were formerly used for elm leaf beetle control. Because of associated hazards to birds and other species, registration of Furadan for this purpose has been discontinued. However, DiSyston remains registered at present.

Recently the beetle-active *Bacillus thuringiensis* strains (*san diego* or *tenebrionis* strains) have been marketed for elm leaf beetle control. Young larvae are much more susceptible than are older larvae and treatments should be applied shortly after most eggs have hatched. Because these treatments have little persistence, it can be difficult to get control if egg hatch is extended, as occurs frequently during the second generation. Eggs and larvae are susceptible to neem extract-based insecticides.

The larvae can also be killed as they migrate down trunks, using a band of a contact insecticide (e.g., Sevin, Dursban, Talstar, Tempo), about one foot in width. These bands should be applied when larvae first move down the trunk. If such treatments are applied area-wide damage by second generation larvae and nuisance populations of overwintering beetles can be reduced. However, if only isolated trees are treated, migration from untreated areas will allow rapid reinfestation.

FLEA BEETLES

Disonycha species, Altica species
Family: Chrysomelidae (Alticinae)

Appearance: **Adults** - Flea beetles tend to be small beetles, typically about 1/4 inch long. Adults of Altica species are usually shiny or even metallic, ranging from dark violet to green. Disonycha species, associated with willow, are considerably larger conspicuously striped and are sometimes known as the fivestriped flea beetles. Adults of all flea beetles have an enlarged hind femur and can jump. **Larvae** - Similar in general form to other leaf beetles, such as the elm leaf beetle or cottonwood leaf beetle. They are dark brown or black, with lighter coloration on the underside.

Hosts: Several flea beetles are associated with trees and shrubs including alder, apple, poplar, and willow.

Damage: Larvae feed on the surface of leaves, often in groups. Injury is a characteristic skeletonizing, where larger leaf veins are avoided. Adults chew circular pits in leaves. Flea beetles can

sometimes become locally abundant, but injury is not significant.

Life History and Habits: Flea beetles spend the winter in the adult stage, under protective cover. They return to the plants in late spring and feed on leaves. Females lay clusters of eggs on the lower surface of leaves or stems. Larvae feed in groups when young, then disperse more as they get older. They mature by midsummer and drop to the ground to pupate. Adults emerge and feed through the remainder of the season. There is probably one generation per year, although a partial or complete generation is possible in warmer areas.

ASHGRAY BLISTER BEETLE
Epicauta fabricii LeConte
Family: Meloidae

Appearance: **Adults** - Large, loose jointed, light gray beetles with soft wing covers, narrow necks, and swollen abdomens. They are from 3/8 to 5/8 inch long, and move sluggishly. **Larvae** - Small, pale parasites, found in grasshopper eggs and bee nests.


Adult of the ashgray blister beetle.

Hosts: Honeylocust, black locust, and many other legumes, including alfalfa. Occasionally other deciduous species are attacked, such as hackberry.

Damage: Adults are plant feeders, often feeding in large groups, and they occasionally can defoliate their hosts. Infestations are sudden in appearance and usually abruptly end. Because the larvae feed on grasshopper eggs, blister beetle outbreaks typically cycle with grasshoppers.

Related Species: Many other species of blister beetles are found in Colorado. However, few feed on trees, with most limiting feeding to vegetables, shrubs, and alfalfa. One common species on caragana shrubs is the caragana blister beetle, *Epicauta subglabra* (Fall), which sometimes masses on this plant in late June and July.

Life History and Habits: Beetles appear in mid-May. They often feed together in groups, responding to aggregation pheromones. Females lay eggs in late June and early July, which hatch at the time that grasshopper eggs are most often laid. The newly hatched larvae feed on these eggs until late September and overwinter as sixth instar larvae. The seventh instar pupates in the spring and emerges in about two weeks. Adults feed on flowers and foliage of various plants. They produce an aggregation pheromone that causes them to often be found feeding in large groups. Blister beetles have the unusual habit of "reflex bleeding" when disturbed. They can exude blood from their leg joints which contains cantharidin and can raise blisters on the skin. The cantharidin which they produce is highly toxic to some animals, notably horses.

Control: Blister beetle infestations are typically short-lived, as beetles depart suddenly. As a result, controls are rarely, if ever needed.

BLACK VINE WEEVIL
Otiorhynchus sulcatus (F.)
Family: Curculionidae

Appearance: **Adults** - Dark-gray or black snout beetles of about 1/3 inch length. The back is marked with gold flecking. **Larvae** - A pale, legless grub found on the roots of host plants.

Hosts: Several shrubs, particularly euonymus, *Taxus*, and rhododendron; occasionally lilac

Damage: Adult weevils feed on leaves at night, producing characteristic notching wounds along the leaf margin. When abundant plants may be heavily defoliated.

Larval stages feed on plant roots. These injuries may be more destructive than caused by adult feeding.

Life History and Habits: The black vine weevil spends the winter usually as a larva, in the soil around the root zone of plants on which it feeds. Occasionally some adults may survive winters if they find the shelter of homes. Black vine weevil

occasionally occurs as a nuisance invader of Colorado homes in summer and fall.

Adult of the black vine beetle. Photograph by J.L. Capinera.

Characteristic leaf notching wounds produced by feeding of adult black vine beetle. Photograph by W.S. Cranshaw.

Larvae resume feeding in spring and can extensively damage roots during May and June. After becoming full-grown they pupate in the soil and adult weevils start to emerge in mid-June. Black vine weevil adults feed on the leaves of various plants during the night, and cause characteristic notching wounds which sometimes resemble grasshopper injury. After about two weeks, the females begin to lay eggs around the base of plants. Eggs begin to hatch in midsummer and the legless larvae feed on plant roots until cold weather temporarily stops development. There is one generation produced per year.

Related Species: The strawberry root weevil [*Otiorhynchus ovatus* (L.)] and the rough strawberry root weevil [*Otiorhynchus rugosostriatus* (Goeze)] are two related root weevils that also are common in Colorado. Both are somewhat smaller in size, but generally the same shape as the black vine weevil. Although they have similar habits neither is as damaging to plants. However, the strawberry root weevil more frequently invade homes during summer than does the black vine weevil, particularly at higher elevations.

Control: Black vine weevil has proved to be quite resistant to insecticides and difficult to control. Best control of adult stages has been with certain pyrethroids, notably Talstar and Samurai. Bendiocarb (Turcam, Ficam) has also been widely used in some parts of the country.

Larval stages are even more difficult to control. However, research has indicated that certain species of insect-parasitic nematodes can be very effective, at least in container-stock. Nematodes in the genus *Heterorhabditis* (e.g., Oti-Nem) have been particularly effective, although these are not commercially available at present. Nematodes in the genus *Steinernema* (e.g., Exhibit, BioSafe) have also been quite promising and are now being sold for this purpose.

Specific recommendations for black vine weevils appear in the supplement on insect control recommendations marked **Black vine weevil**.

Additional Publications: Service in Action 5.551 *Root weevils* discusses the root weevil complex, primarily as nuisance pests that invade homes.

SEVERITY OF DEFOLIATION INJURIES

A great many insects chew or tunnel into the foliage of trees and shrubs. To a great degree, plants have means to compensate for much of this injury and it is, by no means, beneficial to control all defoliating insects. Although there are no set rules as to what constitutes a damaging infestation, the plant protection manager should keep in mind a number of factors that affect plant injury by defoliators:

Percent defoliation. Obviously, the amount of leaf loss caused by insect feeding injuries can be directly related to their potential damage. However, minor leaf loss on deciduous plants, of at least 20% of the total leaf area (individual leaves and total leaves), is fully tolerated without causing detectable stress. Even substantially greater leaf injury can be sustained if the other factors, outlined below, minimize effects of the leaf loss.

Frequency of defoliation. Some insect pests regularly occur in high populations, and as a result these are among the more important pests of shade trees. For example, in much of the state elm leaf beetle defoliation occurs annually on Siberian elm, and Douglas-fir tussock moth caterpillars can repeatedly damage blue spruce in the metro Denver area. These repeated, sustained types of injury can produce significant stress and even mortality.

On the other hand, outbreaks of most insects that chew leaves and needles occur infrequently, often less than once in a decade. Others have life cycles which extend over more than one season (e.g., pandora moth) that serves to space out defoliation. Furthermore, natural controls are usually quite effective for these species, typically causing high populations to collapse after a season or two. Therefore, pest species which have not developed a local track record of causing regular injury rarely warrant control.

Conifers vs. hardwoods. Because conifers typically retain their needles for about three years, premature needle loss can be much more stressful than for deciduous species. Furthermore, most deciduous trees have ability to readily refoliate during the same growing season, allowing them to further compensate for leaf loss.

General health of the plant. One of the most fundamental considerations when assessing defoliation injury is the overall health of the tree or shrub. Vigorously growing deciduous plants with abundant reserves of stored food usually regrow lost leaves. Also, they can also remain healthy enough to defend against attacks by secondary pests. Defoliation is much more serious to plants that are already in poor condition.

Time of injury. As a general rule, the later in the season leaves are lost by defoliating insects, the less stressful is the damage to the tree. Insects which feed on spring growth shortly after it is produced, such as tent caterpillars or gypsy moth, remove tissues that have not had time to return to the plant the energy expended in their production. Conversely, defoliating insects which occur in late summer or fall are removing leaves that have had most of the season to return energy to the plant, and which will soon be shed due to natural processes. Almost never can a late season treatment be justified in solely in terms of protecting plant health.

With some plants, mid to late season defoliation can indirectly cause injury by inducing refoliation that does not sufficiently harden by the time that killing frosts occur. Buds may be injured as a result. There is also some reduction in starch reserves for the next season.

Part of the plant attacked. Defoliating insects all have preferred feeding sites where damage is concentrated. Those which feed on new growth, particularly current-season growth of conifers, can be extremely damaging, such as budworms. Others may concentrate on the upper parts of the plant, such as tiger moths or Douglas-fir tussock moth, which can kill out the main leader and distort the future growth pattern of the plant. On the other hand, pine sawflies and pine butterfly are examples of insects which feed on the older growth, resulting in less stressful type of injury.

Presence of secondary pests. For some defoliating insects the direct damage that they cause may be less important than their interaction with other, potentially more important pests. Several plant diseases, such as Cytospora cankers, as well as wood boring beetles and bark beetles are much more damaging to plants that are weakened and have lowered defenses. Where these secondary pests are an important local concern, defoliation is of greater consequence.

Esthetic considerations. One of the most important considerations in landscape pest management are the esthetic impacts. How plants look as a result of some leaf feeding can be extremely important to a plant owner who may demand control to limit this injury. While this is a valid personal preference, treatments for esthetics should be considered separately from those that are designed for plant protection. For many people, the threshold for injury based on esthetics is far more stringent than that required by the plant to avoid stress. As a result, need for treatments will be greatly increased if esthetics play an excessive role in treatment decision-making.

LEAF FEEDING SAWFLIES

Sawflies comprise a group of non-stinging wasps (Order: Hymenoptera) that develop by feeding on leaves or needles of trees and shrubs. The damaging stage larvae resemble caterpillars, with which they are commonly confused. However, the sawflies are very different insects more closely related to ants, bees and wasps than to moths or butterflies. The larval stages of sawflies can be separated from caterpillars by having six or more pairs of prolegs along their abdomen, in contrast to the two to five pairs of the caterpillars (Order: Lepidoptera).

Sawflies are among the first insects found feeding on plants in spring. The adult stages typically appear in late March through early May, during which time eggs are laid. Defoliation by most species occurs in late spring. On pines, very common hosts for sawflies, old needles are eaten often before the new growth emerges, causing damaged plants to appear tufted when the needles later emerge. Most sawflies have only a single generation a year.

One unusual group of sawflies (represented by species such as the pearslug and the roseslug)are known as the "slug sawflies". Larval stages of these sawflies resemble a bird dropping and feed on the upper surface of leaves. They skeletonize the leaf, leaving the main veins, producing a distinctive type of feeding injury.

Specific recommendations for these insects appear in the supplement on insect control recommendations. Sections in the supplement which deal with sawflies include **Sawflies** and **Pearslug**.

PEARSLUG (Pear Sawfly, Cherry Slug)

Caliroa cerasi (L.)
Family: Tenthredinidae

Appearance: **Adults** - 1/4 inch long, resembling small, black, thick-waisted wasps with clear wings and a broad abdomen. **Larvae** - Olive green and slug-like, one half inch long and covered with a blackish-green slimy secretion.

Hosts: Sweet and ornamental varieties of cherry, plum, pear hawthorn, and cotoneaster

Damage: Larvae feed on the upper surface of leaves, producing distinctive skeletonizing wounds. Heavily damaged leaves turn brown and drop early. Pearslug is one of the most damaging defoliators of landscape plantings in Colorado.

Pearslug larvae and injury. Photograph by W.S. Cranshaw.

Related Insects: The roseslug, *Endelomyia aethiops* (F.), commonly feeds on rose causing a similar skeletonizing feeding pattern on that plant. Related (*Caliroa* species) sawflies on oak may also have been introduced into the state.

Life History and Habits: Adults emerge in late June or early July and lay eggs singly in semicircular slits on the undersides of leaves. Eggs hatch in two weeks and larvae crawl to the upper surface of leaves where they feed on the upper layers of the leaf tissue only. Larvae change from black to yellow-green when mature and drop to the ground to pupate within cocoons made of soil particles and secretions.

Within two weeks, many pearslugs emerge as adults to produce a second generation, causing peak injury in September. This second generation is usually smaller than the first generation, since many pearslugs remain dormant until the following spring. The full-grown larvae from the September generation drop to the soil, and spin a cocoon in which they spend the winter. They pupate the following spring.

Control: Pearslug is readily controlled with several insecticides. (See **Pearslug** section in supplement on controls.) Wood ashes blown on the larvae will readily dry and kill them.

IMPORTED CURRANTWORM

Nematus ribesii (Scopoli)
Family: Tenthredinidae

Appearance: **Adult** - A dark brown, non-stinging wasp of typical sawfly-form. **Larvae** - Pale green larvae, marked with black spots. Between molts they are yellow-green and without markings for about a day. Typical sawfly larval form.

Damage: The larvae chew the leaves of currants and gooseberries, often extensively defoliating the plant early in the season. Foliage in the interior of the bush is first damaged but all leaves may be eaten. Yield and quality of fruit can be affected by this injury.

Hosts: Currants, gooseberry

Life History and Habits: The imported currantworm spends the winter in a cocoon in the soil around previously infested currants and gooseberries. The adults, a black and yellow wasp about one third inch long, emerges early in spring. After mating, the female lays eggs in a row along the main veins of the leaf underside. The larvae hatch about seven to ten days after eggs are laid and first feed in groups. Later they disperse throughout the plant and feed along the leaf margins, becoming full-grown in about three weeks. Young larvae are pale green, but develop distinctive dark spots as they grow and reach a size of about 3/4 inch.

Larva of the imported currantworm. Photograph by W.S. Cranshaw.

The full-grown larvae drop to the ground and form a cocoon. Some usually pupate and emerge in late June and July, producing a small second generation. The remainder become dormant and emerge the following year.

Controls: In small plantings, the larvae can be controlled by hand-picking or shaking. Careful examination of the newly emerging leaves can also identify the eggs which may be crushed. Most eggs and larvae will be found in the interior of the shrub.

At the end of the season, rake and remove all the debris away from the base of the plants. Most of the overwintering cocoons occur in this leaf litter and can be destroyed by this practice.

Chemical control options are limited on currants and gooseberries. Some formulations of malathion and pyrethrins allow use on this crop and are effective for imported currantworm control. However, be sure to check labels carefully to insure that use on the crop is specifically allowed.

Sprays of irritants, such as soaps, dilute dishwashing detergent, and wood ashes, can be effective controls against younger larvae.

Associated Insects: Larva of a moth, the currant spanworm [*Itame ribearia* (Fitch)] is another insect that often feeds on the leaves of currant and gooseberry. The larvae of this insect are also spotted, but are a type of inchworm with a distinctive looping walk. These are the immature stage of a small moth and the caterpillars can be controlled with Bacillus thuringiensis, which is not effective against sawflies.

BROWNHEADED ASH SAWFLY

Tomostethus multicinctus (Rohwer)
Family: Tenthredinidae

Appearance: **Adult** - Small (3/8-inch) heavy-bodied black wasps. **Larvae** - Typical sawfly larvae in form reaching about 5/8-inch when full-grown. General color green, often with white stripes, and a light brown head.

Larva of the brownheaded ash sawfly. Photograph by W.S. Cranshaw.

Hosts: Green ash, white ash

Damage: The larvae feed on ash leaves and can extensively defoliate the tree. This insect has become increasingly important as a defoliator of ash along

much of the Front Range since its apparent introduction in the area around Canon City, Colorado Springs and/or Pueblo.

Life History and Habits: The brownheaded ash sawfly spends the winter as a full-grown larva within a cocoon around the base of previously infested ash trees. Pupation occurs in early spring and adults emerge in April, sometimes found in swarms around the tree. Females insert eggs into young leaves, usually around the edge. Occasionally this results in leaf cupping.

Early stage larvae feed on the interior of the leaf, producing small pinhole feeding wounds. As they get older, larvae feed extensively on the leaf, avoiding only the main veins. Larval development and feeding occurs throughout May and by early June they are full-grown. Full grown larvae shed a papery larval skin that remains attached to the leaf and they then drop to the ground, where they form protective cocoons.

Almost all of the insects remain dormant until the next season, producing one generation per year. However, some emerge in early summer and produce a second generation that can also cause significant plant injury.

Control: Larvae are easily controlled with several contact insecticides. (See **Sawflies** section in supplement on controls.) In addition, many may be dislodged with a forceful jet of water.

POPLAR LEAFFOLDING SAWFLY

Phyllocolpa bozemani (Cooley)
Family: Tenthredinidae

Appearance: **Adults** - Small (1/4 inch) non-stinging wasps primarily black in color with red or orange markings. **Larvae** - Generally green in color with a dark head. The entire larval stage occurs within a leaf fold.

Hosts: Poplars, cottonwood, and willow

Damage: During feeding the larvae secrete saliva that causes distortions of the leaf margin. The leaves fold under and the larva feeds on the lower leaf surface within the leaf roll. The rolled leaves remain folded throughout the season. This injury does not seriously affect plant health but is a curiosity that often attracts attention, particularly because other insects and spiders often hide in the leafroll.

Related species: A closely related species makes a common stem gall on willow.

Typical leaf folding produced by the poplar leaffolding sawfly. Photograph by J.L. Capinera.

Life History and Habits: The poplar leaffolding sawfly spends the winter as a prepupa among debris at the base of trees, pupating in early spring. Adults are active in midspring and lay eggs as leaves first emerge. Wounds made during egg laying and subsequent larval feeding cause edges of leaves to fold. Full grown larvae drop to the ground and diapause. There is normally only one generation per year, but a small second generation is possible.

Controls: A great many natural controls keep populations of these sawflies under damaging levels. Aphids, which frequently colonize the leaf curls started by the sawfly, interfere with them and may indirectly kill the sawfly larvae with their excreted honeydew. A great many parasites also attack poplar leaffolding sawflies.

CONIFER SAWFLIES

Neodiprion species
Family: Diprionidae

Appearance: **Adults** - Small (1/4 to one half inch), dark, non-stinging wasps. **Larvae** - Medium-brown colored elongate larvae about 3/8 inch long when mature. They have dark brown heads and shields on the thorax and posterior. Prolegs are prominent.

Hosts: Pines (particularly pinyon and ponderosa pine) and, rarely, Douglas-fir

Damage: Larvae feed on old needles and during outbreaks can seriously weaken and slow the growth

of infested trees. Damage is particularly severe when other pest insects also occur that feed on new growth (e.g., pine budworm). Although all sizes of pines may be infested, damage is most common to small or medium-sized trees.

Life History and Habits: Several species of conifer sawflies are found in the region including, *N. edulicolus* (Ross), *N. gillettei* (Rohwer), *N. autumnalis* (Say), *N. ventralis* Ross and *N. fulviceps* (Cresson). Life histories vary somewhat, but all prefer to feed on older needles.

Early season defoliation of the old growth is characteristic of most pine sawflies. Photograph by D.A. Leatherman.

Conifer sawflies overwinter either as eggs inserted in the needles or as fully grown larvae (prepupae) within cocoons mixed in the litter at the base of previously infested plants. For the latter, pupation occurs in late winter or early spring and the adults emerge a few weeks later. Females then lay eggs which are inserted in rows in the needles.

Pine sawfly larvae typically emerge from eggs and begin to feed on needles in April and early May; other species may have a midsummer peak of feeding. The larvae feed gregariously, often headed outward from the twig. They finish feeding within a few weeks, drop to the soil and spin a cocoon in which they pupate. There is typically one generation per year.

Related species: The "Bull pine sawfly", *Zadiprion townsendi* (Cockerell) is also found on ponderosa pine. However, its habits differ from Neodiprion species in that larvae are present throughout the winter months.

Control: These insects are commonly found in low numbers but occasionally occur in outbreaks. Several natural controls, notably parasitic wasps, typically cause outbreaks to only last briefly.

Larvae are readily controlled with several contact insecticides. (See **Sawflies** section in the supplement on controls.)

BULL PINE SAWFLY

Zadiprion townsendi (Cockerell)

Family: Diprionidae

Appearance: **Adults** - Heavy-bodied wasps, approximately 1/2-inch in length. They are generally brown in color with light bands on the thorax. **Larvae** - Generally green and wormlike with some golden flecking on the body. Typically found feeding in groups on pine foliage.

Host: Ponderosa pine

Damage: The larvae feed on older needles, occasionally causing obvious defoliation by late winter or early spring. Damage is generally insignificant, but the presence of larvae actively feeding during the cool season may attract attention.

Life History and Habits: The bull pine sawfly is one of the few insects that remain on the the trees and feed throughout the winter months, weather permitting. Like most sawflies, the larvae they typically feed in groups of several dozen individuals, chewing the needles and producing large amounts of frass. The larvae have the unusual habit of curling outwards from the needle and snapping back, a behavior that they may engage in continuously during some periods. The apparent purpose of this behavior is for defense against birds or parasites, that are natural enemies of the insect.

By the onset of winter, the bull pine sawfly larvae are about half grown. They remain semidormant through the cold month, clustering at the base of the needles, but occasionally feed. Feeding resumes in spring and they become full grown by May or June. At this time thie drop to the ground, tunnel an inch or so into the soil, and spin a silk cocoon. Some of the larvae then transform to the pupal stage, while others may not pupate until late summer or even the following season. Adults emerge a few weeks after pupation, cutting through the cocoon to emerge. The adults do not live long and mated females insert their eggs into the pine needles, concentrating egg laying

on the upper areas of the tree. Eggs hatch from July through early fall and the larvae feed throughout this period. The entire life cycle may take one to two years to complete.

Related species: *Zadiprion rohweri* (Middleton) is associated with pinyon.

JUNIPER SAWFLY
Monoctenus fulvus (Norton)
Family: Diprionidae

Appearance: **Adults** - Typical sawfly form, the females are generally pale orange; males generally black with orange on the underside of the abdomen. **Larvae** - Generally gray-green with an orange head.

Hosts: Juniper

Damage: The larvae feed on the tips of junipers, sometimes checking the new growth and causing a thinning of the shrub. However, the larvae do not appear to feed very heavily on shrubs, even when in high populations.

Life History and Habits: The overwintering stage is a full-grown larva, within cocoons at the base of previously infested plants. They change to the pupal stage in early spring and adults emerge and mate in late April and early May. Females insert eggs into the tips of shoots, over the course of three to five weeks.

Larvae hatch during mid to late May. They become full-grown after four to six weeks after which the full-grown larvae drop from the plant and spin a cocoon within the leaf litter and upper soil. Peak feeding typically occurs in early June, although some larvae may be found through mid-July. There is some indication that a small number complete development and produce a second generation. However most remain dormant until the following season.

Control: Larvae are readily controlled with several contact insecticides. (See **Sawflies** section in supplement on controls.)

WEB-SPINNING SAWFLIES
Cephalcia species, *Acantholyda* species
Family: Pamphiliidae

Appearance: **Adults** - Small nonstinging wasps with long, slender antennae. **Larvae** - Resemble free-living types of sawflies but does not have any abdominal legs except on the last segment. Larvae occur within silken tubes or mats and produce a pelleted excrement somewhat resembling rodent droppings. The larvae also produce a characteristic "devil's horn" head capsule that also is shed in the webbing/frass "nest".

Hosts: Pines, spruce, plum

Damage: The larvae feed on needles late in the season. They rarely cause serious injury but gregarious species construct unusual "nests" of webbing and frass that attract attention.

Life History and Habits: Winter is spent in cells formed in the soil under previously infested trees. The adults typically emerge in May or early June and females insert eggs into the needles, typically in rows. The species which attract attention are gregarious, feeding in groups and constructing silk tubes along twigs at base of needles. However, some species are solitary and produce small, fairly inconspicuous silk-tubes. All of the web-spinning sawflies feed on the needles produced the previous season, although sometimes the new growth may also die back. They become full-grown in about three to four weeks, then drop to the soil and form the overwintering chamber. There is one generation per year, but they may remain dormant and not emerge for two or three years.

Associated and Related Insects: A species of pine webworm (*Tetralopha* spp.) makes nests of webbing in ponderosa pine that are similar to that of the web-spinning sawflies.

The webspinning sawfly *Neurotoma inconspicua* (Norton), is found in plum.

Table 4. Sawflies Recorded from Colorado that Feed on Trees and Shrubs

Scientific Name	Common name	Hosts
	Family Cimbicidae	
Cimbex americana Leach	Elm sawfly	Elm, willow
Trichiosoma triangulatum Kirby		Alder, birch, ash, Prunus, willow
Zaraea americana Cresson		Snowberry, honeysuckle
	Family Argidae	
Arge clavicornis (F.)		Willow, birch, alder
Arge pectoralis (Leach)	Birch sawfly	Birch
Arge scapularis (Klug)		Birch, alder
	Family Xyelidae	
Xyela bakeri Konow		Ponderosa pine
Xyela minor Norton		Ponderosa pine, other pines
Xyela obscura (Strobl)		Ponderosa pine
	Family Tenthredinidae	
Caliroa cerasi (L.)	Pearslug*, Pear sawfly	Sweet cherry, cotoneaster, pear, plum
Endelomyia aetiops (F.)	Roseslug	Rose
Tomostethus multicinctus (Rohwer)	Brownheaded ash sawfly*	Green ash, White ash
Pikonema dimmockii (Cresson)	Greenheaded spruce sawfly	Spruce
Nematus ribesii (Scopoli)	Imported currantworm*	Currants, gooseberries
Nematus ventralis Say	Willow sawfly	Willow, poplar
Nematus oligospilus Foerster		Willow
Nematus fulvircrus Provancher		Willow
Nematus vancouverensis (Marlatt)		Populus
Nematus tibialis Newman		Black locust, Honeylocust
Pontania proxima (Lepeltier)	Willow redgall sawfly	Willow (leaf gall)
Pontania c-pomum (Walsh)		Willow (leaf gall)
Pristophora serrula (Wong and Ross)		Chokecherry
Pristophora rufipes Lepeltier		Ribes
Pristophora coactula (Ruthe)		Willow
Pristophora sycophanta Walsh		Willow
Pristophora staudingeri (Ruthe)		Willow
Pristophora lena Kincaid		Spruce
Pristophora mollis (Hartig)		Vaccinium
Periclista albicollis (Norton)		Oak
Blennogeneris spissipes (Cresson)		Snowberry (bud gall)
Ardis brunniventris (Hartig)		Rose
Monophadnoides geniculatus (Hartig)	Raspberry sawfly	Raspberry
Messa leucostoma (Rohwer)		Populus
Messa populifoliella (Townsend)	Poplar leafmining sawfly	Populus
Rhogogaster californica (Norton)		Populus
Dimorphopteryx pinguis (Norton)		Birch, alder
Phyllocolpa excavata (Marlatt)		Willow

Phyllocolpa bozemani (Cooley)	Poplar leaffolding sawfly*	Poplars
Macremphytus testaceus (Norton)	Dogwood sawfly	Dogwood
Croesus lititarsus (Norton)	Dusky birch sawfly	Birch
Fenusa pusilla (Lepeletier)	Birch leafminer*	Birch
Fenusa dohrnii (Tischbein)	European alder leafminer	Alder
Fenusa ulmi Sundevall	Elm leafminer	Elm
Euura bebbianae (Rohwer)		Willow (stem gall)
Euura brachycarpae Rowher		Willow (stem gall)
Euura s. ovulum Walsh		Willow (stem gall)
Euura s. nodum Walsh		Willow (stem gall)
Euura orbitalis Norton		Willow (stem gall)
Euura perdita Rohwer		Willow (stem gall)
	Family Diprionidae	
Neodiprion edulicolis Ross	Pinyon sawfly*	Pinyon, bristlecone pine
Neodiprion gillettei (Rohwer)*		Ponderosa pine
Neodiprion autumnalis (Say)*		Ponderosa pine
Neodiprion fulviceps Cresson)*		
Neodipron ventralis Ross*		Ponderosa pine
Zadiprion townsendi (Cockerell)	Bull pine sawfly*	Ponderosa pine
Zadiprion rohweri (Middleton)		Ponderosa pine
Monoctenus fulvus (Norton)	Juniper sawfly*	Juniper
	Family Pamphiliidae	
Acantholyda terminalis (Cresson)*		Conifers
Acantholyda verticalis (Cresson)*		Several pines
Acantholyda depressa Middlekauff*		Ponderosa pine
Acantholyda runcinata Middlekauff*		Ponderosa pine
Cephalcia provancheri (Huard)*		Spruce
Cephalcia fascipennis (Cresson)*		Spruce
Pamphilius sitkensis (Kincaid)		Rubus
Neurotoma inconspicua (Norton)*	Plum web-spinning sawfly	Plum

* Life history descriptions included in this publication.

LEAFCUTTER BEES

(*Megachile* species)
Family: Megachilidae

Appearance: Adult leafcutter bees somewhat resemble dark, robust honeybees. However, they cut leaves very rapidly, within seconds, and rarely are observed on the plants. Larvae are found within the nest cells of the bees, which are constructed in decayed wood or the pith of various plants.

Damage: Leafcutter bees cut very characteristic semicircular notches out of leaves, using the leaf fragments to construct nesting cells. When very abundant, leafcutter bee damage can defoliate plantings. Rose family plants (e.g., rose, lilac) and ash are particularly preferred.

Life History and Habits: Leafcutter bees are solitary bees, which have each female rear young individually. When rearing young, the females bees cut leaves from rose, ash, and other plants. They work quickly and leaf cutting is very rapid, occurring in as little as ten seconds. The bees then take the leaf disks to nest sites excavated out of rotten wood, pithy plants, or other hollows. The leaves are formed into thimble-shaped rearing cells which are then packed with pollen on which the young develop.

Leafcutter bees (unlike honeybees) are native insects that are important in the pollination of several native plants, and are also extremely useful pollinators of alfalfa.

Control: Most often, damage to leaves is little more than a curiosity and does not require control. In some settings, populations of this insect can be reduced by limiting breeding sites, such as exposed pith of rose and caneberries, by sealing the opening with glue, shellac, or a thumbtack.

Many insecticides can kill the adult bees, but treatments need to be reapplied frequently. Because of the beneficial habits of leafcutter bees as pollinators, insecticides should only be used only when very serious infestations threaten.

In areas where large populations of leafcutter bees occur, such as around shelterbelts in isolated areas, damage can be severe and most controls have little effect. In these situations, the best control is to plant nonpreferred hosts and to cover susceptible plants with mesh screening.

GRASSHOPPERS

Redlegged grasshopper [*Melanoplus femurrubrum* DeGeer)],
Differential grasshopper [M. *differentialis* (Thomas)],
Twostriped grasshopper [*M. bivittatus* (Say)],
Migratory grasshopper [*M. sanguinipes* (F.)] and others
Family: Acrididae

Damage: Grasshoppers feed on the leaves and twigs of many trees and shrubs. Most damage occurs when they graze and girdle tender twigs of poplars, junipers and other plants, which cause twig die back or swellings of callous to develop around the wounds. Tree plantings surrounded by grasshopper breeding sites, are highly attractive to grasshoppers.

Differential grasshopper. Photograph by W.S. Cranshaw.

Life History and Habits: Most of the pest species of grasshoppers in the region spend the winter as eggs. The eggs are laid underground in late summer or early fall in the form of elongate egg "pods" containing 20 to 120 eggs each. Egg laying is concentrated in dry undisturbed areas, being very heavy along roadsides, in pasturelands, and native prairie. Relatively little egg laying occurs in an irrigated yard or garden, and is largely limited to small dry areas in the yard, such as between sidewalk cracks.

Eggs hatch in late May and June. The immature nymphs take two to three months to become fully developed. Adults are present during August and remain until they are killed by a heavy frost.

Grasshoppers feed during the day, resting on shrubbery, tall plants, or man-made structures during the late afternoon and night. Movements into yards accelerate as native vegetation becomes less suitable due to summer drying or defoliation. Light frosts that

may kill many host plants further concentrate them in the fall on the more cold tolerant plants (e.g., strawberries).

Controls: Grasshopper outbreaks tend to occur in cycles of roughly ten to 15 years, with serious populations often lasting for two to three years. However, localized occurrence can be much more erratic. A large number of natural controls exist to bring control of outbreaks.

Cool, wet weather in spring, particularly around the period of egg hatch is one of the most common conditions associated with declining grasshopper populations. Grasshoppers also can suffer from several diseases. The fungus disease *Entomophthora grylli* can be very destructive to populations, although spread is dependent on adequate moisture. The microsporidian *Nosema locustae* also can kill or weaken grasshoppers.

Nosema locustae is also manufactured and sold as a type of microbial insecticide under trade names such as Semaspore, Grasshopper Spore and NoLo Bait. It is most effective against young grasshoppers and may kill many under optimum conditions. Older grasshoppers are much less sensitive and rarely die, although they may be less vigorous and lay fewer eggs the following season.

Insects that feed on grasshoppers include the larvae of blister beetles (predators of the eggs), robber flies, and parasitic flies. Grasshoppers are also common foods of many birds such as the horned lark, American kestrel, and Swainson’s hawk.

Poultry, notably guinea hens and turkeys, feed readily on grasshoppers and can assist in controlling moderate grasshopper populations. Grasshoppers which are caught have been used also as a highly nutritious poultry feed.

Maintaining relatively lush areas of grass or other plants around the perimeter of a property can divert the feeding activities of many grasshoppers from the vegetable or flower garden. (This technique is further improved if this "trap crop" is treated with an insecticide.) Grasshoppers can also be largely excluded by covers (e.g., floating row covers), although they can chew through lightweight fabrics.

Since most breeding of grasshoppers occurs in dry, undisturbed sites outside of a yard or garden, control of grasshoppers in these areas is most productive. Sprays of insecticides such as carbaryl (Sevin), acephate (Orthene) or malathion can kill grasshoppers in rangeland or pastures. In addition, various baits can be used (typically an insecticide on a molasses-bran base) which allow the insecticide to be applied in a more selective manner, killing fewer beneficial insects.

Related Species: Over 60 species of grasshoppers are native to the High Plains and Rocky Mountain region. Most of these do not occur in large numbers and exist as destructive pests. Many also have selective feeding habits and feed only on grasses or native shrubs (forbs) that keep them out of yards and gardens. Life cycles of the various grasshoppers can also vary, with many overwintering as nymphs or adults.

LEAF AND NEEDLEMINERS

Leafminers or needle miners are insects which have a habit of feeding internally in leaves or needles, producing tunneling injuries. Several diverse groups of insects with chewing mouthparts have developed this habit, including larvae of moths (Lepidoptera), beetles (Coleoptera), sawflies (Hymenoptera) and flies (Diptera). Many of these insects feed for their entire larval period within the leaf mine and many even pupate within the plant tissues. Other insects, such as the budworms, as leaf/needleminers only during their early growth stages, later emerging to feed externally on the plant.

Leafminers are sometimes classified by the pattern of the mine which they create. **Serpentine** leaf mines wind snake-like across the leaf. More common are various blotch leaf mines which are generally irregularly rounded. One subgroup of these are the tentiform leafminers, which produce bulging blotch-type mines that curve upwards somewhat like a tent. Mines of all types are typically restricted by larger leaf veins.

Areas mined by insects die and dry out. Although injuries produced by leafmining insects can be unattractive, it is rare for them to significantly affect plant health. Also, most leafminers have important natural controls which check populations.

Injuries caused by leaf and needle mining insects can superficially resemble symptoms produced by leaf spotting fungi or other abiotic problems. They can be differentiated by pulling apart the blotchy area. If damaged by insects the leaf or needle will have a hollow area and may expose either the insect and/or its droppings (frass). Leafspotting fungi cause these areas to collapse, without any tunneling.

Insecticidal controls are best achieved if applied during or prior to egg laying and egg hatch. This timing will differ for each leafminer species. After leafminers have entered the leaves, insecticidal control becomes more difficult. Diazinon, chlorpyrifos (Dursban), and pyrethroid insecticides are contact insecticides for these preventive applications.

Insecticides with some systemic activity (acephate/Orthene, dimethoate/Cygon, Metasystox-R) can be used on some plants and provide partial control even after tunneling has begun. When using these materials, applications can be timed to coincide with observation of the first pinhead sized tunnels.

Specific recommendations for these insects appear in the supplement on insect control recommendations in the **Leafminer** sections.

ASPEN LEAFMINER

Phyllocnistis populiella (Chambers)
Family: Gracillariidae

Appearance: **Adults** - Tiny moths with wingspan of about 1/4 inch, with narrow lance-like wings mottled white and brown. **Larvae** - Tiny, slightly flattened caterpillars, about 1/4 inch long when mature.

Hosts: Aspen. Related species attack cottonwood and poplar.

Damage: Winding, serpentine, silver leaf mines appear in spring and summer. Infestations are rarely serious enough to cause tree damage.

This moth occasionally becomes a minor nuisance problem as the moths move to mountain homes for winter hibernation.

Life History and Habits: The aspen leafminer overwinters as an adult moth, which is often active during much of the fall before hibernating. In spring, they become active again and eggs are laid near the tips of young leaves. The young larvae cut through the bottom of the egg and enter the leaves, mining just under the cuticle. They grow and molt several times, with the last instar (IV) being a nonfeeding

Tunneling produced by the aspen leafminer. Photograph by D.A. Leatherman.

stage. They then pupate within the leaves with and the adults appear in late summer. Adults feed on nectaries (sources of sugar-rich fluids) at the base of aspen leaves. There is one generation per year.

Controls: Controls have not been developed nor are likely ever warranted.

SPOTTED TENTIFORM LEAFMINER
Phyllonorycter blancardella (F.)
Family: Gracillariidae

Appearance: **Adults** - Tiny moths with a wingspan of only 1/4 inch, with feathery golden wings streaked and spotted with white. **Larvae** - Light yellow caterpillars about 1/4 inch long when mature.

Host: Apple

Damage: Larvae make small (one half inch) mines close to the lower surface of the leaf, causing a slight crimping in the leaf and making it appear tentlike. There may be up to 15 mines per leaf. Injury reduces fruit quality and can contribute to premature fruit drop.

Tentiform leaf mines produced on poplar. Photograph by W.S. Cranshaw.

Life History and Habits: Adults emerge in spring at bud break, mate, and deposit their eggs on the young leaves as they appear. The young larvae first feed on sap from the lower leaf surface. They later bore into the leaf and construct a mine just under the lower leaf surfaces, and chew small pits into the leaf which appear as small light spots. They also spin silken threads across the mined tissues, and when the silk dries and shrinks the area forms a raised ridge (tentiform leaf mine). By mid to late June the larvae pupate within the mine. Just prior to adult emergence the pupae wiggle halfway out of the mine, leaving this characteristic sign. Second generation adults appear in late June and early July. There are three generations per year, the last one spending the winter as a pupa within the fallen leaves.

Related Species: *Phyllonorycter salicifoliella* (Chambers) and *Phyllonorycter nipigon* (Freeman) commonly make similar tentiform mines in the lower leaf surface of willow and poplar. Outbreaks are fairly common at higher elevations in the state. Infestations tend to be concentrated on lower leaves. There are probably two generations per year of these species. Related species of leafminers also attack hackberry and aspen, producing blotch mines.

Controls: These leafminers are heavily parasitized by many insects. Outbreaks are typically of short duration, one to two years at most. Control with insecticides is very difficult and rarely warranted except during sustained outbreaks. On apple, only a few Restricted Use pesticides have proved effective for control of spotted tentiform leafminer. The related species on poplars and willow are likely equally difficult to control. Furthermore, these latter plants can sometimes be injured by systemic insecticides that are used for leafminer control.

LILAC LEAFMINER
Caloptilia syringella (F.)
Family: Gracillariidae

Appearance: **Adults** - Small (2/5-inch wingspan) brown moths with wings marked with a series of wavy yellow lines. **Larvae** - Very small caterpillars, about 1/3 inch when grown and glossy green in color. The caterpillars are found within leaf mines or folded leaves.

Hosts: Lilac, privet. Rarely ash, euonymus.

Damage: The larvae first produce a blotch mine of the foliage, then tie and feed on the leaves. Injury can be extensive and unsightly.

Life History and Habits: Lilac leafminer spends the winter as a pupa or full-grown larva within the mines of dropped leaves. The adult moths emerge in spring after leaves emerge and lay eggs in small

groups on the leaves. Newly hatched larvae tunnel directly into the leaf from under the egg. As they develop and grow larger they excavate a blotch-type mine and tunneling by several larvae may coalesce. As the larvae become nearly mature they leave the leaf mine and tie the edge of the leaf with silk. They continue to feed within the folded leaf and later pupate. There are probably two generations per season.

Leaf rolling associated with the lilac leafminer. Photograph by W.S. Cranshaw.

Controls: Raking and removal of infested leaves can be an effective cultural control.

Systemic insecticides, such as acephate (Orthene), can provide best control when applied as mines are first being produced. Alternatively, contact insects may be effective if applied when eggs are laid.

Related Species: The boxelder leafminer, *Caloptilia negundella* (Chambers), feeds on boxelder and causes similar leaf injuries. There are two generations per year and the life cycle is likely similar to that of the lilac leafminer.

PONDEROSA PINE NEEDLEMINER
Coleotechnites ponderosae Hodges and Stevens
Family: Gelechiidae

Appearance: **Adults** - Small, fragile, dark gray moth with a wingspan of one half inch. **Larvae** - Slender caterpillar about 3/8 inch long when mature.

Host: Ponderosa pine

Damage: Larvae bore into young needles, often causing the needle tips to die-back. Browning of foliage is often evidence of injury and closer inspection will reveal hollowed-out needles, typically with the base remaining green. Outbreaks have periodically occurred in several forested areas in the state.

Ponderosa pine needleminer injury. Outline of larva within the needle can be seen. Photograph by D.A. Leatherman.

Life History and Habits: Adults emerge in late summer to mate and lay eggs, usually inside old, previously mined needles. Eggs hatch and the tiny larvae move to green needles, bore in near the tip and begin mining. Development continues slowly through the winter and accelerates rapidly with the coming of spring. The larvae complete their development in a single needle, pupating in midsummer.

Related Insects: The lodgepole needleminer, *Coleotechnites milleri* (Busck) is occasionally destructive to lodgepole pine. Pinyon needleminer, *Coleotechnites edulicola* Hodges and Stevens occasionally damages pinyon. Another species, *Coleotechnites piceaella* (Kearfott) mines the needles of spruce.

Controls: A great many natural controls limit populations of ponderosa pine needle miner. Use of acephate as foliar sprays (Orthene) or injections (Acecap), applied to provide coverage during the period of egg hatch, has provided control on individual trees.

PINYON NEEDLEMINER
Coleotechnites edulicola Hodges and Stevens
Family: Gelechiidae

Appearance: **Adults** - Silver-gray moths with a wingspan of about 3/8 inch. **Larvae** - Medium-brown colored caterpillars with dark brown heads

and shields on the thorax and posterior. About 3/8 inch long when mature.

Hosts: Pinyon

Damage: Needlemining can cause premature defoliation, reduced growth and tree vigor, making them more susceptible to bark beetle attack.

Life History and Habits: The pinyon needleminer spends the winter as dormant second or third instar larvae within a needle. They resume feeding in spring and pupate in late May. Adults emerge from early June until mid-July. Eggs are laid, and newly hatched larvae crawl to uninfested needles and feed until fall. There is one generation per year.

Related Insects: The lodgepole needleminer, *Coleotechnites milleri* (Busck) is occasionally destructive to lodgepole pine. Ponderosa pine needleminer, *Coleotechnites ponderosae* commonly damages ponderosa pine. Another species, *Coleotechnites piceaella* (Kearfott) mines the needles of spruce.

Controls: Controls have not been developed nor are likely ever needed except to protect individual high value trees during outbreaks. Controls as indicated for ponderosa pine needleminer (above) should be effective.

PINE NEEDLE SHEATH MINER

Zelleria haimbachi Busck

Family: Yponomeutidae

Appearance: **Adults** - Silvery white moths with a wingspan of about one half inch. Forewings are light yellow with a white band lengthwise. **Larvae** - Young larvae are bright orange, older larvae are tan with two dull orange lines along the back.

Hosts: Many species of two- and three- needle pines, primarily ponderosa and Jeffrey pines

Damage: Mining in both needles and sheaths causes needles to droop, die and be shed prematurely during late spring.

Life History and Habits: Adults emerge in early to mid summer and lay eggs on the new growth. The eggs hatch during the summer and the young larvae tunnel the needles. Winter is spent as a first instar larva in the needle.

The following spring the larvae emerge from the needles and crawl down to the base of the needle cluster. They mine inside the sheath, severing the needles and causing the primary injury. They periodically move to the sheath of new needle clusters and typically destroy six to ten clusters of needles in this fashion. There is one generation per year.

SPRUCE NEEDLEMINER

Endothenia albolineana (Kearfott)

Family: Tortricidae

Appearance: **Adults** - Dark brown moths with a wingspan of about one half inch. Forewings have three irregular, transverse grayish-white bands while hind wings are brown with a lighter brown fringe. **Larvae** - Light greenish-brown caterpillars with a dark head, about 3/8 inch long and found associated with damaged needles.

Hosts: Most spruce species

Damage: Groups of needles are hollowed out at the base are webbed together, forming a funnel-shaped mass of dead needles. Often, several larvae may feed together producing a large mass of webbing and frass.

Damage to spruce by the spruce needleminer. Note the associated webbing among the needles. Photograph courtesy of the University of Wyoming.

Infestation of large trees is usually confined to lower branches, but entire crowns of small trees may be infested and defoliated. Heavy infestations occur much more commonly in landscape plantings than to forest trees.

Life History and Habits: Spruce needleminer spends the winter as a nearly full-grown larva within a cocoon constructed within mats of webbing and

dead needles. They resume feeding in early spring, becoming full-grown in April or May. Adult moths emerge and lay eggs on the needles in late May and June. Eggs are laid in rows, on the underside of year-old needles.

Larvae mine the interior of needles, and damaged needles are later cut off and bound to the twigs with webbing. They feed throughout the summer, suspending feeding with the onset of cold weather. There is one generation per year.

Controls: Nests can be physically removed by a jet of water in spring, before new buds open. Infested debris removed in this manner should be destroyed to kill the larvae.

Insecticide sprays are best applied during early stages of an infestation cycle, as eggs are starting to hatch. Because of the needlemining habit of this insect, systemic insecticides (e.g., Orthene, Cygon) are likely to be most effective. If larvae continue to be found in high numbers during midsummer, a second application may be of benefit.

WHITE FIR NEEDLEMINER

Epinotia meritana (Heinrich)
Family: Tortricidae

Appearance: **Adults** - Dusty-gray moths with a wingspan of about 3/8 inch. Forewings are mottled with patches of cream and have black bands and gray-fringed bottoms. **Larvae** - Cream to yellow caterpillars, body sparsely covered with thin, short hairs, with a brown to black head. About 3/8 inch long when mature.

Hosts: White (concolor) fir

Damage: Larvae mine and feed inside needles. Larvae prefer year-old needles, but will attack all needles during epidemics. Heavy infestations kill many needles during epidemics. Heavy infestations kill many needles and even whole trees. Most often, foliage is thinned and tree vigor reduced. Weakened trees are especially susceptible to attack by fir engraver beetles.

Life History and Habits: Winter is spent as immature larvae that begin feeding in spring. After mining about six needles, each larva spins a web in which it pupates in June or early July. Adults emerge 10 to 14 days later, mate in two to three days, and deposit eggs soon after that. Eggs hatch in August and September; larvae bore into needles where they spend the winter. One generation per year.

POPLAR BLACKMINE BEETLE

Zeugophora scutellaris Suffrian
Family: Chrysomelidae

Appearance: **Adults** - Beetles are about 1/8 inch long, with yellow head, prothorax and legs. Wing covers are punctate in texture and yellow. There is a prominent tubercle on either side of the prothorax. **Larvae** - Flat and legless, found only within the black blotchy leaf mines.

Hosts: Poplar, cottonwood

Damage: The larvae feed individually in the inner tissues of the leaf creating large, black blotchy mites. Adults feed on the lower surface of leaves, skeletonizing them. Heavily infested trees may be completely defoliated. Damage is common in many communities along the Platte River Valley.

Large dark areas are produced by mines of the poplar blackmine beetle. Photograph by D.A. Leatherman.

Life History and Habits: Adults emerge from May through July. They feed on the under surface of leaves and produce small skeletonizing injuries. Females also lay eggs in some of the leaf pits. The emerging larvae tunnel the leaves and feed inside the leaf until September or October. They then drop to the ground, burrow into the soil, and pupate in cells several inches below the surface. There is one generation per year.

Related Insects: The locust leafminer [*Odonota dorsalis* (Thunberg)] can sometimes be found attack-

ing black locust in eastern Colorado. This insect produces a distinctive hand-shaped (digitate) mine during the earlier stages of feeding, before consuming more of the leaf and turning it into a blotch mine. The adult beetles lay egg masses shortly after new leaves emerge and the larvae first feed on the lower leaf, before tunneling and mining.

Controls: Insecticides are most effective when applied against the adult stage before eggs are laid. Early to mid June would be most appropriate form many areas. Carbaryl (Sevin, Sevimol) and the pyrethroid insecticides (Talstar, Tame, Tempo, Mavrik, Samurai) can control adults. Larvae within mines cannot be killed with contact insecticides and the systemic insecticide Orthene can cause plant injury to some cottonwoods and poplars. For specific recommendations see the section in the supplement on **Leafminers**.

ELM LEAFMINER
Fenusa ulmi Sundevall
Family: Tenthredinidae

Appearance: **Adults** - Resemble small (1/8 inch), black, thick-waisted wasps. **Larvae** - Full grown larvae are one quarter inch long, flattened and whitish-green with a brown head capsule.

Host: Elm, particularly American elm

Damage: Larvae feed between the upper and the lower leaf surfaces, mining out serpentine areas which later turn brown and dry out.

Life History and Habits: Adults fly in May, the females laying eggs singly in slits on the upper leaf surface. Eggs hatch within a weeks and larvae begin burrowing into the inner leaf layers, confining their mines to the areas between leaf veins. In late spring, larvae emerge, drop to the ground, and burrow to a depth of about an inch. Here they spin papery cocoons and spend the duration of the summer, fall, and winter. There is one generation per year.

BIRCH LEAFMINER
Fenusa pusilla (Lepeletier)
Family: Tenthredinidae

Appearance: **Adults** - Resemble small (1/8 inch), black, thick-waisted wasps. **Larvae** - Mature larvae are 1/4 inch long, slightly flattened, and yellowish white in color.

Host: Birch

Damage: Large, dark blotch mines cover leaves. Entire leaves may wrinkle and turn brown, causing them to drop prematurely.

Life History and Habits: Adults first appear in May when the first leaves are half grown, laying their eggs singly near the center of the new leaves. Larvae hatch and mine out the middle layers of the leaf; several mines may grow together to form one large blotch mine. After 10 to 15 days, larvae cut exit holes and drop to the soil where they burrow one to two inches below the surface and pupate within cells made of soil particles. Two to three weeks later the adults emerge and the cycle repeats. Normally there are two generations per year, although if conditions are dry many of the first generation wasps will remain dormant and not emerge until the second year.

Birch leafminer larvae and frass exposed in leaf mine. Photograph by W.S. Cranshaw.

Controls: Systemic insecticides, applied to provide coverage during the period when eggs are being laid and hatching, provide the best control. For specific recommendations see the section in the supplement on **Leafminers**.

Related species: A closely related species, *Fenusa dohrnii* (Tischbein) commonly produces blotch leafmines on alder.

Table 5. A Key to Common Insect Groups Causing Chewing Injury to Woody Plant Foliage.

Note: This key is organized by couplets. Start from the beginning (1 a and b) and read the description. At the end of the line will be either the correct answer or the number of the next couplet which to move. For example, if the damage that you are seeing involves some removal of the surface leaf tissues, you are directed to move to couplet 2.

1a. Damage involves removal of surface leaf tissues 2
1a. Damage limited to tissues between leaf surfaces (leafminers) or involves swellings of leaf (galls) 15

2a. On coniferous trees 3
2b. On deciduous trees 5

3a. Webbing associated with insect . . . . . Tiger moth, Spruce needleminer (43), Web spinning sawfly (34)
3b. No webbing associated with insect 4

4a. Damage primarily confined to older needles . . . . . Conifer sawflies (31), Bull pine sawfly (32), Pine butterfly (20)
4b. Damage primarily confined to current season growth . . . . . Budworms (10, 11), Douglas-fir tussock moth (9)

5a. Most leaf tissues are consumed, including many of the smaller veins 7
5b. Feeding is selective and avoids leaf veins, leaving veins intact (skeletonizing) 6

6a. Skeletonizing occurs on upper leaf surface . . . . . Leaf beetle larvae (20)
6b. Skeletonizing occurs on lower leaf surface . . . . . Slug sawfly larvae (29)

7a. Webbing conspicuously associated with leaf injury 8
7b. Webbing not produced, or not conspicuous 10
(Note: Some webbing can be produced by spider mites, during outbreaks. Webbing produced by spiders and cottonwood fluff may also be easily confused with silk produced by insects.)

8a. Webbing ties together only a few (less than 5) leaves and a single larva present within the webbed area
. . . . . Leafrollers (14), Large aspen tortrix (12)
8b. Webbing very prominent and covers branch terminal growth or concentrated along branch crotch 9

9a. Webbing dense, concentrated at crotch of branches . . . . . Tent caterpillars (16)
9b. Webbing covers foliage on which caterpillars are feeding . . . . . Fall webworm (4), Uglynest caterpillar (13)

10a. Injury is generally confined to the interior of the leaf, consisting of roughly circular holes
. . . . . Leaf beetle adults (21), Sawflies (early stage feeding)(28)
10b. Injury originates along leaf margin (notching) 11

11a. Injury confined to leaf margin, occurring as a series of small irregular wounds (notching) that penetrate less than 1/2 inch
. 12
11b. Injury may penetrate more than 1/2 inch into the leaf. Wounds may be large and irregular; or very smooth and semicircular . . 13

12a. Notching wounds in shallow, moderately regular pattern and are limited to only a few species of plants . Black vine weevil (26)
12b. Wounds occur in an irregular manner and are scattered among a large range of plant species . . . . . Grasshoppers (37)

13a. Wounds very regular, occurring as a semicircular cut . . . . . Leafcutter bees (37)
13b. Wounds irregular. Smaller veins as well as other leaf tissues are consumed 14

14a. Petioles of leaves severed. Generally restricted to maple . . . . . American dagger moth (6)
14b. Petioles of leaves not severed . . . . . Caterpillars (1), Sawflies (28)

15a. Injury involves a hollowing out of the leaf or needle . . . . . Leafminers (39), Needleminers (39)
15b. Injury involves as swelling or growth on the foliage . . . . . Gall making insects and mites (48)

GALL MAKERS

Several types of insects and mites cause plants to produce abnormal growths in response to their feeding activities. These **galls** typically develop around the gall maker, housing, protecting, and providing a steady food source for the insects or mites within the gall.

Many insects, such as the gall midges, produce fairly simple galls that are the result of stunting and/or thickening of leaf tissues. These are sometimes referred to as **indeterminate galls**. Other insects and some mites produce very bizarre changes in the plant growth, sometimes appear as fruit or other radically different structure than the original tissues. These are called **determinate** galls and the various gall wasps that frequent oaks and rose are well-known for this habit. Regardless, all gall making insects and mites create galls unique for the species and they are almost invariably restricted to a single plant species.

Since only actively growing tissues are susceptible to the gall making stimuli, most galls are produced solely during the rapid growth period of late spring. Once galls are initiated, their formation is irreversible. Although the galls are often conspicuous and may be unattractive, rarely does any real plant damage occur. **Under most circumstances control of galls is not recommended**.

A few gall-making insects and mites overwinter on the trees and may be controlled by dormant oil applications. However, most galls are produced by insects that move to the new growth as it develops in spring and can only be controlled by insecticides that cover the leaves during the egg laying period. Because the quality of the insecticide coverage diminishes as leaves expand, repeat applications are often necessary.

Sevin may be effectively used against the Cooley spruce gall adelgid and for control of eriophyid mites. Gall-making midges (honeylocust podgall, pinyon spindlegall) are best controlled with Diazinon, dimethoate (Cygon), chlorpyrifos (Pageant, Dursban) and various pyrethroids (Talstar, Samurai, Mavrik, Tempo). For specific control recommendations refer to the supplement on insect control recommendations. Gall making insects and mites are discussed in the sections **Cooley spruce gall adelgid**, **Pinyon spindle gall midge**, **Honeylocust podgall midge**, **Poplar twiggall fly**, and **Eriophyid mite galls** (**Poplar budgall**, **Ash flower gall**).

COOLEY SPRUCE GALL ADELGID

(Cooley spruce gall aphid)
Adelges cooleyi (Gillette)
Family: Adelgidae

Appearance: On spruce nymphs are covered by a waxy substance and occur within chambers in the gall. On Douglas-fir the insect exists as a woolly aphid exposed on the needles. Winged forms sometimes are produced.

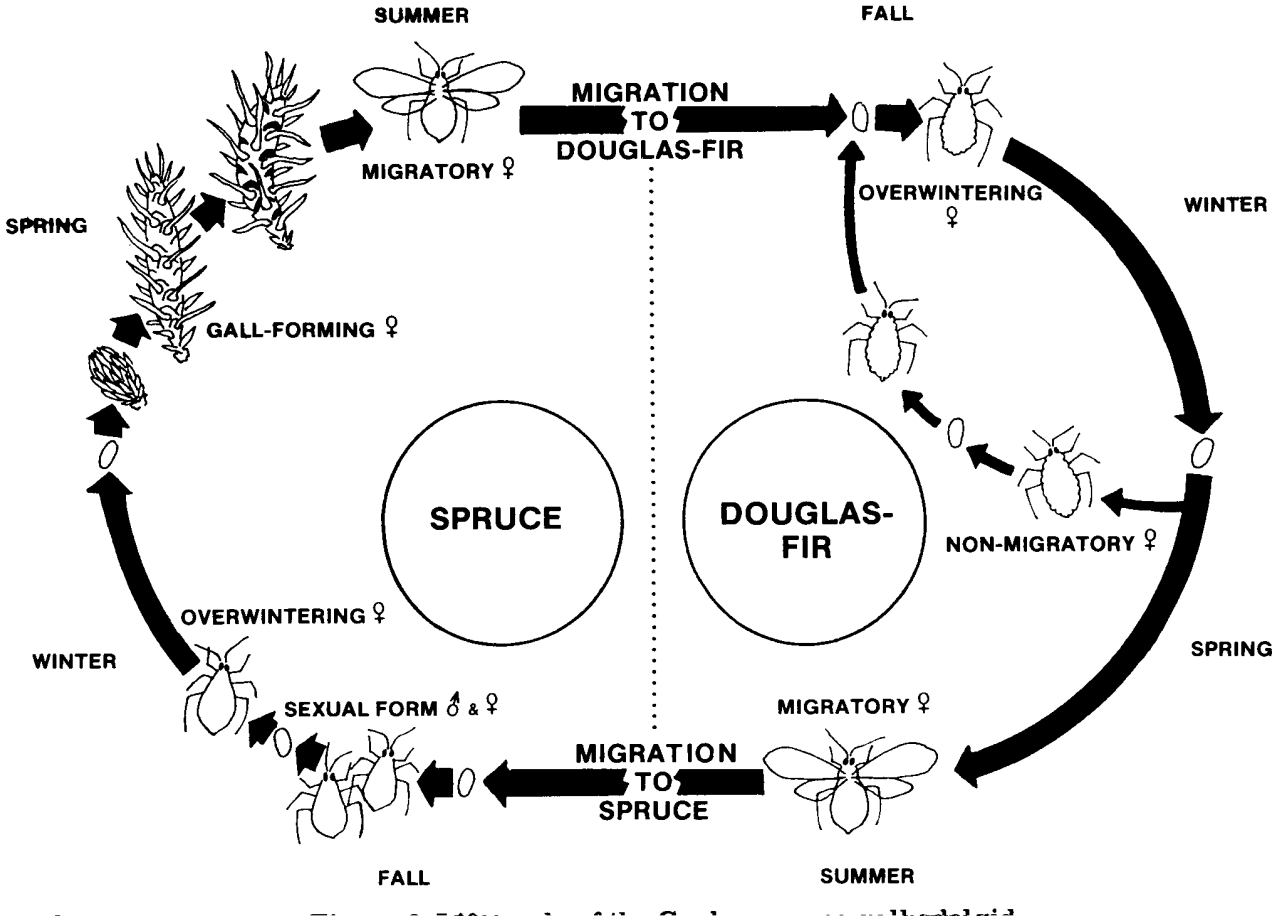
Hosts: Douglas-fir, spruce

Damage: On spruce distinctive cucumber-shaped galls develop on the new growth. These usually kill the terminal growth, although occasionally partial galls form that allow many of the upper needles to survive and the terminal continues to grow. Galls produced by this insect may be considered unsightly but rarely have significant effects on tree health.

On Douglas-fir sap-sucking causes needles to become yellow and twisted. Some secondary damage often is caused by sooty mold that grows on honeydew excreted by the insects. Large numbers also occur on cones, which may affect seed production.

Old galls produced by the Cooley spruce gall adelgid. Photograph by W.S. Cranshaw.

Life History and Habits: The typical life cycle involves two alternating hosts, Douglas-fir and spruce. The entire cycle is completed over two years



Life cycle of the Cooley spruce gall adelgid.

and involves multiple forms of the insect. (See figure.)

On Douglas-fir, the nymphs overwinter as partially developed nymphs on the needles. They continue to develop in spring, producing a large egg mass around early May. The eggs hatch in about 20 days and the nymphs move to tops of twigs to feed. They become full-grown in July and produce a generation of adults that are a mixture of winged and wingless forms. The wingless forms remain on Douglas-fir and have a second generation. The winged forms fly to spruce and start the cycle on this host.

On spruce, winged adults from Douglas-fir lay eggs that hatch into nymphs. These nymphs overwinter at base of needles, resume feeding in spring, and mature in May. The adults produce a very large mass of eggs on the underside of the twigs, and eggs hatch as the new growth forms. The nymphs move to feed at the base of newly developing needles, which induce the formation of

Overwintered females of the Cooley spruce gall adelgid on the underside of spruce twig. Photograph by W.S. Cranshaw.

greenish-purple cone-like galls that envelop the feeding aphids. They continue to feed and develop within the galls. During late June and July, they are fully mature and emerge from cracks in the drying gall. They molt to a winged adult form and migrate

to Douglas-fir. The galls continue to dry and become more conspicuously brown, but no longer contain aphids.

There is some evidence that local populations of Cooley spruce gall may be able to sustain a spruce-to-spruce life cycle in the absence of Douglas-fir.

Nymphs of the Cooley spruce gall adelgid exposed within gall. Photograph by W.S. Cranshaw.

Control: Late spring frosts and winds are very destructive to the overwintering stages of the Cooley spruce gall adelgid. Population cycles are highly variable due to these natural controls.

Spruce and Douglas-fir show a wide range in susceptibility to this insect. Many individual trees are highly resistant, apparently due to leaf waxiness.

Chemical controls directed against the overwintering stage females can be applied in fall through early spring. Treatments are best applied before the egg sack is produced, which typically begins in late April or early May. Effective treatments include carbaryl (Sevin), Orthene, Talstar, Tempo, and Mavrik.

Insecticidal soaps have been very effective for controlling Cooley spruce gall on Douglas-fir. However, control on spruce has been marginal.

Hand removal of the galls may be desirable from an asthetic view. However, this practice has not benefit in managing the insect.

Related Species: The eastern spruce gall adelgid, *Adelges abietis* (L.), produces a pineapple-shaped gall on the interior of branches, primarily restricted to Norway spruce. This species occurs throughout much of the northern and eastern parts of the United States and along southern Canada but is not known from Colorado.

The pine leaf adelgid, *Pineus pinifoliae* (Fitch), also makes a loose gall in the terminal growth of spruce that resembles that of the Cooley spruce gall adelgid. Galls remain green late in the season and are less conspicuous. Spruce is the primary (overwintering) host of these aphids, which infest pines during the subsequent season.

PETIOLE-GALL APHIDS

Pemphigus species
Family: Eriosomatidae

Appearance: Forms produced on *Populus* are about 1/8 inch long, whitish-green to green, with head and thorax dark. Root-feeding summer forms are covered with wax and resemble a mealybug.

Hosts: Poplars and cottonwoods are the winter host on which galls are produced. Summer stages of these insects feed on the roots of many different plants including sugarbeets, lettuce, and crucifers.

Damage: Feeding causes marble-like galls to form, usually at the base of leaves or on petioles. The sugarbeet root aphid, *Pemphigus populivenae*, can be a serious pest of sugarbeets in the region.

Thickening of the petiole produced by poplar petiole gall aphids. Photograph by D.A. Leatherman.

Life History and Habits: The various *Pemphigus* species found in Colorado have a one-year life cycle that involves alternation between a winter host of some *Populus* species, and the roots of a separate summer host.

Eggs are laid in autumn in cracks of the bark of *Populus*. The eggs hatch in spring and the nymphs (fundatrices) feed on the developing leaf petioles. Feeding induces the plants to produce a swollen overgrowth that surrounds the developing aphid. As the overwintered stage becomes full-grown, they produce young that remain in the gall until full-grown. These progeny have wings.

The galls later open along a slit, and the winged stages leave the plant during late June and July to colonize summer hosts. They develop on roots of various annual plants (e.g., sugarbeets, lambsquarters, lettuce), that they locate by following soil cracks. Several generations may be produced on these summer hosts. At the end of the summer, sexual winged stages are produced that fly back to the winter host, mate, and lay eggs.

The poplar petiole-gall aphid (*Pemphigus populitransversus* Riley) forms a spherical green gall with a transverse slit on the petiole of plains cottonwood, and is also a root aphid on cabbage family crops. The sugarbeet root aphid [*Pemphigus populivenae* (Fitch)] forms an elongated gall on the midvein of narrow-leaved cottonwood leaves and alternately attacks the roots of sugarbeets and other garden plants. There is some confusion regarding the taxonomy of this genus and other species may be present.

Control: Gall-forming causes little injury to the trees and controls have not been developed. Dormant oil applications should be able to control the overwintered eggs.

The root-feeding forms on the summer host are very difficult to control. Maintaining soil moisture to reduce soil-cracking has been the best methods for avoiding infestation.

POPLAR VAGABOND APHID

Mordwilkoja vagabunda (Walsh)
Family: Eriosomatidae

Appearance: **Adults** - Yellow-green, pear-shaped aphids, with relatively long antennae and delicate, membranous wings. About 3/16 inch long. **Nymphs** - Wingless, smaller and paler than adults.

Hosts: Aspen and other *Populus*

Damage: Aphids feeding on the developing leaves cause them to become highly-distorted, leathery leaf galls. Galled leaves tend to remain on trees and may not be visible until after normal leaf fall. Galling is concentrated on the upper third of the tree.

Life History and Habits: Similar to other gall-making aphids, the poplar vagabond aphid uses two hosts during its life cycle. The overwintering stage are eggs laid in bark crevices or old galls on aspen or other *Populus* species. Eggs hatch in spring and the aphids feed on the expanding tips of the twigs. Feeding induces twig tips to form large irregularly shaped galls within which the aphids feed and reproduce. Several generations of aphids occur within the folds of the gall, and as many as 1600 individual aphids have been reported from a single gall.

In early summer, winged forms of the aphid leave the gall and fly to a summer host. Local hosts are not known from the region, but likely are some member of the primrose family. After several generations on this host, winged stages fly back to *Populus* in early fall, mate and produce the overwintering eggs.

Associated Species: Marginal leaf curling of aspen is sometimes associated with eriophyid mites. Also, an unidentified gall midge has been found to make reddish colored leaf folds in which it lives.

Control: Controls have not been identified. Dormant applications of horticultural oils should kill overwintering eggs.

HACKBERRY NIPPLEGALL MAKER

Pachypsylla celtidismamma (Riley)
Family: Psyllidae

Appearance: **Adults** - Resembling tiny cicadas, these insects known as psyllids are about 1/8 inch long, commonly called jumping plant lice. **Nymphs** - Found within galls. Pale colored with large wing pads present by late summer. The galls on a leaf resemble nipples.

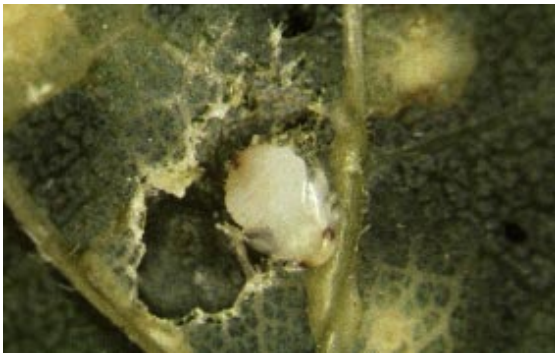
Hosts: Hackberry species (American and netleaf)

Damage: Hackberry nipplegall psyllid produces prominent warty leaf galls, sometimes nearly covering the leaf. High levels of galling are usually

restricted to only a few branches and do not produce much damage. However, the galls are sometimes considered to be unattractive.

Well developed galls produced by the hackberry nipplegall psyllid. Photograph by D.A. Leatherman.

Life History and Habits: Hackberry nipplegall psyllids overwinter as adults in protected areas. In spring as the hackberry buds are expanding, the adults emerge and deposit eggs on the undersurfaces of the leaves. Eggs hatch and young nymphs begin to feed on the leaf. An overgrowth that appears as a raised swelling on the lower leaf surface is induced by this feeding, ultimately producing the gall that covers the insect. The nymphs develop within the gall all summer and adults emerge in late summer. There is one generation per year.



Galls and exposed nymph of the hackberry blistergall psyllid. Photograph by W.S. Cranshaw.

There can a great difference in the number of galls produced on different leaves within the tree or between nearby trees. This is largely due to how synchronized the leaf development is when the adult psyllids are laying eggs and eggs are hatching since leaves are suitable hosts for only a brief period during their early development.

Controls: The hackberry nipplegall psyllid is commonly attacked by parasitic wasps that help reduce populations. The wasps remain in the old galls through the winter, emerging the following spring.

Hackberry psyllids are also common and important prey of many resident and migratory birds. Overwintering psyllids are favorite prey of chickadess, creepers, nuthatches, and other species. Migrating warblers, ruby-crowned kinglets, pine siskins, American goldfinches and chipping sparrows eat many adults in spring. Psyllids within galls are sometimes extracted by house finches, evening grosbeaks and fox squirrels.

Controls are rarely needed to protect tree health and most applications are made for aesthetic reasons. Insecticides should be applied to coincide with periods when eggs are being laid. The eggs can be easily seen on the underside of newly expanding leaves. Orthene is highly effective for control.

Related Species: The hackberry blistergall psyllid, *Pachypsylla celtidivescula* Riley, produces a gall in the form of a small raised swelling, often concentrated around the base of the nipple galls on the upper leaf surface. Life cycle of this species is similar to the hackberry nipplegall maker. Blistergall psyllids are small enough to pass through most screens and sometimes enter nearby homes during fall and can be a nuisance problem.

Another gall-maker, *Pachypsylla venusta* Osten Sacken, sometimes forms large galls on the petioles of net-leaf hackberry.

HACKBERRY BUDGALL PSYLLID

Pachypsylla celtidisgemma Riley
Family: Psyllidae

Appearance: General appearance is similar to the other hackberry psyllids such as described above. The adults are somewhat smaller than the hackberry nipplegall psyllid. Nymphs, found within the galls, are marked with black.

Hosts: Hackberry

Damage: Budgall psyllids produce an enlarged, spherical swelling of the bud tissues, killing the affected bud.

Galls produced by the hackberry budgall psyllid. Photograph by W.S. Cranshaw.

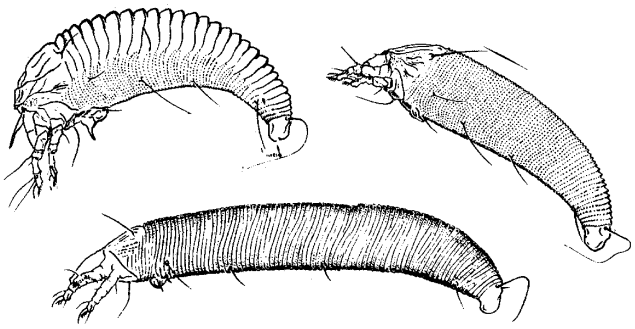
Life History and Habits: Unlike the other common hackberry psyllids, the budgall psyllid spends the winter within the gall. Adults emerge in late spring, laying eggs near the developing buds. The nymphs feed on the buds, causing them to swell and form a gall.

Related Species: Another *Pachypsylla* species produces a small blistergall on the outer bark of small branches.

ERIOPHYID MITES

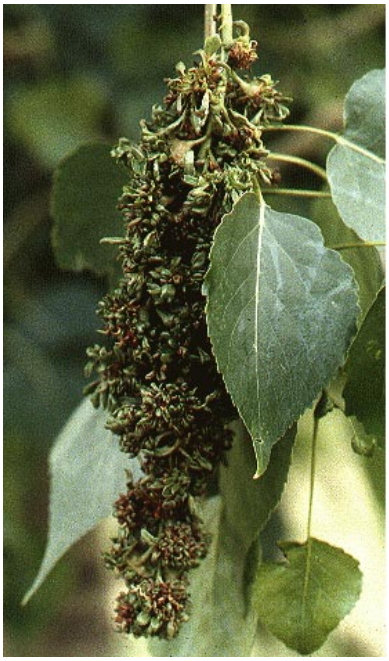
Acari: Eriophyidae

Appearance: These extremely tiny mites are characterized by having a slender body and only two pairs of legs, rather than four. There are many species in this large family, but all measure less than 1/100 inch long. Unlike spider mites they cannot be seen without a microscope or powerful hand lens.



Various forms of eriophyid mites. From USDA Agricultural Handbook 573.

Hosts: Virtually all broadleaf trees and a number of conifers are host to some species of eriophyid mite. Common species occur on the flowers of ash, the flowers and buds of cottonwood, and the leaves of aspen, plum, and chokecherry.



Catkin gall of cottonwood.

Damage: Feeding by the mites causes a wide variety of galls including: erineum galls (felty patches produced by a profusion of leaf "hairs"), spindle galls, bud galls, petiole galls, bladder galls, pouch galls, leaf blister galls, nipple galls, finger galls, and a profuse form of dense twig branching appropriately named **witches broom**. Some mites in the eriophyid family are known as **leaf vagrants** because they roam and feed freely on the leaf surface and producing injuries such as russeting, leaf reddening, or leaf margin curling.

Ash flower galls.

Life History and Habits: A generalized life history is presented here, although there may be some variation due to the large number of species in the Eriophyidae. Adult females overwinter on the trunk and branches of the tree. In spring as buds expand they migrate out to the young leaves and

begin feeding. This starts abnormal cell growth that surrounds the female in the characteristic gall. Eggs are laid in this protective site and here the immature stages feed, emerging as adults in two to three weeks. Later generations may continue to cause galls in the immediate vicinity if leaves are still developing. Many generations may occur in a year.

Finger galls produced on Prunus.

Velvety pouch on underside of aspen.

Velvety red growth on Rocky Mountain maple.

Table 6. Common deformities to woody plants caused by eriophid mites in Colorado.

Eriophyid mite	Plant injury
Pear leaf blister mite	Causes a rusty blister on leaves of pear
Apple leaf blister mite	Causes a rusty blister on leaves of apple, crabapple
Pear russet mite	Causes a russetting discoloration of pear fruit
Chokecherry finger mites (*Phytoptus* spp.)	Causes green/red gall finger galls on the upper leaf surface of chokecherry
Plum finger gall mite	Causes a green finger gall on the lower surface of wild plum
Phytoptus tiliae	Produces small finger galls on leaves of linden
Eriophyes calaceris	Produces a velvety, red growth on leaves of Rocky mountain maple
Phyllocoptes didelphis	Produces a velvety red or brown growth on leaves of aspen
Eriophyes negundi	Produces a cottony growth and pouch in leaves of boxelder
Aculops tetanothrix	Produces red or yellow pouch galls on willow
Ash flower gall mite	Produces a distortion of male flowers on ash
Cottonwood catkin gall mite	Produces a distortion of catkins on various *Populus* species
Unknown	Common leaf vagrant thought to be associated with leaf twisting of elm
Unknown	Produces a twisting of new leaves of boxelder
Unknown	Produces a curling of leaf edges on aspen
Unknown	Produces a small, yellow pouch gall on ash leaves
Aculops sp.	Involved in producing rusty color of honeylocust leaves
Poplar budgall mite	Distorts buds of poplars, cottonwoods
Eriophyes celtis	Involved in witches broom disorder of hackberry

POPLAR BUDGALL MITE
Eriophyes parapopuli (Keifer)
Family: Eriophyidae

Appearance: The mites are microscopic. They are most easily found within discolored reddish areas of the gall. They have a typical elongate form and are reddish-brown.

Hosts: Poplar, some cottonwoods

Damage: Poplar budgall mites produce large, corky, irregularly shaped galls around the buds of poplars. Since infested buds do not produce leaves, the tree can have a thin, spindly appearance following repeated heavy attacks. The knobby galls also detract from appearance of the tree.

Poplar budgalls. Photograph by W.S. Cranshaw.

Life History and Habits: Biology of this mite is not well known. The mites overwinter primarily within the galls produced the previous season, as well as in protected areas around buds. In spring feeding within the old galls continues and mites begin to move to and feed on the new buds. As the buds develop, they become distorted and cover the mites. Reproduction appears to occur throughout the growing season.

There are two nymphal stages plus the adult stage. Ten to 14 days are required to complete one generation.

Control: Predator mites are commonly associated with poplar budgall mites and presumably are important natural controls. Hard winters, which can kill the galled tissues, also appear important in limiting populations. Serious infestations rarely are sustained for long due to these natural controls.

Chemical control is difficult. The mites emerge from the galls over an extended period so repeat applications would be necessary to maintain adequate control. If attempted, sprays should be initiated before bud break. Dormant oil sprays may control mites and mite eggs near bud scales, but fail to sufficiently penetrate old galls.

ASH FLOWER GALL MITE
Eriophyes fraxiniflora Felt

Hosts: Ash

Damage: The mites greatly distort the male flowers of ash. Flower growth becomes generally disorganized and remains yellow or green, producing a highly disfigured gall. These later dry and turn brown. There is no evidence that this injury significantly damages the health of ash.

Related Species: *Eriophyes neoessigi* Keifer, the cottonwood catkin gall mite, infests the developing catkins of cottonwood, producing a large distorted growth.

Life History and Habits: The ash flower gall mites survive winters in the adult female stage under bud scales and other protected sites on the ash. As temperatures warm in spring, overwintering females commence feeding, initiate gall formation, and begin egg laying on the newly expanding buds. The tissues of the flower become disorganized and form numerus small pouches in which the mites continue to develop. In mid summer, as the galls dry, they move to the bud scales for overwinter shelter.

Control: Control has been erratic. There has been some success when effective pesticides have been applied shortly before bud break of flowers and again repeated. Dormant oils may kill some overwintered eggs.

PINYON SPINDLEGALL MIDGE
Pinyonia edulicola (Gagne)
Family: Cecidomyiidae

Appearance: **Adults** - Small, delicate flies, about 1/16 inch long, with an orange abdomen. **Larvae** - Small maggots, legless and orange that fill the gall when they are full grown. Galls are formed from the needle base, are spindle-shaped and about 1/2 inch long.

Host: Pinyon. Galls can form on bristlecone pine but the insects do not complete development.

Damage: A common gall of pinyon is the pinyon spindle gall, caused by an insect - the pinyon spindlegall midge. These galls can be found wherever pinyon grows in Colorado, although they are usually at very low levels in native pinyon stands.

Pinyon spindlegall midge adult and old galls. Photograph by W.S. Cranshaw.

Pinyon spindle galls are swellings produced at the base of developing needles. Generally there is some discoloration (yellowing, reddening) of the affected area although this may not be evident until spring. Galls kill the infested needles prematurely. By late summer such needles turn brown and drop prematurely. Following heavy infestations during which a high percentage of needles are killed, gaps in the normal pinyon foliage will appear. Established needles are not affected by the insect.

Pinyon spindle galls uncommonly cause serious damage to pinyon and are usually only a minor aesthetic problem to trees. Rarely, outbreaks occur that affect significant numbers (greater than 25 percent) of the new needles but outbreaks are almost invariably of short duration (one to two years).

Related Species: Another gall midge is also common on pinyon in Colorado, the pinyon stunt needlegall midge (*Janetiella* species). This insect also forms a swollen area at the base of the needles but can easily be separated from the spindlegall midge since it severely stunts the elongation of the needles.

Life History and Habits: Adults of the pinyon spindlegall midge are small, delicate, orange flies. These are active around the pinyon from mid-June until early-July but are rarely observed. This period coincides with the development of new needles. Mating and egg laying occurs at this time. Eggs hatch in about a week.

The immature (larval) stages of the insect are orange-yellow and feed within the gall. On the average, 6 to 15 midge larvae occur within each gall. The feeding of these insects causes the formation of the gall. Only the actively growing needles are capable of being affected by the insects and the gall growth is completed in about a month. The insects continue to grow inside the gall cavity and may nearly fill it when they become full-grown in early June.

After growth is completed, larvae of the pinyon spindle gall midge cease feeding and change to the pupal stage. During this period they produce a silken, frothy covering within the gall. The pupal stage lasts two to three weeks.

There is one generation per year of the pinyon spindlegall midge.

Controls: Except during unusually intense outbreaks, pinyon spindle galls rarely affect tree growth and control is usually not needed to protect tree health. Natural controls exist which include rainy/windy weather during adult midge activity, various parasitic wasps, and failure of the insects to properly synchronize egg laying with susceptible periods of needle growth.

Because biological controls are so important in the natural control of pinyon spindle gall midge, it is recommended that a survey be made of parasites prior to spraying. Parasites appear different from the yellow midge larvae and can be easily detected in spring. Large numbers of parasites indicate that adequate natural control will likely be effective.

Insecticidal control is best achieved if treatments are timed during periods of egg laying and early gall growth. This generally occurs in late June and can be predicted by opening galls to watch for the silking produced during pupation that precedes adult emergence.

Dimethoate (Cygon) has been the most effective insecticide for control of pinyon spindle gall midge. Sprays should thoroughly cover newly developing needles. Because this insecticide has systemic activity, it also is capable of killing many midge larvae even after galls have started to form. However, galls remain intact even after the insects are killed. Dimethoate is also highly effective at controlling the insect after galls have started to form. Because of this, treatments can be delayed until after large numbers of new galls are observed in July or early August, before significant injury is caused. These "rescue treatments" can allow for the natural controls to establish themselves. Such treatments would only

be needed if large numbers of developing galls were observed.

PINYON STUNT NEEDLEGALL MIDGE
Janetiella sp.
Family: Cecidomyiidae

Appearance: **Adults** - Small, delicate orange flies, about 1/16 inch long. **Larvae** - Small orange, legless maggots, about 1/16 inch long when mature. Eggs are very tiny, spindle-shaped and orange in color. The gall is the swollen base of a needle consisting of two compartments, and is about 1/3 of normal needle length.

Host: Pinyon

Damage: Infested needles become severely stunted. Shortened needles drop early the following spring, resulting in the serious defoliation under heavy infestations. Damaged trees are weakened and subject to attack by diseases and other insect pests. This gall is considered a problem in land-scape plantings of pinyon, but is not as common or serious as those produced by the spindlegall midge.

Galls produced by the pinyon stunt gall midge. Photograph by W.S. Cranshaw.

Life History and Habits: Larvae overwinter in the gall and pupate in early May. Adults emerge, mate and lay eggs in late May and early June. Eggs hatch in early June, then young larvae go to the base of needles where they begin feeding and produce galls. There is one generation produced per year.

Controls: Serious infestations are infrequent. Control evaluations have not been conducted with this species. However treatments that have been effective against other gall midges (dimethoate, Talstar, diazinon) are likely to be effective against this species when applied during the egg laying period.

STUBBY NEEDLEGALL MIDGE
Contarinia coloradensis (Felt)
Family: Cecidomyiidae

Appearance: **Adults** - Mosquito-sized, delicate flies. **Larvae** - Orange, legless maggots. Eggs are tiny, torpedo-shaped and milky in color. The gall is a globular growth at the base of the needle which is severely shortened.

Hosts: Ponderosa pine

Damage: Insect feeding stunts the needle forming a rounded gall. Galled needles die at the end of the first summer and heavy infestations can affect the appearance and vigor of the tree. However, serious outbreaks are very uncommon.

Galls produced by the stubby needlegall midge. Photograph by D.A. Leatherman.

Life History and Habits: Adults emerge from soil litter from mid-April to June. Females lay eggs in small masses on developing needles. These eggs hatch into larvae that begin feeding on the needle, producing a gall in which they become enclosed. Adults emerge from galls in late summer and move to overwintering protection. There is one generation per year.

Controls: Serious infestations are rare and treatments are not likely to be warranted. Control evaluations have not been conducted. However, treatments that have been effective against other gall midges (dimethoate, Talstar, diazinon) are likely to be effective against this species when applied during the egg laying period.

GOUTY VEINGALL MIDGE

Continaria negundinis (Gillette)
Family: Cecidomyiidae

Hosts: Boxelder

Damage: The midge larvae feed on the expanding leaves, causing them to thicken and curl. Later, these leaves turn yellow and may drop prematurely. Damage is generally minor, although it can be conspicuous.

Thickening of the midrib of a boxelder leaf produced by the gouty vein gall midge. Photograph by W.S. Cranshaw.

Related Insects: The ash midrib gall midge, *Contarinia canadensis* Felt, can produce a thickening along the midrib of ash leaves. The chokecherry gall midge, *Continaria virginianae* (Felt), causes the fruit of chokecherry to swell and form a hollow pouch in which the midges feed. Life history is likely similar for these species.

Life History and Habits: The gouty vein gall midge has one generation per year. Winter is spent in the pupal stage around the bases of previously infested trees. The adult midges emerge in spring, about the time that new leaves are emerging on boxelder trees. Females insert their eggs into small folded leaflets.

The young midges feed on the developing leaflets, causing them to curl and thicken. They usually have completed development by early June, at which time they drop to the soil and burrow into the soil. Their they produce a small cocoon in which they pupate.

Controls: Controls are not recommended since only a small amount of the leaves are ever damaged. Several natural enemies are reported to attack the midge including parasitic wasps and predatory bugs.

HONEYLOCUST PODGALL MIDGE

Dasineura gleditschiae (Osten Sacken)
Family: Cecidomyiidae

Appearance: **Adults** - Small, delicate gray flies, about 1/8 inch long. **Larvae** - Small, yellowish, legless larvae, found only within the pod galls. **Gall** - Thickened pod-like swellings of honeylocust leaves.

Hosts: Honeylocust

Damage: Larvae feed on developing leaves causing the production of thickened pod-like galls that dry and fall after about two months. Most damage is cosmetic, but repeated attacks may cause early defoliation and twig dieback. In some cases, attacks that kill most growing points result in a thickened club-like swelling of the twigs.

Severe galling produced by the honeylocust podgall midge. Photograph by W.S. Cranshaw.

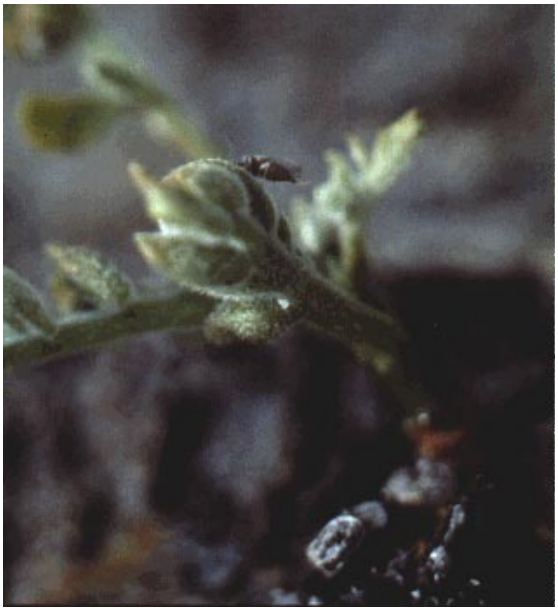
Life History and Habits: Honeylocust podgall midge spends the winter in the adult stage under protective cover around previously infested honeylocust plantings. They fly to honeylocust and lay eggs as soon as buds start to break. The newly hatched larvae feed on the developing leaves, which fold over and enclose the midges. They become full grown in about three to four weeks and pupate within the gall. The adults emerge from the gall, often pulling out the old pupal skin.

There are typically about three generations per year, with populations usually declining by early July. Later infestations may extend for additional generations where sprout growth continues to be produced or in highly fertile sites.

Controls: Several natural controls are present for this species. Parasitic wasps are important natural enemies later in the season and predatory plant bugs feed on the larvae.

Competition has also been an extremely important control. During outbreaks, excessive egg laying on the new growth can cause leaves to prematurely abscise, killing the larvae. Honeylocust plant bug also competes with the honeylocust podgall midge, killing the new growth needed by the developing midges.

Talstar is highly effective against this species. Mavrik and diazinon also have some activity. Treatments of all products need to be applied during periods of egg laying and egg hatch.



Adult honeylocust podgall midge visiting new growth on which eggs are laid. Photograph by W.S. Cranshaw.

WILLOW CONEGALL MIDGE
Rhabdophaga strobiloides Osten Sacken and other species
Family: Cecidomyiidae

Hosts: Willow

Damage: The larvae feed on the terminal growth of willow and prevent the stems from normally elongating. This causes compact growth of the leaves somewhat resembling a cone.

Life History and Habits: The adult midges emerge in late April or early May and lays an egg on the terminal bud as it begins to swell. Feeding by the larva causes the bud to cease further develop, remaining bud-like but still capable of directing plant nutrients to the tissues. The bud swells as the small fly larva develops within a cavity in the bud. The larva spends the winter in the gall, pupates in the early spring. There is one generation produced per year.

Many other insects may later feed on and develop within the galled tissues.

Willow cone gall. Photograph by W.S. Cranshaw.

Control: Controls are not warranted and have not been identified. Chickadees and other birds eat them during the winter.

JUNIPER TIP MIDGE
Oligotrophus betheli (Felt)
Family: Cecidomyiidae

Appearance: **Adults** - Typical gall midge appearing rather like a miniature (1/30 inch) mosquito. **Larvae** - Pale colored maggots found within the gall.

Gall produced by the juniper tip gall midge. Photograph by W.S. Cranshaw.

Hosts: Juniper

Damage: The developing larvae produce a reddish or yellow gall on the tips of juniper that

appears as a rosette of leaves. These tips prematurely die.

Life History and Habits: Winter is spent in the larval stage within the gall. They pupate in spring, emerging from the gall as adult midges. Females mate then lay eggs on the new foliage. After egg hatch, the young larvae move to the branchlet tips and feed on the developing growth, inducing production of the characteristic gall.

Control: None have been developed for this insect nor appear needed.

POPLAR TWIGGALL FLY

Hexomyza (= Melanagromyza) schineri (Giraud)
Family: Agromyzidae

Appearance: **Adults** - A stout-bodied, shiny dark fly, about 1/6 inch long. **Larvae** - Pale yellow maggots, found within the gall. **Gall** - A spherical swelling on the twigs of aspen and poplars at the base of buds.

Hosts: Primarily aspen, but poplars may also be attacked

Damage: The poplar twiggall fly produces a spherical gall on the new twigs. This gall remains in place and continues to grow and enlarge as the plant develops, giving the plant a gnarled and knobby appearance. Galls do not appear to significantly weaken plants. Occasionally Cytospora canker may develop around a gall.

The galls are in the form of smooth swellings on the current season twigs. Obscured by leaves, these original galls are rarely noticed until autumn leaf fall. However, what attracts attention and particular concern is that galled tissues continue to grow and swell. Ultimately galls appear as large knots on trunks and larger branches, giving the plants a gnarled, bonsai-like appearance. Serious galling has been limited to aspen. However, it has been visible on other *Populus* species.

Apparently the fly is native to the region or at least has been present for a long time. For example, museum records of the species in Ft. Collins date to 1914. However, outbreaks began to attract attention in the mid 1980's. Originally, problems seemed limited largely to the southern Metro Denver area but recently there has been an extensive expansion of the outbreak so that it currently extends across the Front Range of Colorado.

Adult of the poplar twiggall fly (top) and its primary parasite (bottom). Photograph by W.S. Cranshaw.

Areas galled by the poplar twiggall fly usually continue to grow although growth of buds adjacent to the galls is inhibited. During subsequent seasons the galled area becomes incorporated into the growing twigs and branches, ultimately appearing as large swollen bands on trunks and branches. Although these old injuries produce a permanent disfigurement of the trunks, they do not appear to threaten tree health.

Galling of aspen produced by the poplar twiggall fly. Photograph by W.S. Cranshaw.

Life History and Habits: The poplar twiggall fly overwinters within the gall as a full-grown, yellow-green maggot. Pupation occurs in late winter or early spring, within the gall. The majority of the pupae then drop to the ground.

At the time that the new growth is forming, the adult flies emerge from the pupae and become active. During the day they may easily be found resting and sunning themselves on leaves. After mating females move to the developing twigs and insert eggs into the stems. The larvae then hatch from these eggs and produce the distinctive swelling in response to their feeding.

Areas below buds appear to be particularly favored sites for galls to be produced. As the stems continue to grow, the area where eggs were laid becomes increasingly swollen. At first, the swelling involves a fairly indistinct enlargement. However, within two months the full sized gall is usually present.

The developing gall fly is a greenish-yellow mag-got that grows slowly within the gall all summer. It is very difficult to find until late summer and fall when it grows rapidly, filling a small cavity within the swollen area of the twig. Individual galls typically contain two to three larvae.

There is primarily one generation per year. Some observations indicate that a few flies may have a second generation during seasons that are unusually warm and allow a period of extended development.

Related Species: Another species of *Hexomyza* makes small swellings in the twigs of willow.

Control: At least one biological control organism does occur naturally. A small chalcid wasp, *Eurytoma contractura* Bugbee, parasitizes and commonly kills large numbers of the poplar twiggall fly. Observed parasitism rates typically range from 20 to 30 percent but have exceeded 80 percent in some years. Predation of the pupae by chickadees and other birds also occurs.

The adult wasps emerge from the galls about two weeks after the adult flies first appear. Life cycle has not been developed but apparently they are larval parasites that first attack the poplar twiggall fly shortly after egg hatch.

Problems with poplar twiggall fly are most severe in succulently growing stands of aspen. It is likely that managing aspen so that growth is more moderate will result in retarded rates of gall production.

Removal of galls is commonly considered by homeowners. However, this has limited potential for control. Pruning would often require substantial branch destruction. Furthermore, it may be counter-productive if done after flies have emerged in late winter. In that case, pruning will primarily remove only those galls containing the chalcid wasp parasite of the poplar twiggall fly, decreasing the effectiveness of natural controls.

Attempts to control the poplar twiggall fly on aspen with insecticides have shown little success. Trials conducted in 1987-1991 demonstrated no effectiveness with Sevin, Talstar, Tame, or Margosan-O. Furthermore, many insecticides registered for use in landscape plantings have shown phytotoxicity problems on developing aspen leaves.

However, one effective treatment was finally identified in 1990. Abamectin (Avid) applied during the period when eggs are laid in mid-spring gave excellent (95 percent+) control in a preliminary study. This has since been repeated in two 1991 studies where control rates of 90 percent have been achieved. Avid is currently registered only for nursery use.

RABBITBRUSH GALL MAKERS

Aciurina bigeloviae (Cockerell), other *Aciurina* spp., *Procecidochares* spp.

Family: Tephritidae

Appearance: Adults are small "picture-winged" flies with patterned or generally dark wings. Larvae are pale-colored maggots found within plant galls.

Hosts: Rabbitbrush

Damage: Several different gall-forming fruit flies make galls on the stems and buds of rabbitbrush. Perhaps the most conspicuous are cottony swellings of the buds. Others produce green flower-like growth of leaf axils or sticky globular swellings on stems. These do not appear to damage the plant but attract attention when plants are in landscape settings.

Life History and Habits: The gall makers on rabbitbrush are generally similar in habits to the gall midges. Overwintering typically occurs as a partially grown larva within the gall. They complete development and adults emerge during periods when the plant is actively growing. After eggs are laid, the developing larvae stimulate gall development by their secretions and feeding activities.

Cottony gall produced on rabbitbrush by gall flies. Photograph by W.S. Cranshaw.

Control: Controls have not been developed nor are needed. If galls are considered unattractive, they may easily be pruned out. In native stands of rabbitbrush, these gall makers are heavily parasitized by several species of wasps. Also, several gall midges may also develop within the gall, competing with the flies creating the gall.

ROSE GALL WASPS

(*Diplolepis radicum* (O.S.) and other *Diplolepsis* species
Family: Cynipidae

Appearance: **Adults** - Small black wasps, less than 1/8-inch long. **Larvae** - Small white 'grubs' found in chambers within the galls they induce in the plants.

Hosts: Rose. Species, rugosa, and old garden roses are most commonly galled.

Damage: Several species of gall wasps are associated with *Rosa* species, producing bizarre growths on leaves and stems known as galls. The galls may take the form of balls, spikes, or mossy growths. Little plant injury occurs from these galls, and they are primarily a curiosity. However, growth may stop beyond the point of galling.

Life History and Habits: Gall wasps overwinter in cells within the interior of the galls. They pupate in spring, within the gall. Adults emerge in mid-spring, emergence synchronized with the presence of actively growing rose shoots. Adults are small, inconspicuous dark wasps, and females lay eggs at the base of axillary buds. The newly hatched larvae on the stem and cause it to deform into the characteristic gall, in which they grow and develop. There is one generation per year.

Rose gall.

Controls: Other species of wasps that do not make their own galls (inquilines) often take over the galls and kill the developing gall wasps. Several parasitic wasps also attack them.

Old galls can be hand-picked and destroyed before adult insects emerge in spring.

GALL WASPS ASSOCIATED WITH OAK

Of all the insects that produce galls on woody plants, none are so numerous and diverse as the various gall wasps (Cynipidae) associated with oak. In the United States and Canada, over 550 different types of galls have been recorded from oak (76 percent of all types of galls produced by insects and mites).

Most galls on oak are produced on leaves or twigs. Common leaf galls found in Colorado take the form of small pale-colored balls, reddish cup-like swellings, bright-red raised areas along the veins, or woolly patches. The woody galls found on oak twigs include 'bullet' gall forms, that resemble a chocolate drop, or generally round balls. Galls on oak leaves are generally innocuous, although they can be a considerable curiosity. However, some of the twig galls are associated with twig dieback.

The life cycles of gall wasps can be very complex, with alternating forms and types of galls produced by some species. For example, many of the twig galling species spend the winter in the woody galls, and only females are found in these galls. They emerge in spring and lay eggs in young leaves. Galls

A common ball-shaped leaf gall on oak. Photograph by W.S. Cranshaw.

along the leaf veins are formed by this stage, which involve both males and females. These emerge in midsummer and females insert eggs into the twigs. The developing gall wasps feed on the twigs, producing the gall. However, gall development is slow and it may take almost two years for the wasp to complete this development cycle, emerging in spring of the second year.

Intensity of attacks by gall wasps is highly variable. Much of this is related to how much susceptible new growth is present when the insects are laying eggs. Gall wasps are also heavily parasitized by other wasp species.

Effective controls have not been developed for gall wasps. Insecticide applications, if attempted, should be synchronized with periods when adult wasps emerge from galls and are laying eggs.

ROUGH BULLET GALL WASP

Disholcaspis quercusmamma (Walsh)
Family: Cynipidae

Appearance: **Adult** - Small, dark heavy-bodied wasp, less than 1/8 inch. **Larvae** - White and grub-like found within the gall.

Hosts: Bur oak, swamp white oak

Damage: The larvae produce large a characteristic gall on twigs. Galls are woody, generally rounded, with a slight point. Very heavy infestations can occur that largely cover twigs, reducing growth rate of the tree. Following leaf drop, the galls can be highly conspicuous. The galls also produce a sweet material that is attractive to bees and wasps.

Rough bullet galls produced on the twigs of oak. Photograph by D.A. Leatherman.

Life History and Habits: Life history is poorly understood. Females emerge in late October and early November, after a hard frost. Eggs apparently are laid in the terminal growth during the fall.

In late spring, the developing insect stimulates a pocket of stem tissue to produce a large rounded gall, in which the young wasp develops. Galls are pale brown and soft in early stages, later darkening and hardening. Only a single wasp develops in each gall, although sometimes other insects (inquilines) also share the gall. The larva pupates within a small cell in the center of the gall, emerging in early fall. Only females are known from this species. There is one generation per season.

Controls: None have been developed. Some individual trees appear to be resistant to attack, particularly those that have less fluted bark. Removal of galls **before** the wasps emerge may be useful controls on smaller trees.

Insecticide applications, if attempted, may give best control when applied during the period of adult emergence, to prevent subsequent egg laying. THis occurs in late October or early November.

Natural enemies, such as parasitic wasps, are common and can be important in control. Since these wasps emerge in spring, removing galls during winter and spring, after the gall wasps have emerged, will have the adverse effect of destroying natural enemies, while not affecting the gall wasp. Emerging parasites produce a smaller emergence hole than do the gall wasps.

WILLOW GALL SAWFLIES

Euura species
Family: Tenthredinidae

Appearance: **Adult** - Small, pale brown wasps, varying in size from about 3/20 to 3/10-inch **Larvae** - Pale yellow-green with black eyes and head tinted brown.

Hosts: Willow

Damage: Several sawflies in the genus *Euura* form galls in the stems, twigs, or leaf petioles of willow. The swellings can become extremely numerous in willow thickets but do not appear to cause significant injury.

Life History and Habits: Winter is spent as prepupae in cocoons at base of plant or sometimes within the old gall. Adults emerge in spring, usually over a period of about two to three weeks. They live for only a few days, but during this time the females insert their eggs into the developing stems of willow, and the act of oviposition induces rapid swellings to occur. Larvae develop within the stem gall, and sometimes several larvae will occur in a single gall, and there can be a great range in size. Most species emerge from the gall in late summer and move to cover on the ground. Others may cut an emergence hole in late summer, later emerging in spring. There is one generation per year.

Controls: None have been developed nor do they appear needed. The larvae are heavily parasitized.

Swellings of twigs produced by gall wasps on willow.

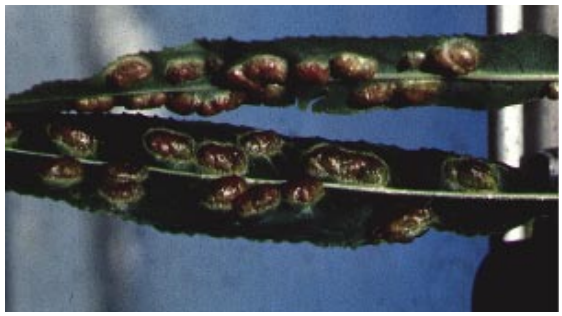
WILLOW REDGALL SAWFLY

Pontania proxima (Lepeletier)
Family: Tenthredinidae

Appearance: **Adult** - Typical, sawfly adult form, a heavy bodied, non-stinging wasp. **Larvae** - Most are pale cream color, but some are greenish with dark heads. Typical sawfly larval form and usually found within the closed galls on willow leaves.

Hosts: Willow

Damage: The willow redgall sawfly produces a pronounced, reddish swelling on the leaves of willow. This can be highly conspicuous but does not appear to seriously affect the health of the tree. High levels of galling are rarely sustained for more than a couple of seasons.



Leaf galls produced by the willow redgall sawfly. Photograph by W.S. Cranshaw.

Life History and Habits: Winter is spent in the pupal stage, in soil or under protective debris. Adults emerge in spring and lay eggs in young, emrging leaves during late spring and early summer. At this time the female wasps also lay down chemicals that initiate formation of gall tissue. (Galls can be produced following oviposition even if the larvae subsequently die.) The developing larvae feed on the soft tissues within the gall, later moving into firmer tissues to feed but remaining within the gall. When full grown, they drop to the ground and spin a cocoon. They may then transform to the pupal stage or remain in the gall; soil moisture has been shown to affect this stage in related species. Ones that pupate produce a second generation that similarly confines attacks to the new growth. Others may remain dormant until the following season. Typically there are probably two generations per year under Colorado conditions.

Related Species: The related species *Pontania s-pomum* (Walsh) creates prominent, red ball-like

swellings on willow leaves that develop in small clusters. Occasionally, similar fleshy leaf galls are produced on currant or gooseberry by an unknown species.

Control: Since this species does not appear to serious affect the growth of willow no applied controls have been developed.

The developing larvae are heavily parasitized by various parasitic wasps. Also many other insects may also utilize the galls in their development and incidently kill the developing willow redgall sawfly larvae.

Willow leaf galls produced by the sawfly Pontania s-pomum. Photograph by D.A. Leatherman.

TIP MOTHS, TWIG AND TERMINAL BORERS

Several species of insects attack terminal growth of woody plants, usually causing dieback of terminal growth. Most common are the larvae of various moths, although the white pine weevil can be very damaging to spruce at higher elevation areas.

Tip moth control requires that the insecticide cover susceptible terminals at the time of egg laying and egg hatch. Often this coincides with shoot elongation, although it varies with different insect-host plant combinations.

For some species pheromone traps are available to identify flight and egg laying periods. Because the insecticide is being applied to expanding tissue, repeat applications are often required. Insecticides with systemic activity (e.g., Orthene, Cygon) are standard for the treatment.

Some measure of control could be gained by mechanically destroying tip moth pupae of species that overwinter just beneath the ground line. Typically these species, such as the common southwestern pine tip moth, have pupae that attach themselves to the root collar of the extreme lower trunk by means of plasterlike cocoons. Use care not to injure the bark of the tree, as wounds in these areas are ideal for invasion by harmful fungi.

Tip moth injuries are typically much more conspicuous than they are actually damaging. As the plants recover, there is often little long-term injury, other than slight increased bushiness at the injury site or curve in the stem as it continues to grow. However, tip moths do occur as serious pests of landscape plants in some areas (e.g., Nantucket pine tip moth in the Albuquerque area) and their effects on tree growth can be significant in forest production and in Christmas tree plantations.

Tip moth populations tend to be highly cyclic. Several natural enemies, primarily parasites, act to reduce the survival of the tip moth larvae and can be highly effective.

Specific control suggestions appear in the supplement with section related to tip moths and other insects affecting terminal growth detailed under **Southwestern pine tip moth**, **Pinyon tip moths/Pinyon nodule maker**, and **White pine weevil**.

SOUTHWESTERN PINE TIP MOTH

Rhyacionia neomexicana (Dyar)
Family: Tortricide

Appearance: **Adults** - Small moths with mottled reddish patterns on forewings and light tan-colored hind wings; wingspan of about 3/4 inch. **Larvae** - Reddish-orange to yellow caterpillars, about 1/2 inch long when mature. Head capsule and anal plate are light brown.

Hosts: Several species of pines, particularly Austrian and mugho. Scots, ponderosa, and bristlecone (foxtail) are occasionally attacked.

Damage: Larvae mine and kill new shoots causing them to brown and crook. Heavy infestation for consecutive years may retard growth, leaving trees short and bushy.

Pine tip moth injury to terminals of pine. Photograph by D.A. Leatherman.

Life History and Habits: The southwestern pine tip moth spends the winter as a pupa, in plaster-like cocoons attached to the base of the trunk. Adults emerge from early to mid spring, typically laying eggs as new needles emerge (candling stage). Eggs hatch in 14 to 21 days, and small larvae first feed inside a needle. Later feeding occurs inside needle sheaths or buds and eventually hollows out growing shoots. Larvae mature by mid-summer and then

usually drop to the ground to pupate. There is one generation per year.

Controls: Several parasites attack the tip moths, and outbreaks tend to be highly cyclical due to these natural controls.

Insecticide treatments should be applied during the period when eggs are being laid and newly hatched larvae and eggs are exposed. This typically occurs during the early candling stage, when needles are emerging from new shoots. Chlorpyrifos (Dursban), Orthene, and dimethoate (Cygon) are effective for control of this species.

Related Species: At least eight other species of *Rhyacionia* are found in Colorado including the western pine tip moth [*R. bushnelli* (Busck)] and the ponderosa pine tip moth [*R. zozana* (Kearfott)]. The western tip moth has somewhat different habits than the southwestern pine tip moth in that pupation occurs within the damaged shoot, rather than around the root collar, and they may have two generations per year.

Other tip moths are common on pinyon (see following).

PINYON PITCH NODULE MOTH

Retinia (= Petrova) arizonensis (Heinrich)
Family: Tortricidae

Appearance: **Adult** - a rusty brown moth with a wingspan of approximately 3/4 inch. Forewings are mottled with brown, white, and silver scales. **Larvae** - Reddish-yellow caterpillars with a black head and dark area behind the head. **Pitch nodule** - Pitch nodules are rounded, smooth and often light purple or red color.

Nodule of pitch at the feeding site of the pinyon pitch nodule maker. Photograph by D.A. Leatherman.

Host: Pinyon

Damage: Larvae feed on terminal growth, causing twig dieback. A characteristic nodule of purple-red pitch is produced around the feeding site.

Life History and Habits: Winter is spent as a partially grown larvae within the characteristic nodules of pitch. Feeding resumes in spring followed by pupation in late spring. Adult flights typically peak in late July and early August. Eggs are laid on needle sheaths and the newly hatched larvae feed first on the young needle tissue before tunneling into shoots. There is one generation per year.

Controls: Individual larvae can be fairly easily located in pitch nodules during late spring, picked and killed from small plantings. Plants that are being used for new landscaping should be checked and receive some such treatment, since this species can cause significant damage in some settings.

Preventive insecticide applications should be applied during midsummer, the only time when the larvae are exposed on the exterior of the twigs.

Related Species: Another related tip moth, *Petrova metallica* (Busck), attacks terminal growth of ponderosa pine and is found statewide. In pinyon, the pinyon tip moth [*Dioryctria albovittella* (Hulst)] often kills terminals but does not make the same pitch nodule. Discussion of latter follows the next page.

COTTONWOOD TWIG BORER

Gypsonoma haimbachiana (Kearfott)
Family: Tortricidae

Appearance: **Adults** - Ash-gray moths with a two-toned forewing and a wingspan of about 5/8 inch. **Larvae** - Dirty gray caterpillars with brown heads, about 5/8 inch long at maturity. The caterpillars are almost invariably found within tunnels in the terminal growth of infested *Populus*.

Hosts: Cottonwood and other poplars

Damage: The larvae tunnel into new shoots causing branch tip dieback. Long-term infestations lead to a distorted branching pattern, particularly characterized by bushiness. Excessive twig shedding can also become a significant nuisance problem.

Life History and Habits: The overwintering stage in Colorado is apparently a very young larva, which makes small pits in the bark, often near old

leaf scars or tunneling wounds. Some older larvae may overwinter within hollowed out terminal buds.

Larvae resume activity in spring, boring into actively growing shoots, tunnelling down the pith. When full-grown (late May-early June), they emerge and crawl down the trunk, pupating in protected sites on trunks and branches. Adults emerge in about 8 to 10 days and females typically lay eggs on the upper leaf surface. The very young larvae first feed on the midrib or vein of leaves. Later, they migrate to twig tips and begin tunneling. The twig tunneling phase takes about a month to complete. There are probably two or three generations produced per year.

Control: Several species of birds feed on the larvae within tunnels. Presumably, this species is attacked by various insect parasites.

No chemical controls have been identified. Dormant applications of oils should provide some control of overwintered larvae on bark. Foliar sprays of insecticides effective against Lepidoptera (e.g., carbaryl/Sevin, Tempo, Talstar, Mavrik, Dursban) applied shortly before bud break should also provide sufficient residue activity to kill larvae as they first become active. Because of the multiple, overlapping generations of this species, it will be difficult to precisely time treatments during the growing season.

PEACH TWIG BORER

Anarsia lineatella Zeller
Family: Gelechiidae

Appearance: **Adults** - Small steel-gray moths with white and black scales, wingspan about 5/8 to 3/4 inch. **Larvae** - Pinkish red to dark brown caterpillars, about 5/8 inch long when mature.

Hosts: Peach, primarily. Other stone fruits and apple are rarely infested.

Damage: Larvae burrow into the developing twig tips, killing them back three to four inches.

Life History and Habits: The peach twig borer overwinters as a partially grown caterpillar, protected in a small silk-covered cell on the bark of fruit trees. In early spring, the caterpillars become active, migrate to the twigs and tunnel the buds and emerging terminal growth. The damaged new growth typically wilts and dies (flagging). The caterpillars then pupate in the tree and emerge as moths in May.

The emerged moths lay eggs on the twigs, small leaves, and developing fruits. The caterpillars usually first feed on terminal growth of twigs, later moving to fruits shortly after the pits start to harden. After becoming full-grown, these caterpillars pupate on the trunk and larger branches. Moths that emerge from this second generation lay eggs on the fruit. Caterpillars restrict their feeding to the fruit at this time, causing most crop injury. (Apricots, which fruit earlier than peaches, are damaged more by the first generation.)

After the caterpillars become full-grown, there is a third generation. This produces that overwintering larvae, and no significant injury is caused by it.

Twig dieback caused by tunneling of the peach twig borer. Photograph courtesy of Clemson University.

Control: Several different species of parasitic wasps commonly attack peach twig borer and may kill 50 percent or more of the caterpillars. In addition, caterpillars exposed on leaves or bark are susceptible to general predators such as green lacewing larvae and damsel bugs.

Dormant oil or lime-sulfur sprays used for control of other insects and diseases also can kill many of the overwintering larvae on the tree. Sprays of several other insecticides, applied just prior to bloom can effectively kill the caterpillars as they begin to emerge from their overwinter shelters and move about on the tree. (Insecticides should **never** be applied during bloom to protect pollinating insects, such as honeybees.)

The moths are small (about 1/4 inch), and ash-grey. They are rarely observed but can be easily captured in pheromone traps baited with the peach twig borer lure. This can help to better time sprays used for control of the insect later in the season.

There is promising research indicating that the 'male confusion' method, involving permeating the air with the female insect's sex pheromone to inhibit mating, might be useful to control peach twig borer in isolated orchards or plantings. These products are currently in development and have not yet been marketed.

Additional Publications: Colorado State University Publication XCM-41, *Colorado Tree Fruits: Pest and Crop Management Guide*, provides annually updated recommendations for controlling this species in orchards.

PINYON TIP MOTH
Dioryctria albovittella (Hulst)
Family: Pyralidae

Appearance: **Adults** - Small grayish moths with forewings marked in a zig-zag pattern and a wing-span of about 1 inch. Hindwings generally grayish white. **Larvae** - Older larvae are light golden brown in color with a dark brown head capsule. Full-grown larvae reach approximately 3/4 inch in length.

Larva of the pinyon tip moth exposed in damaged terminal.

Host: Pinyon

Damage: Larvae feed on terminal growth causing twig dieback. Cones may also be infested.

Life History and Habits: Overwintering stage is a first instar larva found within a small silk cocoon (hibernacula) on the bark. In mid to late May the insects begin to feed by tunneling into base of un-opened buds. As insects grow they mine the pith of the terminal growth. Large amounts of pitch and silk may collect at the wound site. Large larvae often leave the original wound site and move to new tissue, cones, or new shoots. Pupation takes place in the terminals and cones. Adult flights and egg laying occur primarily from late June through August. There is one generation per year.

Controls: Control should be timed for periods when the larvae are exposed on the plant. This occurs both in midsummer, after egg laying, and again in May as they become active and begin to enter stems. For specific controls see the sections on the supplement on **Pinyon tip moth/Pinyon pitch nodule maker**.

Related Species: Other damaging species of *Dioryctria* in Colorado include the pinyon pitch mass borer (*D. ponderosae* Dyar) and Zimmerman pine moth [*D. zimmermani* (Grote)]. These trunk and branch borers are discussed in a separate section. Non-damaging species also feed on cones. Discussion of the other common tip moth of pinyon, the pinyon pitch nodule maker (*Petrova arizonensis*), occurs above.

WHITE PINE WEEVIL
Pissodes strobi (Peck)
Family: Curculionidae

Appearance: **Adults** - The adult stage of the white pine weevil is a small (1/4-in) snout beetle flecked with brown and white patches. A feature it shares with other weevils is the long, curved snout with elbowed antennae arising from it. **Larvae** - Almost identical to those of bark beetles, looking like a grain of cooked white rice. The larval head is brown. The larvae are found within the terminal growth of spruce.

Hosts: Colorado blue spruce, Engelmann spruce. White pine is the common host in eastern states.

Damage: White pine weevil is sometimes the most serious insect pest of Colorado blue spruce in landscape plantings, particularly at the higher

elevations. In other parts of the U.S. this insect is also an important pest of white pine. Feeding by the developing insects causes the top terminal (leader) to suddenly wilt and die in early summer. Upper branches are affected less frequently. This damage can subsequently result in a bushy, deformed tree that may be considered aesthetically undesirable.

Immature stages (larvae) of the white pine weevil feed underneath the bark of the spruce leader, girdling the plant. When sufficient damage has been done, the top growth will wilt and curl, becoming completely dead in a few weeks. Only the top leader and upper branches are affected by the insect and damaged leaders have an overall characteristic appearance involving a "shepherd's crook" appearance with the needles turning a gray-blue color. Often, at the base of the damaged growth, there are small (1/8-in) round exit holes in the bark made by the emerging insects.

Flagging of the top leader of spruce due to injury by the white pine weevil.

Once the top leader is killed, some side branches will change their growth habit and begin to grow upwards to take the place of the killed leader. If successful, these new leaders will form main trunks and multiple main trunks will occur above the damaged area. This changes the form of the tree from its normal tapering growth to one that is more densely bushy. This can be considered to detract from the appearance of the tree.

Life History and Habits: The insect overwinters in the adult stage, under leaf litter and in other protected areas. After snow melts and temperatures begin to warm, (mid-March to early May) the weevils become active and females seek out spruce trees. They feed on the cambium of main branches near the leader and insert eggs into the feeding cavities that are formed. Small points of oozing pitch on the main leader are indicators of this feeding and egg laying activity.

Eggs hatch in one to two weeks and the young grubs (larvae) tunnel downward underneath the bark. Damage increases as the insects grow and wilting starts to become noticeable in June and July.

When full-grown, the white pine weevil larvae tunnel deeper into the stem and form a cocoon made of wood chips in which they pupate. In about two weeks the adult beetles emerge through small holes they chew through the bark. The chip cocoons remain behind and are a useful means of diagnosing old white pine weevil injury.

Adult weevils feed on the needles, buds and twigs of spruce for several weeks before going into a dormant condition for overwintering. Some minor chewing injury to buds may result if infestations are severe.

Typical chip cocoons produced under the bark by pupating white pine weevils.

Related species: A closely related weevil species, *P. terminalis* (Hopping), occurs in the tops of lodgepole pine.

Another weevil associated with pines is *Magdalis lecontei* Horn. Adults are metallic blue-black snout weevils that may be found feeding on the foliage of pines in spring. The larvae apparently develop under the branches of various pines but only attack wood that is dead or in severe decline.

Control: Small spruce trees in open locations are most susceptible to white pine weevil. If some shading can be provided until the trees become 12 to 15 feet high most attacks can be avoided.

Insecticides applied in spring when adult weevils feed on trees and lay eggs can provide control. Standard bark beetle or wood borer insecticides should provide control if used at rates labelled for the above insects. These include the insecticides carbaryl (Sevin), chlorpyrifos (Dursban), and lindane. (Note: Metasystox-R, formerly recommended for control of this insect, is no longer labelled for spraying of trees.) Timing of these treatments will vary by location and year but usually should be

made in late March or early April. Only the upper areas of the tree need to be treated.

Mechanical removal of infested terminals while the insects are still present can provide some future control if other sources of weevils are not in the area. This is best done in June or July before adult emergence. Infested terminals should be destroyed since weevils can survive in pruned wood. Terminals should only be cut as far down as necessary to remove the weevil larvae, rarely much past the first whorl of branches.

If top growth has been killed, proper training of a single side branch as a replacement leader can help to salvage the future appearance of the tree. Often several side branches will begin to grow upward and the healthiest of these should be favored. Temporarily binding competing shoots or pruning the tips of competing shoots will allow for a single leader to again be established. This new leader should be annually protected with insecticides until the tree is no longer highly susceptible to attack. Such a decision can be based on the incidence of attacks to hosts in the area.

GOUTY PITCH MIDGE

Cecidomyia piniinopis Osten Sacken
Family: Cecidomyiidae

Appearance: **Adults** - A small, delicate fly, typical midge form. **Larvae** - Bright red or orange-red maggots, often found in groups, within pockets of pitch on twigs and small branches.

Hosts: Pines, particularly ponderosa pine

Damage: The midge larvae feed under the bark of shoots, in small resin-filled pockets. Light infestations may cause little damage or minor distortion of the bark around the pitch pocket. Heavy infestations can girdle and kill the terminals. Evidence of dieback progresses through out the summer and by late summer needles or entire terminals may be killed.

Young trees are particularly susceptible. Conditions causing twigs to be sticky tend to greatly increase attacks by this insect.

Wounds caused by pitch midge may later be attractive to other insects, such as pinyon pitch mass borer.

Related Insects: Other species of pitch midges occur in the United States. At least one, *Cecidomyia resinicola* (Osten Sacken), is thought to occur in Colorado. Life cycle is likely similar to that of the gouty pitch midge.

Life History and Habits: The gouty pitch midge spends the winter within pitch pockets on the bark of twigs. In spring, they move to the base of needles and spin a cocoon in which they pupate. Adult midges emerge in spring, shortly after the new shoot have emerged, and lay eggs on the surface of the shoot. The newly hatched larvae first tunnel into resin droplets that form at the base of needles and later migrate to resin pockets in the bark for further development. There is one generation per year.

Control: Controls have not been developed. Populations fluctuate greatly under normal conditions due to natural controls. There is also great variability in genetic susceptibility to this insect among individual pines.

PEMPHREDON WASPS

Pemphredon spp.
Family: Sphecidae

Appearance: **Adults** - Small (less than 1/4-inch) black wasps with a very prominent constriction at the "waist". **Larvae** - Pale colored "grubs" found within cells constructed in the pith of plants. Usually found in association with fragments of aphids they use as prey.

Hosts: Pemphredon wasps nest in cavities they excavate from pithy plants. Ash, elder, sumac, rose, and caneberries are among the plants most often used.

Damage: No plant injury results, as the insects restrict their nesting to the pith. As these hunting wasps prey on aphids, they may provide modest beneficial effects.

Life History and Habits: These are hunting wasps that use aphids for prey.

Female wasps establish nests by excavating the pith from plants; these species only use plants with pith intact. In most plants, particularly those with a small diameter pith, the individual nest cells are built sequentially on top of each other. However, a system

of branching chambers may be made in large diameter twigs.

Prey are located by the female who grasps a single aphid, paralyzes it by stinging and returns to the nest. She then repeats this process until the cell is adequately provisioned, usually with about two dozen aphids. She then lays an egg on the aphids she has stored and seals the cell with a plug of chewed pith. A series of cells are subsequently provisioned and sealed off.

Eggs hatch in about 3 to 5 days and the developing wasp larva feeds on the aphids for about two weeks, before becoming full grown. They then remain in this prepupal stage for a variable amount of time, depending primarily on what the season is. Late in the year most remain as a prepupa, overwintering before resuming development in spring. However, generations that develop in spring or early summer remain as a prepupa for only a short time and then transform to the pupa. Regardless of the season, pupal stages last about three weeks. Adults then emerge, in reverse order of when eggs were laid, i.e., those reared in the last cells produced are first to exit. There are probably two generations annually produced.

Other insects may be found in the cells and cavities these wasps produce. Several parasites attack the developing wasps. Also, other species of hunting wasps that utilize existing cavities may colonize nests of pemphredon wasps, sometimes destroying in the process the developing stages of pemphredon wasps.

Related Insects: Dozens of species of wasps in Colorado develop by hunting other insects and returning the prey to their nest. Unlike the Pemphredon spp. most do not excavate pith and instead use existing cavities or tunnel into soil when constructing nests. Others make nests of mud and certain social species, such as hornets and yellowjackets, construct paper nests using chewed wood. Most species of hunting wasps tend to specialize in use of certain prey, which may include leafhoppers, crickets, spiders, weevils or many other insects. The largest hunting wasp in the state is the cicada killer, which paralyzes dog-day cicadas and stores them in underground chambers that they dig.

Control: No controls are recommended. Sealing pruning cuts to prevent access to the plant pith can prevent nesting.

ROSE STEM-BORING SAWFLY

Hartigia trimaculatus (Say)

Family: Cephidae

Appearance: **Adult** - A small, dark colored wasp that is generally elongate in shape. About 1/2 inch in length. **Larva** - Cream-colored and elongate with a distinct head, found within the canes of host plants.

Hosts: Rose, Rubus

Damage: A common cane borer infesting rose and raspberry is the stem boring sawfly. Damage is caused by the larvae which tunnel into the stem, often girdling it. The top of the plant, beyond the injury, wilts and dies. Canes break easily at the injury point.

Life History and Habits: The stem boring sawfly spends the winter as a full-grown larva within the old canes. They pupate in spring and adults emerge in April and May.

Larva of the rose stem-boring sawfly.

The adult stage is an elongate, 1/2-inch black and yellow wasp. Females insert eggs under the bark at the tip of current season canes, leaving a small puncture wound. Upon hatching the larva enters the stem to feed. As they get older, they tunnel downward under the bark, girdling the tip. They feed in the pith, eventually forming a small chamber in the upper stem during late June and July.

At least some of the stem boring sawflies pupate within the stem and a second generation of adult wasps gnaw their way out and emerge in mid summer. These wasps repeat the cycle, laying eggs which hatch into larvae that cause late summer cane die

back. At the end of the summer larvae within the stems tunnel downward in the pith, spending the winter near the base of the plant.

Rose plantings near wild rose are more likely to be infested since the wild plantings may be a reservoir of this insect.

Related Insects: The raspberry horntail, *Hartigia cressoni*, causes similar injury to the canes of raspberry, blackberry, boysenberry, and rose. It is originally a Pacific Coast species and has not been identified from Colorado but has been described from Montana.

Control: Parasitic wasps commonly attack and kill the full-grown sawfly larvae as they prepare to pupate.

Destroy the developing larvae by cutting and destroying canes when injury is first detected. Cut each affected cane below the wilted portion and examine the pith. Continue making short cuts until the pith is white.

BARK AND TWIG BEETLES (SCOLYTIDAE)

Bark beetles are insects that develop feeding on the cambium under the bark of trees. Typically the adult beetles first make distinctive galleries in which they mate and lay eggs. The larvae tunnel outwards from these galleries and can girdle the tree.

Another very important aspect of bark beetles is their involvement with various fungi, particularly those in the genus *Ceratocystis*. These include the fungi involved in Dutch elm disease and the 'blue stain' fungi of conifers. Bark beetles are very important in the distribution of these fungi to new trees. In many instances the two organisms - bark beetle and fungus - are very co-dependent. Bark beetles spread the fungus and the fungus helps to provide declining hosts that are optimal for beetle development.

Most bark beetle species successfully breed in trees that are severely stressed or dying. Newly transplanted trees are particularly susceptible to attack by these insects. Proper cultural practices to promote tree vigor are the most important means of preventing most bark beetle problems. Often, these techniques are sufficient for control.

A few bark beetles are capable of killing healthy trees, either through coordinated "mass attacks" (mountain pine beetle for example) and/or through introduction of disease causing fungi into healthy trees (elm bark beetles). Sanitation and insecticide applications are of great importance in managing these pest situations.

An active area of research develop involves the behavioral chemicals (pheromones) used by bark beetles to regulate their attacks. Both pheromones that are involved in attraction (aggregation pheromones) and pheromones that are repellent to bark beetles (anti-aggregation pheromones) have been identified for some species. These have promise in managing beetles when populations are not high, but have been generally ineffective in preventing attacks during outbreaks.

Bark beetle preventive insecticide applications involve a thorough wetting of the bark (point of run-off) immediately prior to the egg laying period. Sevimol is the standard bark beetle preventive insecticide, with some use of chlorpyrifos (Dursban, Pageant) and Lindane. Bark beetle infestations within infested trees or logs can be controlled with Lindane and Dursban, that will kill the insects as they emerge.

Specific recommendations for bark beetle control are included in the supplement in the sections: **Mountain pine beetle**, **European elm bark beetle**, and **Engraver (Ips) beetles**.

TWIG BEETLES

Pityophthorus species,
Pityogenes species, and
certain other minor genera of bark beetles
Family: Scolytidae

Appearance: **Adults** - Tiny beetles, 1/32 - 1/6 inches long, are generally dark brown. Most species have rounded rear ends but a few have a pair of blunt spines. **Larvae** - Typical of bark beetles: a fat, "C"-shaped grub with a caramel-colored head.

Hosts: Pines, spruce, and certain other conifers.

Damage: The larvae tunnel the inner bark and girdling kills branches, tops and small trunks. Damaged plants show distinctive 'flagging' of terminal growth.

In natural situations these beetles function as pruners of shaded-out, storm-damaged twigs and branches. They also often serve as indicators of conditions that favor outbreaks of other, more damaging bark beetles such as mountain pine beetle. In urban settings they are major contributors to the death of recently transplanted or stressed pines.

Life History and Habits: Adults are active throughout the warm months. They find suitable hosts and produce broods in the inner bark. Attacks produce much tan sawdust but little pitch. The pattern of galleries made beneath the bark by adults and feeding larvae is generally star-shaped and lightly etches the wood. Most species of twig beetles have two to four generations per year.

Control: These beetles are usually secondary pests, breeding in dying wood or indicative of substantial stress on the plant. Improvement of cultural conditions to allow more vigorous growth should be fundamental to control. Where dead wood occurs, these beetles can build to high populations.

Such breeding sites should be eliminated from the vicinity of landscape plantings.

If transplanted trees are being threatened, standard bark beetle treatments during the first season should provide control. Treatments should be persistent enough to maintain coverage through the season, since multiple, overlapping generations occur with this group of bark beetles.

Galleries formed by feeding of twig beetle larvae. Photograph by D.A. Leatherman.

WESTERN CEDAR BARK BEETLES

Phloeosinus species
Family: Scolytidae

Appearance: **Adults** - 1/8 inch long, reddish brown to black shiny beetles. The wing covers are marked by lengthwise rows of minute puncture marks. **Larvae** - Small, white grubs, found within their tunnels.

Hosts: Junipers including Eastern redcedar. Bark beetles attacking juniper are almost invariably from this genus.

Damage: Adults feed on and may girdle small twigs, typically several inches back from the tip. Developing bark beetle larvae feed under the bark and kill the infested branch, resulting in conspicuous flagging. Trees or branches subject to attack are almost always dead, dying or severely stressed.

The gallery system has a central tunnel running parallel to the branch or trunk, with numerous side tunnels coming off it at right angles. These galleries are usually free of extensive sawdust. Attacks, including the adult twig feeding, result in flagging of foliage on the affected part of the tree.

Some *Phloeosinus* bark beetles have been implicated as vectors of the tree killing fungus *Coryneum cardinale* on cypress. Association of cedar bark beetles and fungus diseases in Colorado is not known to occur. Isolated bark beetle flagging does not necessarily indicate the entire tree is at risk of dying.

Life History and Habits: The life cycle of western cedar bark beetles are little studied in the Rocky Mountain region. Overwintering stage is the larvae found under the bark. Adults emerge in late spring or early summer and feed on twigs. The brood chamber under the bark is tunneled by pairs of beetles that first excavate a short gallery around the entrance chamber then extend it along the grain of the wood. Larvae feed perpendicular to the central egg gallery and girdle the branch. There is probably one generation per year.

Control: Improving cultural conditions for the trees to improve vigor can usually eliminate most threat of future attacks. Infested branches should be removed when flagging is observed, to remove developing larvae.

Chemical controls have not been reported. Standard bark beetle treatments applied to maintain coverage during the period of adult activity (June, July) should be effective.

MOUNTAIN PINE BEETLE

Dendroctonus ponderosae Hopkins
Family: Scolytidae

Appearance: **Adults** - Cylindrical, stout bodied beetles, brown to black in color and about 1/4 inch long. **Larvae** - Yellowish-white, legless grubs with dark heads; about 1/4 inch long. Eggs are pearly white.

Adults of the mountain pine beetle.

Hosts: In Colorado, ponderosa, Scots, lodgepole and limber pines are the primary hosts

Related Species: A related insect, the Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopkins), can be almost destructive to Douglas-fir. Most often out-

breaks are associated with previous injury by western spruce budworm (Service-in-Action 5.543). Injured pines also can be attacked by the red turpentine beetle, (*Dendroctonus valens* LeConte). These insects are discussed in the following sections.

Engelmann and blue spruce can be attacked by the spruce beetle, *Dendroctonus rufipennis* (Kirby). This beetle is considered to be less aggressive than mountain pine beetle and usually limits attacks to wind-thrown trees, slash, and tree stumps. However, apparently healthy spruce trees can be attacked when beetle populations become epidemic. The largest single mass-killing of trees recorded in North America is attributed to spruce beetle, in the White River National Forest during the 1940's.

Damage: Mountain pine beetle (MPB) is an insect native to the forests of western North America. Previously called the Black Hills beetle or Rocky Mountain pine beetle, periodic outbreaks of the insect can result in losses of millions of trees. Outbreaks develop irrespective of property lines, being equally evident in wilderness areas, mountain subdivisions, and back yards. Even windbreak or landscape pines many miles from the mountains can succumb to beetles imported in infested firewood.

Mountain pine beetles develop in pines, particularly ponderosa, lodgepole, Scots (Scotch), and limber pine. Bristlecone pine and pinyon are less commonly attacked. During early stages of an outbreak attacks are limited largely to trees under stress from injury, poor site conditions, fire damage, overcrowding, root disease, or old age. However, as beetle populations increase, MPB attacks may involve most trees in the outbreak area.

Trees already weakened by budworm defoliation are common targets. Weakened trees over six inches in diameter are most susceptible to attack, and once infested the trees usually die. A blue staining fungus that turns the sapwood grayish-blue and clogs the vascular system is introduced into the tree by the beetles.

Signs and Symptoms of MPB Attack:

* Popcorn-shaped masses of resin, called 'pitch-tubes' on the trunk where beetle tunnelling begins. Pitch tubes may be brown or white in color.
* Boring dust in bark crevices and on the ground immediately adjacent to the tree base.
* Evidence of woodpecker feeding on trunk. (Patches of bark are removed and bark flakes lie on ground or snow below tree.)
* Foliage turning yellowish to reddish throughout the entire tree crown. (Usually occurs eight to ten months after a successful MPB attack.)
* Presence of live MPB (eggs, larvae, pupae, and/or adults) as well as galleries under bark. (This is the most certain indicator of infestation. A hatchet for removing bark is needed to check trees correctly.)
* Bluestained sapwood. (Check at more than one point around the tree's circumference.)

Life History and Habits: Mountain pine beetle has a one-year life cycle in Colorado. In late summer adults leave the dead, yellow to red needled trees in which they developed. Females seek out living, green trees that they attack by tunneling under the bark. Coordinated mass attacks by many beetles are common. If successful, each beetle pair mates, forms a vertical tunnel (egg gallery) under the bark, and produces about 75 eggs. Following egg hatch, larvae (grubs) tunnel away from the egg gallery producing a characteristic feeding pattern.

MPB larvae spend the winter under the bark. They continue to feed in the spring, transforming to pupae in June and July. Emergence of new adults can begin in early July and continue through September. However, the great majority of beetles exit trees during late July (lodgepole pine) and mid-August (ponderosa pine).

A key part of this cycle is the ability of MPB (and other bark beetles) to transmit bluestain fungi (*Ceratocystis* species, *Europhium clavigerum*). Spores of these fungi contaminate the bodies of adult beetles and are introduced into the tree during attack. Fungi grow within the tree and, together with beetle feeding, weaken the tree. This mutual network of beetle galleries and bluestain fungi disrupt transport of water in the tree and rapidly kill it. The fungi give a blue-gray appearance to the sapwood.

Controls: Natural controls of mountain pine beetle include woodpeckers and insects such as clerid beetles that feed on both mountain pine beetle adults and larvae under bark. Extremely cold temperatures also can reduce MPB populations. However, during outbreaks these natural controls often fail to prevent additional attacks.

Perhaps the most important natural control is tree vigor. Healthy trees are less attractive to beetles than trees under stress. Vigorously growing trees also have better defenses that allow them to 'pitch out' pine beetles.

Cultural controls which promote tree health and spacing are the primary means of preventing MPB outbreaks. The forest management of thinning is the best long-term means to minimizing MPB losses. Consult a professional forester to select the best cultural practices for your land.

Logs infested with MPB can be treated in various ways to kill developing beetles before they emerge as adults in summer. Logs may be burned to kill the larvae under bark. Intense solar radiation that dries out the cambium and raises temperatures to lethal levels (110^0F+) can kill MPB larvae. Beetles also die if the bark is removed by peeling or milling. Burying is another option to kill MPB in infested logs. In some cases, hauling infested logs to "safe sites" a mile or more from susceptible tree hosts is also practiced. Following beetle emergence, wood can be used without threat to other trees.

Chemical control options for MPB have been greatly limited in recent years. Former treatments involving ethylene dibromide fumigation have been banned. Cacodylic acid (Silvisar products) and most formulations of lindane are unavailable or Restricted-Use. These treatments were primarily used to kill larvae in trees or adults as they emerge. (A few formulations of lindane, usually marketed as some brand of 'borer spray', remain available for treating infested logs.)

Certain formulations of carbaryl (Sevin) are registered for use in preventing attacks on individual trees. These sprays are applied to living green trees in early summer to kill at-tacking beetles. This preventive spray is quite effective through one MPB flight (one year) in ponderosa pine areas. In lodgepole pine areas, recent evidence indicates one spraying may provide satisfactory protection through two flights (two years). Sprays for MPB made during the same time as treatments for Douglas-fir beetle can be expected to persist sufficiently to provide MPB control.

DOUGLAS-FIR BEETLE

Dendroctonus pseudotsugae Hopkins

Family: Scolytidae

Appearance: **Adults** - Beetles resemble mountain pine beetle, about 1/4 inch long. Some individuals are all black, others have black head and thorax with reddish brown wing covers. **Larvae** - White grubs with brown heads.

Host: Douglas-fir

Damage: Gallery construction and feeding on the inner bark of trunks usually kills host trees. Large groups of Douglas-fir may be killed during multi-year outbreaks.

Life History and Habits: The Douglas-fir beetle appears to occur in two situations: apparently healthy host stands where isolated, infested dead-tree groups increase to 15 to 20 trees over a few years and then decrease; and in seriously stressed stands such as those suffering from spruce budworm defoliation. In the latter, dead trees may number in the hundreds per group. The largest diameter trees preferred, but these beetles may attach stems as small as 6 inches in diameter. Adults and large larvae overwinter.

Douglas-fir beetles spend the winter as either large larvae or adults under the bark. Adults typically begin emerging in late April and May (earlier than MPB), but over 75 percent of the population emerges the last three weeks of June. Thus, the emergence period can extend from April through July.

Attacking beetles bore under the bark, mate there and the females lay eggs in small groups along a vertically-oriented gallery. These attacks result in accumulations of reddish boring dust at the tree base and streams of clear pitch running down the bark. The larvae feed outward in the inner bark area killing the tree. The needles of infested trees turn red a few to several months after initial attack. There is one generation per year, but more than one developmental stage often occurs in any one tree, because the attack period can extend over three to four months.

Associated Insects: The Douglas-fir pole beetle, *Pseudohylesinus nebulosus* (LeConte) fills a similar niche in smaller diameter Douglas-fir. The insect is widespread and often found in areas infested with Douglas-fir beetle, sometimes in the same tree.

Controls: Controls for Douglas-fir beetle are generally similar to MPB. However, since adults can emerge earlier, developing beetles must be destroyed and preventive sprays applied by late April.

RED TURPENTINE BEETLE

Dendroctonus valens LeConte
Family: Scolytidae

Appearance: **Adults** - Closely resemble mountain pine beetle adults, but are larger and wine red in color. They are about 1/4 - 3/8 inches long. **Larvae** - white grubs with brown heads, somewhat C-shaped and up to 3/8 inch long.

Hosts: Pines, particularly those recently damaged by fire or wounding.

Damage: Pines and rarely, other conifer species are sometimes attacked by the red turpentine beetle. Trees scorched near the base by fire or injured during construction are particularly susceptible. Turpentine beetle attacks are characterized by large, pinkish-purple pitch tubes confined to the lower eight feet of the trunk. Beetles may be active throughout the warmer months, peaking in mid-summer.

Tunnels produced by red turpentine beetle do not have a regular egg gallery. Beetles make short, irregular tunnels and developing larvae feed as a group, excavating a shallow cavity under the bark. Trees can survive attack, but weakening can make them more susceptible to other bark beetles.

Life History and Habits: Turpentine beetles favor large declining or injured trees. Pines scorched by fire or wounded by construction equipment are common targets. They bore into the lower trunks, where large pink masses of resin called pitch tubes form at attack points. The adult beetles lay clusters of eggs within their tunnels, and when these hatch the larvae feed in groups, consuming irregular areas of cambium/phloem just under the bark. These areas may join each other and girdle the tree depending on the density of attacks. Adult attacks occur through the warm months. There are two to three generations per year.

Controls: Cultural practices promoting tree vigor can help avoid attacks by red turpentine beetle. Preventive insecticide sprays (carbaryl) applied before adult attacks, are also effective.

Beetles in the genus Dendroctonus (left) can be separated from those in the genus Ips (right) by the profile of the hind wing cover.

Beetles in the genus Dendroctonus (left) can be separated from those in the genus Ips (right) by the profile of the hind wing cover.

ENGRAVER BEETLES

Ips species

Appearance: **Adults** - Small beetles, 1/8 - 1/4 inch long, reddish brown to black in color, with a pronounced cavity at the rear end lined with three to six pairs of tooth-like spines. **Larvae** - Small grubs, about 1/4 inch long when mature, white to dirty gray in color, legless, with dark heads.

Central chamber and radiating egg galleries typical of engraver beetles (Ips species). Photograph by D.A. Leatherman.

Hosts: Pines and spruce

Damage: A yellowish- or reddish-brown boring dust in bark crevices or around the base of tree is indicative of *Ips* attack. Blue-stain fungi are often introduced into trees by adult beetles. *Ips* beetles usually attack weakened trees of all sizes such as recent transplants, tops and limbs of mature trees already attacked by other bark beetles, trees injured by construction, drought-stressed or overwatered trees.

Life History and Habits: Adults overwinter and begin to attach weakened trees in the spring. They bore into the bark and construct "Y" or "H"-shaped

egg galleries, pushing the boring dust out of the entrance hole as they work. Eggs are laid along the gallery and young larvae soon hatch and begin tunneling small lateral galleries that lightly etch the sapwood. From two to five generations of these beetles may develop during the summer.

ASH BARK BEETLES

Hylesinus species (= Lesperisinus species)
Family: Scolytidae

Appearance: **Adults** - Small, stout beetles, about 1/16 inch long, mottled in gray and black. **Larvae** - Small white grubs with brown heads found within tunnels under the bark of ash.

Hosts: Ash, particularly green ash

Ash bark beetle adult and galleries. Photograph by S. Krieg.

Damage: Adult bark beetles girdle small branches, causing die back. Larvae tunnel under the bark of branches and sometimes even trunks of trees. Limbs, large branches, and whole trees can be killed during outbreaks. Infested trees tend to get reinfested subsequently, leading to further decline. This insect has become increasingly important within the region during recent years.

Life History and Habits: At least two species occur in Colorado, *Hylesinus californicus* (Swaine) and *H. aculeatus* (Say). Life history of both species is poorly understood under local conditions but the following is based on information from more northern areas.

Adults overwinter in niches cut in green bark of the outer trunk. They emerge in early to mid-spring and females construct girdling tunnels under the bark of ash. During this tunneling small ventilation holes are also constructed that are exteriorally visible and sap may ooze from the wounds. These tunnels are the main egg galleries characterized by running at right angles to branch length. Fungi often are associated with these beetles and may colonize the wood near tunnels.

The larvae develop feeding under the bark, often extensively scoring the wood. They become full grown in late spring and pupate within the tunnels. Adults emerge from the branch and feed on green wood, causing little damage. At the end of the season, beetles move to the trunks and cut hibernation chambers in which they winter.

There is some evidence that a second generation may occur. Larvae of an unidentified species have been seen in advanced development in early fall.

Control: Ash bark beetle outbreaks often are, at least in part, related to conditions of growing stress. Well-sited, vigorously growing ash should be at much less risk of attack by this insect. Good cultural practices are fundamental to ash bark beetle management.

Pruning and disposal of infested branches can limit population development of the beetle. This needs to be done in spring, before adults emerge. Infested branches can be identified by showing wilting.

Insecticides applied to the lower trunk in late summer can kill overwintering beetles. It is unknown if preventive insecticide sprays of branches, applied in early spring as for elm bark beetle control, may also be an effective control of adults as they move to trees for egg laying.

SHOTHOLE BORER

Scolytus rugulosus (Muller)
Family: Scolytidae

Appearance: **Adults** - Tiny grayish-black beetles, about 1/16 - 1/8 inches long, with somewhat hairy wing covers that are reddish at the rear margin. **Larvae** - Very small, whitish grubs found under the bark of infested trees.

Hosts: Fruit trees (particularly *Prunus* species) and a few other hardwoods like mountain-ash, hawthorn and in rare cases elm. Most infestations in

Colorado involve overmature or damaged plum and cherry.

Damage: The grub-like larval stage tunnels under the bark of twigs and branches of peach, plum and cherry. (Apple and pear are less common hosts.) This produces girdling wound that can weaken, and sometimes kill, the plant beyond the damaged area. Trees in poor health are much more susceptible to shothole borer damage.

Shothole borer exit holes. Photograph courtesy Clemson University Cooperative Extension.

Oozing gum often occurs where beetles enter the wood to lay eggs. When the adult beetles emerge through the bark they chew small exit holes, the most commonly observed evidence of shothole borer activity.

Life History and Habits: The shothole borer spends the winter as a grub-like larva under the bark of trees. They continue to develop, pupate and change to the adult stage in late spring. The small (1/10-inch), brown adult beetles emerge in June and July. After mating the females seek out tree branches in poor health and chew out a one to two inch long egg gallery under the bark. Eggs are laid along the gallery and the newly hatched larvae later feed under the bark, making new galleries away from the central egg gallery. (The pattern made by the egg and larval galleries is useful for diagnosing shothole borer infestations.)

There are usually two generations per year. The larvae become full grown by midsummer and a second generation is produced at that time.

Related Insects: The fir engraver, *Scolytus ventralis* LeConte, develops under the bark of true firs.

Controls: Shothole borers rarely attack, and survive poorly, in trees that are actively growing. Serious damage by shothole borer can be almost entirely avoided by growing trees under favorable growing conditions. Trees stressed by drought, winter injury, poor site conditions, wounding injuries, or other problems are at greatest risk of shothole borer damage.

Regularly prune dead or dying branches limbs in which shothole borers breed. Since the insects can continue to develop in pruned wood, remove or destroy it before adult beetles emerge.

On non-bearing trees, some insecticides are registered to control shothole borers (and other bark beetles). These need to be applied to the branches before the adult beetles have tunneled into the tree and laid eggs (early to mid-June).

SMALLER EUROPEAN ELM BARK BEETLE

Scolytus multistriatus (Marsham)
Family: Scolytidae

Appearance: **Adults** - Shiny black beetles, about 1/8 inch long with reddish-brown to reddish-black wing covers. The posterior end of the beetle is concave and has a small projection or spine. **Larvae** - Small white grubs, 1/8 inch long, legless with brown heads.

Hosts: Elm

Damage: This introduced beetle is the principal U.S. vector of the Dutch elm disease fungus, *Ophiostoma (=Ceratocystis) ulmi*. By breeding in dead or dying (diseased) trees, and then flying to healthy trees to feed, the beetles effectively spread the disease.

Adult of the European elm bark beetle.

Life History and Habits: The smaller European elm bark beetles overwinters in the larval stage,

under bark. Larvae mature in the spring and pupate. Adult beetles typically emerge around mid-May, although earlier emergence may occur.

Beetles emerging from diseased trees may be contaminated with spores of the Dutch elm disease fungus. Emergence holes indicating prior infestations appear as small pin holes in the bark, and the bark ultimately loosens from the larval tunneling.

Adult beetles fly to healthy elm trees and feed on the crotches of two to three year old twigs. During this twig feeding period, most beetle transmission of the Dutch elm disease fungus occurs. After feeding, adults seek out diseased and weakened trees, construct brood galleries around the bark, and lay eggs. (Egg galleries run parallel to the wood grain.) The larvae develop over the course of about two months and adults emerge in mid to late summer. Adults again produce a second round of twig feeding and egg laying, with the subsequent larval generation overwintering. New infections of Dutch elm disease are considerably rarer following second generation feeding, since the xylem vessels of the summer wood are smaller and restrict movement of the fungus.

Control: There is currently no known cure for Dutch elm disease. Realizing this, the best hope is to slow the spread of the disease. Management of Dutch elm disease requires the use of several different control approaches applied in an integrated manner.

Fundamental to any Dutch elm disease management plan is a program of strict sanitation. Prompt identification and removal of diseased elm trees prevents the development of large populations of elm bark beetles carrying the fungus. American elms should be regularly checked for symptoms of infection during the growing season. A tree infected late in the growing season may live through the winter. Early season (June) surveys can detect such trees and allow for prompt removal before the disease spreads to other elms. Historically, the Colorado State Forest Service has been in charge of processing twig samples from trees suspected of Dutch elm disease to verify infection.

Trees determined to be infected with Dutch elm disease should be promptly removed, at least within 20 days. If trees cannot be removed immediately, they should be girdled by a two inch deep cut into the wood to prevent the fungus from moving to the roots where infections can move to adjacent trees. However, girdling does not prevent beetle development so beetle transmission is not inhibited by this method.

Because Dutch elm disease can move from tree to tree through root grafts, without the insect involvement, trenching should be done immediately around infected trees to prevent root graft transmission. Trenches should be 18 inches deep and two inches wide.

Beetle transmission of Dutch elm disease can sometimes be further reduced by spraying tree crowns with insecticides to kill the beetles. Sprays should be made before late April, to catch the first emerging beetles. Since insecticides can persist for fairly long periods on bark, these applications can be made as early as November.

Galleries produced by the European elm bark beetle. Photograph courtesy of the Colorado State Forest Service.

BORERS OF TRUNKS AND LARGER BRANCHES

Several insects develop by tunneling into the trunks and/or branches of trees and shrubs. Among the most important are the 'clearwing borer' moths (Family: Sesiidae) the metallic wood borers/flathead borers (Family: Buprestidae) and the longhorned beetles/roundheaded borers (Family: Cerambycidae). Most damage typically results from girdling of the cambium causing decline and die back. Some borers, notably the roundheaded borers, can tunnel extensively through the wood and cause structural weakening.

Most borers are only capable of successfully attacking dying or stressed trees. Proper watering and care is the first-line approach for prevention of borer injuries. Good cultural practices can also allow an infested tree to better tolerate borer injuries.

Insecticidal control approaches require applications just prior to egg laying and egg hatch. The occurrence of these life stages vary with different borer species and often last a month or longer. Consequently, repeat applications are often necessary for control. After eggs hatch and young borers have moved underneath the bark, insecticide treatments are ineffective. Pheromone traps are available to aid in the timing of treatments for control of clearwing moth borers (peach crown borer, lilac/ash borer).

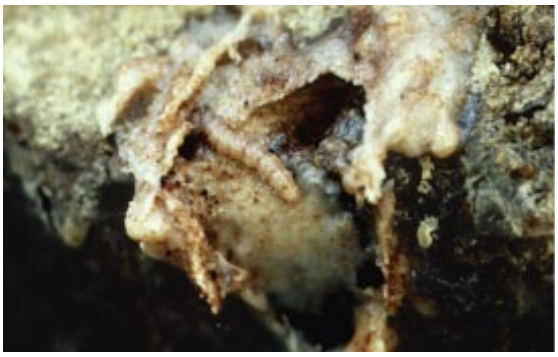
In the past, lindane has been the standard insecticide for shade tree borers. Currently, chlorpyrifos (Dursban) or the pyrethroids are recommended as the availability of lindane declines. These materials are used as coarse sprays applied to the trunk until point of run-off. Lower branches and the crown area may need protection, depending on the habits of the borer. Spray deposits typically last for several several weeks to months; insecticide degradation is much slower on coarse bark (e.g., elm) than on smooth bark (e.g., birch).

Specific recommendations for control are included in the supplement with sections related to wood borers including: **Zimmerman pine moth**, **Pinyon pitch mass borer**, **Lilac/Ash borer**, **Peach tree borer**, **Bronze birch borer**, and **Wood borers (General)**.

PINYON "PITCH MASS" BORER

Dioryctria ponderosae Dyar
Family: Pyralidae

Appearance: **Adults** - Gray-brown snout moths with white zig-zag markings, approximately 1/2 to 3/4 inches in length. **Larvae** - White to pink, resides underneath pitch mass.



Pinyon pitch mass borer larva exposed in wound. Photograph by W.S. Cranshaw.

Hosts: Pinyon, primarily. Ponderosa pine and other pines may be occasional hosts.

Damage: The pinyon pitch mass borer has been a serious pest of pinyon in landscape plantings throughout much of the state. Ponderosa pine is another recorded host and there is some indications that they may occur in mixed infestations with Zimmerman pine moth in Scots and Austrian pines. Larvae tunnel into the cambial area causing large gouges which ooze a light pinkish pitch. Damage occurs on trunks and large branches. Wounding disfigures and weakens the tree. Heavily infested branches may break.

Life History and Habits: Observations of the life history of the pinyon borer in Colorado suggests that most require two years to complete full development. Adult, moth stages are active and laying eggs from late June through August. Larvae, the damaging stage, are pale yellow or pink in color with a light brown head. They tunnel under the bark and feed actively during the warmer months, undergoing four molts before changing to the pupal stage. Pupation occurs in the chamber of pitch and silk produced earlier by the larvae.

Table 7. Flight Periods and Hosts of Common Woody Plant Borers in Colorado.

Scientific name	Common name (if any)	Common Hosts	Typical Flight Periods
	METALLIC WOOD BORERS (Coleoptera: Buprestidae)		
Chrysobothris femorata	Flatheaded appletree borer	Apple, maple, *Populus*, other hardwoods	June-August
Agrilus anxius	Bronze birch borer	Birch	June-July
Agrilus difficilis		Honeylocust	June-July
Agrilus politus		Willow, Populus, many hardwoods	June
Agrilus aurichalceus	Bronze cane borer	Caneberries, rose, currant	late May-June
Chalcophora species		Pines	June-August
Dicerca species		Aspen	June-August
	LONGHORNED BEETLES (Coleoptera: Cerambycidae)		
Plectodera scalator	Cottonwood borer	*Populus*, willow	July-August
Megacyllene robiniae	Locust borer	Black locust	August-September
Saperda calcarata	Poplar borer	*Populus*, willow	June-August
Saperda inornata	Poplar gall borer	Poplar, cottonwood	July-September
Parandra brunnea	Pole borer	Maple, other hardwoods	July-September
Neoclytus acuminatus	Redheaded ash borer	Ash, other hardwoods	April-June
Monochamus species	Pine sawyers	Pines, spruce, fir	May-Sept.
Callidium antennatum	Black-horned pine borer	Pines, other evergreens	May-June
Atimia huachuchae	Juniper borer	Juniper	June-July
	WEEVILS (Coleoptera: Curculionidae)		
Cryptorhynchus lapathi	Poplar and willow borer	Willow, poplar	July-August
Pissodes strobi	White pine weevil	Spruce, some pines	March-May
	CLEARWING BORERS (Lepidoptera: Sesiidae)		
Podosesia syringae	Lilac/ash borer	Ash, lilac, privet	April-June
Sesia tibialis	Cottonwood crown borer/American hornet moth	Cottonwood	mid June-July
Synanthedon exitiosa	Peach tree borer	*Prunus*	mid June-September
Synanthedon tipuliformes	Currant borer	Currant, gooseberry	late May-June
Synanthedon viburni	Viburnum borer	Viburnum	June-July
Synanthedon novaroensis	Douglas-fir pitch moth	Spruce, some pines, Douglas-fir	June-July
Pennesetia marginata	Raspberry crown borer	Raspberry	July, August
	CARPENTERWORMS (Lepidoptera: Cossidae)		
Prionoxystus robiniae	Carpenterworm	Elm, maple, ash	June-July
	DIORYCTRIA BORERS (Lepidoptera: Pyralidae)		
Dioryctria ponderosae	Pinyon pitch mass borer	Pinyon, ponderosa pine	June-August
Dioryctria zimmermani	Zimmerman pine moth	Austrian, Scots pine	August-September
	NOCTUID BORERS (Lepidoptera: Noctuidae)		
Achatodes zeae	Elder shoot borer	Elderberry (*Sambucus*)	July, August
	HORNTAILS (Hymenoptera: Siricidae)		
Tremex columba	Pigeon tremex	Maple, elm other	late July-August

Recent information from Nebraska, where it is a pest of ponderosa pine, indicates that some of the insects can develop within 12 to 14 months. Presumably, these include individuals produced early in the season (June, early July), which emerge in August of the following year.

Control: Several cultural factors appear to be associated with injury to pinyon pine by the pinyon pitch mass borer. Problems tend to be greatest in irrigated settings where pinyon receives far more than their natural requirement for water (6 to 10 inches/year). Such overirrigation promotes succulent growth and branch cracking that should favor the insect. Also, pinyons that are closely planted and overly crowded have had a history of increased problems with pinyon borer in the Denver area. Properly siting pinyons is considered important in managing problems with the pinyon pitch mass borer.

Pinyon borers lay most eggs near existing wounds. When possible, pruning of pinyons should be made in a manner to allow wound closure prior to periods when adult moths are active (late June-August).

Individual borers in trees can be punctured and killed by "worming" with a flexible wire. However, larvae can be difficult to find since they often tunnel for several inches under the bark. Alternatively, moth crystals containing paradichlorobenzene may be inserted into borer pitch masses and used to fumigate the larvae. Some formulations of these crystals are sold with labelling that allows use in shade trees.

Preventive **trunk sprays** can reduce new attacks. Coverage of the trunks during periods of adult moth flight activity and egg laying can kill the newly hatching caterpillars. However, coverage of the trunk and branches must be thorough, particularly around active wounds. Two or more treatments per season, repeated over at least two years, may be needed to reduce an infestation. In Colorado State trials, Mavrik and Dursban have been among the most effective treatments.

Experimentally, use of Dimethoate injected into the root zone has provided some control in Colorado State University trials. Certain dimethoate formulations are registered for soil injection use.

Related Species: Several other species of *Dioryctria* affect pines including the pinyon tip moth (see tip moth section) and Zimmerman pine moth (following). In addition, unknown species have been recovered from pinyon and ponderosa pine.

ZIMMERMAN PINE MOTH

Dioryctria zimmermani (Grote)

Family: Pyralidae

Appearance: **Adults** - A mid-sized moth, with gray wings blended with red-brown and marked with zig-zag lines. Adults are difficult to distinguish from other members of this genus. **Larvae** - Generally dirty white caterpillars, occasionally with some pink or green coloration. They are found within characteristic popcorn-like masses of sap on the trunks and branches.

Hosts: Pines, particularly Scots and Austrian pines

Typical popcorn-like masses of gum at the wound of a Zimmerman pine moth larva. Photograph by D.A. Leatherman.

Damage: In recent years, the Zimmerman pine moth has also become introduced and established along the Front Range. Austrian pines have been most commonly infested. Scots and ponderosa pines are also reported as hosts. Branches typically break at the crotch area where they join the trunk. Infestations are commonly marked by dead and dying branches, often in the upper half of the tree. First external symptoms of injury are the production of pitch masses at the wound site. The pitch may reach

the size of a golf ball and appear like a cluster of small grapes.

Life History and Habits: The Zimmerman pine moth has a one year life cycle. The insect overwinters as a very young caterpillar, inside a small cocoon (hibernaculum), underneath scales of bark. In mid-late April and May, they again become active and tunnel into the tree. Tunneling may first occur around the branch tips, sometimes causing tip dieback. In late spring, they migrate to the base of branches, tunnelling into the whorl area, where and masses of pitch form at the wound site. The larvae continue to feed into July, at which time they become full-grown and pupate within a chamber in the pitch mass.

Adult moths are active primarily in late July and August. After mating, female moths lay eggs, often near wounds or previous masses of pitch. Eggs hatch in about a week and the larvae feed for only a brief time before preparing to overwinter.

Control: Zimmerman pine moth is most vulnerable to control during the periods when larvae are active and exposed on the bark in late summer and spring. Drenching trunk sprays, which penetrate the bark scales, applied in early August and in mid April should catch larvae before they have entered into trunks. Data from Illinois suggest that the early August application is most effective, if only one treatment is to be used.

Dimethoate/Cygon has been shown to be effective and is recommended in other states, but most formulations currently have uncertain labelling for use on most pines in Colorado. Talstar, Tempo, Mavrik, Dursban and Sevin are alternative treatments that should be effective when applied as a properly timed trunk spray.

Related Species: Several other species of *Dioryctria* affect pines including the pinyon tip moth (see tip moth section) and pinyon pitch mass borer (preceding). In addition, unknown species have been recovered from pinyon and ponderosa pine.

CARPENTERWORM

Prionoxystus robiniae (Peck)

Family: Cossidae

Appearance: **Adults** - Large stout-bodied moths with grayish-mottled forewings. The female wingspan is about three inches with grayish hind wings. The male wingspan is about two inches with black and yellow hind wings. **Larvae** - Pinkish-white caterpillars with a dark head and dark brown tubercles on the body, up to three inches long at maturity.

Hosts: Elm, ash, cottonwood and other hardwoods

Damage: Larvae tunnel into sapwood and heartwood, weakening trunks and branches. Tunneled trees may be broken off in high winds. This insect is common in eastern Colorado shelterbelts, where trees infested over many years appear gnarled and misshapen.

Life History and Habits: Carpenterworms winter as larvae in the tunnels produced in infested trees. Pupation occurs in spring and adult moths appear around May, leaving behind their large purplish pupal cases sticking out of the exit hole. The females then lay eggs in clusters in bark and crevices or wounds. Eggs hatch and young larvae bore directly to the inner bark and feed. When about half-grown the larvae bore into sapwood, tunneling upward into sapwood and heartwood. It takes an average of three years to complete development.

Control: Because of the extended period during which the larvae develop within the tree, control requires a considerable period. Trunk sprays of insecticides, similar to that for other borers, can prevent new attacks. Pheromone traps are available for this species that can be used to best time sprays so that they will coincide with adult activity and egg laying.

Unlike most borers, the larvae create an opening to the outside as they develop and they continually push out sawdust leaving smooth tunnels. Moth crystals or injections of insect parasitic nematodes into these active tunnels can control larvae within the wood.

PEACH TREE BORER (Crown Borer)
Synanthedon exitiosa (Say)
Family: Sesiidae

Appearance: **Adults** - All members of this family, the clearwinged moths, look deceptively wasp-like. The adult male has a narrow body shape with a purplish luster and yellow stripes. The female is heavier bodied, dark colored with a wide orange band on the abdomen. Both have a wing span of about one inch **Larvae** - Light yellow caterpillars, with light brown areas behind the head and at the hind end. Head is dark brown, and the body is sparsely covered with brownish hairs. They are about one inch long when mature. Pupa - Pupation takes place underground, inside a cocoon constructed of shredded wood.

Hosts: Peach, cherry, plum and other stone fruits.

Damage: Larvae cause extensive damage by burrowing into the sapwood of the tree trunk, usually at or below the soil line. Girdling injuries weaken and frequently kill trees. This is the most important insect pest of stone fruits (*Prunus* spp.) in Colorado.

Infestations of peach tree borer result in production of clear gum at wound areas, mixed with light brown wood fragments. Almost all injuries occur at, or slightly below, the soil line. This is different from other gumming on stone fruits caused by stress, mechanical injury, or infection with *Cytospora* fungi. These produce a clear, amber gum and can occur throughout the upper areas of the tree.

Larva of the peach tree borer. Photograph courtesy of Clemson University Cooperative Extension.

Life History and Habits: Females lay eggs on the bark of the lower trunk or even on the soil near the trunk during July and August. Eggs hatch in about a week and the larvae immediately burrow through the bark into the sapwood of the tree. Tunnelling under the bark continues until late fall,

Table 8. Common Colorado Clearwing Borers That Can Be Captured by Pheromone Traps

Species	Hosts	Pheromone attractant[1]	Flight period
Podosesia syringae (Harris)[2]	ash, lilac, privet	ZZ-3,13 ODDA or ZZA/EZA/ZZOH 3,13	late April through June, usual peak around mid May
Sesia tibialis (Harris)	cottonwood	ZZA/EZA/ZZOH 3,13	mid-June through July
Synanthedon scitula (Harris)[2]	dogwood	ZZ-3,13 ODDA	mid-June through early August
Synanthedon exitiosa (Say)[2]	Prunus	ZZ-3,13 ODDA or ZZA/EZA/ZZOH 3,13	mid-June through August
Synanthedon tipuliformis (Clerck)[2]	Currants	EZA-2,13/ZZA-3,13 (99:1 ratio)	early June to early July
Synanthedon culiciformis (L.)	Alder	ZZ-3,13 ODDA	late May
Albuna fraxini (Hy. Edwards)	Virginia creeper	ZZA/EZA/ZZOH 3,13	late July to early August

[1] ZZ-3,13 ODDA is the attractant in the standard "clearwing borer" lures.
[2] Species covered in detail in this publication.

with the insects mining down the trunk as cold weather approaches. In the spring, the larvae again feed extensively and complete development in June and July. Pupation occurs within the trunk and lasts about two weeks.

Adults typically emerge in late June and July. They live for several weeks, the females laying eggs over a period of one month or more. Eggs are most commonly laid under bark flaps or near wounds on the lower trunk.

Adult male of the peach tree borer. The standard "clearwing borer" pheromone trap captures this stage. Photograph by W.S. Cranshaw.

Related Insects: Other *Synanthedon* species can attack shrubs in Colorado including the viburnum borer (*Synanthedon viburni*), dogwood borer [*Synanthedon scitula* (Harris)], and the currant borer [*Synanthedon tipuliformis* (Clerck)]. *Synanthedon novaroensis* (Hy. Edwards) is occasionally associated with wounds of spruce.

Controls: Egg laying is concentrated around wounds. Practices that avoid wounding, and control of existing peach tree borer infestations, can decrease later attack by the insect. White paint applied to the trunk can seal bark cracks used by female moths for laying eggs.

Individual larvae can be dug out or killed by a sharp wire. However, this needs to be done with care to avoid excessive tree wounding.

Larvae can not be controlled by insecticides after tunnelling has progressed. Preventive treatments of insecticides should be applied to the trunk during periods when moths are active and eggs are being laid. This typically occurs in early July and August. Since mulch around the base of trees can provide some protection of the larvae, this should be cleared from the base of the trunk before treatments are applied.

Moth crystals (paradichlorobenzene) can be used to fumigate larvae within the trunk. The crystals are applied around the base of the trunk and are temporarily mounded with soil to retain the fumigant gas in the area of the borer infestation. The crystals should not directly touch the trunk and applications rates vary by trunk diameter. Fumigation "rescue" treatments are best applied during warm periods in fall, after harvest. However, future registration of paradichlorobenzene fumigants for fruit trees may become more restricted, so always check labels to insure that it remains a legal treatment.

Insect parasitic nematodes (e.g., *Steinernema carpocapsae*) have been reportedly used successfully to control peach tree borer larvae on ornamental *Prunus*. This has not been confirmed yet in Colorado trials. If attempted, suspensions of nematodes should be applied as a drench in fall or spring, when soil temperatures are above 55^0F.

A promising future control is the use of peach borer sex pheromones in the 'male confusion' method. The goal of this technique is to permeate the atmosphere with the sex attractant and to disrupt mating. At present, this is in development for use in commercial peach orchards.

Additional Publications: Colorado State University Service-in-Action 5.566, Peach Tree Borer: Characteristics and Control. For orchards, annually updated recommendations occur in publication XCM-41, *Colorado Tree Fruits: Pest and Crop Management Guide*.

CURRANT BORER

Synanthedon tipuliformis (Clerck)

Appearance: **Adults** - A type of clearwing borer moth. Generally blue-black in color with tufts of yellow scales on the hind end. Somewhat smaller than the peach tree borer. **Larvae** - Pale colored caterpillars found in stems and crowns of plants.

They can be separated from other borers by having small 'prolegs' on the abdomen.

Hosts: Currant, gooseberries

Damage: Larvae tunnel canes, particularly near the base of the plant. Leaves on infested canes are small and yellow, and canes often dieback. This is the most damaging borer to currants.

Associated Species: The bronze stem girdler, *Agrilus aurichalceus* Redtenbacker, is a metallic wood borer that frequently attacks *Ribes*. However, attacks are limited to the upper canes and generally are limited to stressed or overmature wood. *A. polistus* (Say) also attacks currants as well as other woody plants.

Life History and Habits: The currant borer spends the winter as a nearly full-grown in the base of canes of currant, gooseberry, sumac, or black elder. They feed for a brief period in spring, but cause little damage. They then pupate and later emerge as adults in late May or early June. The bluish-black adult 'clearwing borer' moths appear similar to wasps, and can be seen resting or mating on leaves of the plants.

Eggs are laid on the bark during June and early July and the caterpillar stage larvae bore into the plant. They move downwards, tunneling the pith and wood. These feeding injuries may girdle or weaken the plant causing cane dieback in late summer.

A mating pair of the currant borers. The adults can be observed during early June in most locations. Photograph by W.S. Cranshaw.

Related Insects: Other *Synanthedon* species can attack shrubs in Colorado including the viburnum borer (*S. viburni*), dogwood borer (*S. scitula*),strawberry crown moth (*S. bibionipennis*) and peach tree borer (*S. exitiosa*).

Control: Cut out and discard all canes that show evidence of wilting and dieback in spring, before adult moths emerge.

Insect parasitic nematodes, applied as a drench to the crown area of the plants, can control currant borer larvae that are tunneling canes.

Increasing plant vigor through proper culture can reduce the severity of infestations.

Control of currant borer with insecticides has had only marginal success. If attempted, treatments should be applied to coincide with periods when the moths are flying and laying eggs, typically early June. However, very few insecticides are registered to permit use on currants and gooseberries.

LILAC/ASH BORER

Podosesia syringae (Harris)
Family: Sesiidae

Appearance: **Adults** - Clearwing moths, superficially resembling wasps in appearance, with a wingspan of about 1 1/4 inches. The adult is black in color, with an opaque front wing marked with clear streaks and a dark brown fringe. The hind wing is transparent with yellowish-brown veins. **Larvae** - Creamy white caterpillars with brown heads, about 3/4 inch long at maturity.

A mating pair of adult lilac/ash borers. Photograph by W.S. Cranshaw.

Hosts: Ash, lilac and privet.

Damage: On ash, the larvae tunnel in branches and trunks, excavating galleries several inches long. On lilac and privet the larvae bore into main stems,

causing them to wilt and die back. Stems and branches may also break due to the weakening and infested trees may become gnarled. Often, large amounts of fibrous boring dust accumulates at the base of infested trees.

Life History and Habits: The ash borer spends the winter as a nearly full-grown larva within tunnels under the bark. It completes larval development in early spring and pupates. Adults emerge during April and May, characteristically pulling the old pupal skin out of the emergence hole. After mating, females lay eggs on bark, typically near wounds or bark cracks. The larvae tunnel into the tree after egg hatch and continue to tunnel and feed throughout the summer.

Lilac/ash borer larvae in tunnels of an ash trunk. Photograph by D.A. Leatherman.

Controls: Lilac/ash borer is most severe in plantings on marginal sites where stressful conditions occur. Proper siting to relieve future stresses can greatly limit attacks.

Fresh pruning wounds are highly attractive to the egg laying moths. It is important to avoid pruning prior to periods when moths fly.

Pheromone traps can be very useful for monitoring flight periods of this insect. The standard 'clearwing borer' lure is attractive to this species and lilac/ash borers are usually the only clearwing borer moth trapped during the early season. Trunk sprays of insecticides should be applied about two or three weeks after first moths are captured. If heavy flights continue a month after application, reapplication may be needed if the plants have previously sustained injury.

Pupal skins of the lilac/ash borer, pulled from the trunk during emergence. Photograph by D.A. Leatherman.

Several parasitic wasps are recorded as natural enemies of the larvae of this insect.

Related Insects: Several longhorned beetles also attack ash, although they limit attacks primarily to dying trees and are much less important than the lilac/ash borer in landscape plantings.

The banded ash clearwing, *Podosesia aureocincta* Purrington and Nielsen, has not been captured in pheromone traps in Colorado. However, isolated infestations may be established or become introduced on infested plants. This species flies and lays eggs in late summer.

RASPBERRY CROWN BORER

Pennisetia marginata (Harris)
Family: Sesiidae

Damage: Larvae tunnel into the base (crown) of raspberry plants. This causes wilting of the entire cane and can kill plants. Symptoms are most severe in midsummer.

Raspberry crown borer in the base of a plant. Photograph by J.L. Capinera.

Life History and Habits: Life cycle of the raspberry crown borer requires two years to complete. Adult moths emerge from the base of infested plants from mid-July through August. After mating the females lay eggs around the canes. Eggs hatch in three to five weeks and the young borer larvae tunnel into the lower canes. The first winter is spent in a small chamber cut into the side of the lower canes.

The larvae feed throughout much of the following season, moving finally to the soft areas within the crown. They overwinter a second season within the plant and resume feeding in spring. Most damage is done by the larger, nearly full-grown, larvae. During June and July, the larvae stop feeding, pupate and later emerge as the adult moths.

Control: Sprays of the insecticide diazinon, directed at the base of the plant during late-summer, can kill the moths and newly hatched larvae. Drenches of insecticides applied after harvest in early fall, can kill young larvae before serious injury occurs. However, registration of this treatment may be discontinued by the manufacturer. Regardless, since the raspberry crown borer has a life cycle that requires two years to complete controls need to be sustained over at least two years to kill the larvae when they are exposed on the outside of the cane.

Alternatively, a promising biological control involves drenches of insect parasitic nematodes (*Steinernema* species) around the base of plants. Applications should be done in a high volume of water during periods when soil temperatures are at least 50 degrees F.

Immediately dig up and discard infested plants as soon as wilting occurs to kill larvae before they emerge.

Related Species: The strawberry crown moth, *Synanthedon bibionipennis* (Boisduval), is a slightly smaller species of clearwing borer that develops in Rubus and rose, as well as strawberry. In Colorado, it has only been recorded from the Front Range.

ELDER SHOOT BORER

Achatodes zeae (Harris)
Family: Noctuidae

Appearance: **Adult** - Fairly typical cutworm-type moth, with rusty red wings mottled with gray and a tawny spot along the wing tip. Wing span about one and 1/4-inches. **Larva** - Generally yellowish caterpillar with dark bands on the head, first, and last body segments. When full-grown they reach a length of between 1 and 1 1/2 inches.

Hosts: Various species of elder (*Sambucus*), particularly golden elder. Corn and dahlia are also reported to be uncommon hosts.

Damage: Larvae tunnel the new canes, causing them to die back in late spring.

Life History and Habits: The elder shoot borer spends the winter in the egg stage, within an egg mass attached to bark of the old canes. Eggs hatch about the time that the new shoots start to emerge, typically late April. The young larvae first feed on the unfolding leaves for several days before boring into the new shoots. They feed within the shoot for several weeks. They often remain in they original shoot, but if food is exhausted, they will migrate to a new lateral shoot, usually entering near the base. Caterpillars feed and develop for about six to eight weeks, pupating in late June or early July. Pupation may occur within the damaged shoot, but often occurs in the pithy center of dead, dry branches, or on the ground.

Adults emerge in July. Females lay eggs under loose bark of old canes. Eggs are laid in masses averaging about 18 eggs and numerous egg masses may be produced. Eggs do not hatch until the following spring. There is one generation per year.

Control: Several parasitic wasps are reported to attack the elder shoot borer, as well as a tachinid fly. Downy woodpeckers sometimes dig the caterpillars out of elder shoots.

Since the eggs overwinter on older canes, cutting and removing old wood before spring is a highly effective control.

Chemical controls have not been identified and are unnecessary if the above cultural controls are practiced. Timing of insecticide treatments, if attempted, would likely be best made as soon as new shoots emerge from the soil in spring.

COTTONWOOD BORER

Plectodera scalator (F.)
Family: Cerambycidae

Appearance: **Adults** - A large beetle, from one to one and one half inches long, with white and black checkered markings on the wing covers. **Larvae** - Legless elongate grubs with retracted head. Larvae reach one and one half to two inches when full grown.

Hosts: Cottonwood, other poplars, willow

Damage: Larvae tunnel into heartwood of trees. During heavy infestations trees may be severely weakened and break at the base in periods of high wind. Adult feeding on bark of twigs and tender branches may cause some dieback.

This species is most common in the southeastern area of the state, particularly around Lamar.

Life History and Habits: Adults are active in late spring or early summer, and feed on tender young shoots. This adult feeding often causes the shoots to break, shrivel and turn black. Eggs are then deposited in pits chewed in the bark at the tree base. Larvae hatch and feed in the phloem, progressing downward into larger roots during their first fall. Larvae spend the second summer feeding in galleries at the tree base. The life cycle requires two years to complete.

Control: Rarely needed. Controls would be similar to those used for other wood boring beetles.

Mating pair of the cottonwood borer.

LOCUST BORER
Megacyllene robiniae (Forster)
Family: Cerambycidae

Appearance: **Adults** - Black beetles marked with yellow cross bands on thorax and "W" shaped bands on the wing covers, about 3/4 inch in length. **Larvae** - Robust, cream colored, legless grubs with brown heads, about one inch in length.

Host: Black locust (*Robinia* sp.)

Damage: Infested trees are physically weakened by extensive larval tunnels. Older trees can be damaged or killed. Younger trees may grow slowly. This borer is a major limiting factor when growing black locust in Colorado.

Life History and Habits: Adults are active in late summer and early fall, and are commonly seen feeding on various flowers. Also at this time eggs are deposited in cracks and crevices in bark of host trees. Larvae hatch in late fall, bore into bark and construct small hibernation cells for overwintering. They resume activity in the spring and tunnel extensively through heartwood. The larvae mature in the latter part of July. There is one generation per year.

Adult locust borer.

Control: Preventive trunk sprays of insecticides can be applied in mid to late summer to control the insect during the egg laying/egg hatch period.

POLE BORER
Parandra brunnea (F.)
Family: Cerambycidae

Appearance: **Adults** - Not typical of other longhorned wood borers. It is about 3/4 inches long, very; shiny, reddish-brown, with short antennae. The jaws are prominent. Because of its unusual form it is sometimes call the "aberrant wood borer". **Larvae** - Slender, white grub with a brown head, up to 1 1/4 inches long.

Adult of the pole borer.

Hosts: Maple, elm and many other hardwoods. Also may attack conifers.

Damage: This insect is usually a borer in trunks of recently dead or dying trees. Tunnels can exten-

sively riddle the wood inviting collapse or storm breakage. Telephone poles can also be badly damaged.

Life History and Habits: Adults are active in midsummer. In addition to dying trees, any situation where wood contacts the soil may be attractive. On living trees, areas such as wounds or pruning scars are occasionally used. Larvae honeycomb the wood during their development which might stretch over three to four years.

BLACKHORNED PINE BORER

Callidium antennatum hesperum (Casey)
Family: Cerambycidae

Appearance: **Adults** - Bluish-black beetles, about 1/2 inch long with antennae the same length as the body. The wing covers are more leathery than with other beetles. **Larvae** - Resemble most wood borers, being off-white, legless grubs with brown heads. The immature forms are found within their tunnels under bark.

Adult of the blackhorned pine borer visiting the terminal growth on which it feeds. Photograph by W.S. Cranshaw.

Hosts: Pines primarily, but other conifers are hosts

Related Species: A closely related species, *Callidium texanum* Schaeffer, occurs in junipers and also is common in Colorado.

Damage: These borers are abundant and attack dying trees or trees under severe stress, such as recent transplants. As they feed they deeply score the wood under the bark and can kill declining trees.

This borer also causes much concern to home owners by emerging from firewood or unseasoned lumber. It can also loosen the bark from rustic homes by tunnelling the cambium of logs. In firewood, large amounts of sawdust are produced by larvae, creating some confusion between these borers and the genuinely serious termites or powderpost beetles.

Callidium borers leave a distinctive packed, granular frass in the tunnels they produce and deeply score the wood.

Tunneling of the wood by the blackhorned pine borer larva.

Life History and Habits: Winter is spent within the trees, as a full-grown larva. Adults can emerge throughout the warm months of the year and have been observed in early May along the Front Range. Adult beetles feed on tender bark of twigs and shoots and females lay eggs in pits in the bark. The larvae tunnel under the bark making very wide, wavy tracks that characteristically score the outer wood deeply. Older larvae then excavate oval tunnels deep in the wood, where they overwinter. There is one generation per year.

PONDEROUS BORER

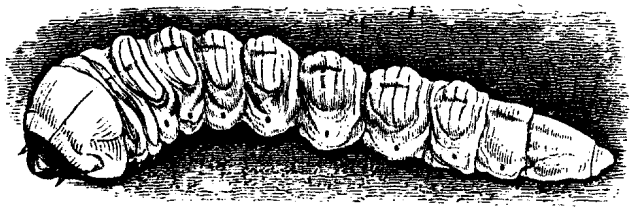
Ergates spiculatus (LeConte)
Family: Cerambycidae

Hosts: Ponderosa pine and Douglas-fir are the principle hosts

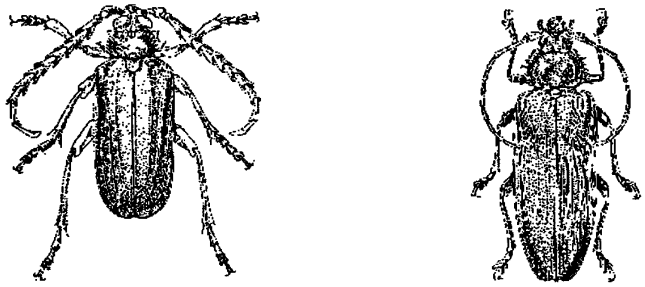
Damage: The ponderous borer only develops on fallen trees and is not a threat to landscape plantings. However, this is the largest species of wood boring beetle found in Colorado and their large size attracts attention.

Life History and Habits: Larvae of the ponderous borer are known to foresters as timber worms. As larvae they feed in the wood of dead and dying pines. Borer weakened snags often fall more

quickly than other trees so that it reduces the fire danger. Eggs are laid in the bark crevices of dead trees and stumps. Larvae excavate large tunnels through the sapwood and heartwood. The life cycle takes several years to complete.



Larva of a Prionus species, a very large roundhead borer.



Adults of Prionus californicus, male (left) and Ergates spiculatus, female (right). Drawings from Univ. Calif. Publications in Entomology.

Related Species: Several dark-colored long-horned beetles in the genus *Prionus* occur in Colorado. Although all are smaller than the ponderous borer, one species, the California prionus (*Prionus californicus* Motschulsky) can reach a length of two to three inches. In Colorado, the California prionus is limited to areas along the West Slope.

PINE SAWYERS

White spotted sawyer beetle [*Monochamus scutellatus* (Say)],
Monochamus clamator (LeConte), and
other *Monochamus* spp.
Family: Cerambycidae

Appearance: **Adults** - Large beetles (about one inch long), black to brownish-gray with white speckling, with long antennae two to three times the body length. Segment behind the head (thorax) has a toothlike spine projecting outward on each side. **Larvae** - Legless grubs, heads of older larvae slant sharply downwards.

Adult of the white spotted sawyer beetle. Photograph by D.A. Leatherman.

Hosts: Pine, spruce, fir and Douglas-fir

Damage: Larvae bore extensively in sapwood and heartwood of dying and recently killed trees. Adults cause minor injury by feeding on needles and shoots. In parts of the Midwest this genus includes the primary vectors of the pine wilt nematode, which produces pine wilt disease.

Life History and Habits: Adults are present from spring to late summer. They feed in tree crowns and lay eggs in round niches cut in the bark. The larvae construct wide galleries just under the bark which are filled with fibrous frass. Large piles of sawdust and fiber often accumulate below infested trees or longs. Larvae enter the wood and tunnel for several months. There is one generation per year.

REDHEADED ASH BORER

Neoclytus acuminatus (F.)
Family: Cerambycidae

Appearance: **Adults** - The beetles have a narrow brown body with reddish head and thorax, about 5/8 inch long. Wing covers are marked with four yellow transverse bands. They have long spindly legs and move rapidly. **Larvae** - Legless, dirty white grubs with brown heads, about one inch long when mature.

Hosts: Ash, several fruit trees, and other hardwoods

Damage: Usually attacks only dead and dying wood, but will also bore into twigs and branches. Can reduce sapwood to powder.

Adults of the redheaded ash borer and banded ash borer very commonly emerge during early spring from firewood stored indoors.

The redheaded ash borer. Photograph by S. Krieg.

Related Insects: The banded ash borer, *Neoclytus caprea* (Say), is another roundheaded borer that is generally similar in appearance and habits to the redheaded ash borer. It is marked with yellow stripes on the wing covers and is slightly larger than the redheaded ash borer. Another similar species common in the state is *N. muricatulus* (Kirby), associated with spruce logs.

Associated Insects: The ash borer, *Podosesia syringae* (Harris), is the most damaging borer of ash in Colorado. It is a clearwing borer moth, discussed above.

Banded ash borer.

Life History and Habits: Adults become active in late spring and females deposit eggs beneath bark of dead or dying hardwoods. Newly hatched larve first feed beneath the bark, then tunnel into sapwood. They pupate in the fall. There is one generation per year.

POPLAR BORER

Saperda calcarata (Say)

Family: Cerambycidae

Appearance: **Adults** - Gray beetles with a central yellow stripe on the thorax and fine yellow and black stippling on the wing covers. About 1 1/4 inches long. **Larvae** - Large, yellowish, round-headed grubs, about 1 3/8 inches long when mature, and found only within their tunnels.

Adult of the poplar borer. Photograph by W.S. Cranshaw.

Hosts: Primarily aspen, but cottonwood, poplar and willow are also hosts.

Damage: Interior limbs and trunks can become "honey-combed" with galleries produced by the larvae. A black varnish-like stain commonly forms on the bark below points of borer attack and the larvae push out stringy sawdust as they feed. Branches and trunks may break off in high winds and trees may be invaded by wood rot. Wound sites also develop rough growths on the bark. The poplar borer is the most destructive insect to aspen in many areas of the state. Poorly watered ornamental plantings of aspen appear particularly susceptible.

Related Species: The poplar-gall saperda, *S. inornata* (Say), forms galls on the twigs of aspen, poplar and willow. The elm borer, *S. tridentata* Olivier, develops in dead or weakened American elms sometimes causing dieback of individual limbs. Both species are uncommon in Colorado, but are reported to seriously damage trees in other areas of the United States.

Life History and Habits: The poplar borer has an extended life cycle that likely requires three years to complete; shorter life cycle may occur in warmer areas of the state. Adult beetles may be present from mid June through early fall, and feed on bark of young twigs. After mating, females chew pits in the bark and insert eggs. Most egg laying is concentrated in the middle of the tree, particularly near existing areas of infestation. During the first year, the young larvae spend the winter under the bark.

Oozing and shellac-like staining on the bark are typical reactions to infestation of the poplar borer.

In spring, they enter the sapwood and heartwood where they feed for two years, producing large, black, swollen scars on trunks and limbs. Throughout their period of feeding, they maintain an opening to the outside, through which they push the boring dust. After the larval stage is complete, they form a chamber under the bark, where they pupate and spend the winter.

Control: Because of the long (probably three year) life cycle, poplar borer is particularly difficult to control. Standard preventive borer treatments of insecticides applied to the trunk should provide coverage throughout the period of adult activity (primarily July and August). Application should be most thorough to existing areas of attack, in the middle of the tree, where egg laying is concentrated.

Insertion of 'borer crystals' (paradichlorobenzene) or injections of insect parasitic nematodes (*Steinernema* species) into active borer tunnels have given partial control of larvae. Because this species does maintain an external opening, sprays of nematodes may also be effective, as they have for wood-boring species of similar habit.

Often, individual trees may serve as "brood trees" which can serve as sources of large numbers of poplar borers which may infest other plantings. Removal of these highly susceptible trees should be considered. Most often, large, overmature trees in open areas are particularly susceptible to attacks by this species.

JUNIPER BORER

Atimia huachucae Champlain and Knull
Family: Cerambycidae

Appearance: **Adult** - Generally gray-brown, longhorned beetle, about 1/2 inch in length, with wing covers marked by numerous small dark spots. **Larva** - A roundheaded borer, found tunneling within the trunks and larger branches of juniper.

Hosts: Junipers, particularly upright junipers such as 'Blue Haven'

Damage: The larvae tunnel under the bark of the trunk and larger branches, producing girdling wounds. Portions of the plants affected by this injury often turn brown and die back.

This insect apparently attacks weakened trees and damage may occur gradually over several years before obvious symptoms are visible. Injury points, such as wounds made by support wires, are common areas where the insect attacks are concentrated.

Life History and Habits: Adults emerge from mid-May through June. They feed on the foliage and females lay eggs under bark scales, concentrating egg laying near wounds. The larvae develop by feeding between the wood and bark, packing fibrous frass behind them as they tunnel. At the end of the summer they form a pupal chamber within the sapwood, plugged with coarse wood fibers.

Controls: Relieving or avoiding important sources of stress, such as root disturbances or wounding, is very important in management of this, and most other borers.

Preventive insecticide sprays are best applied to coincide with periods when the adults are active on the foliage and bark. For this species, adult emergence and egg laying usually begins in late May or early June.

FLATHEADED APPLETREE BORER
Chrysobothris femorata (Olivier)
Family: Buprestidae

Appearance: **Adults** - Dark olive-gray to brown beetles, about 1/2 inch long. Wing covers have narrow lengthwise grooves and a metallic luster. The body is blunt at the head, and tapers to a rounded point. **Larvae** - Yellowish-white, legless grubs with a broad, flat enlargement just behind the head. Up to one inch long when mature.

Hosts: Almost all broad-leaved fruit, forest and shade trees. Maples, particularly red maples, and apple are among the more common hosts in Colorado.

Damage: The immature stage (flatheaded borer) tunnels under the bark of trunks and larger branches. Large areas of bark die beyond the wounds, weakening and sometimes girdling trees. Apple is the most common fruit tree damaged by flathead borers. However, a wide variety of plants can be attacked including pear, maple, rose, willow and sycamore. Newly transplanted trees and trees in poor health are at greatest risk of attack.

Damage is generally first concentrated on the sun-exposed sides of the tree, but later can expand. The meandering mines are packed with a fine sawdust, which is diagnostic for these and other flatheaded borers. A slight darkening of the bark and depression may be external evidences of infestation.

Two closely related species occur within the region. The Pacific flathead borer (*Chrysobothris mali* Horn) predominates in the western areas; the flatheaded apple tree borer in the east. However, their ranges overlap.

Life History and Habits: Both the flatheaded apple tree borer and Pacific flathead borer have similar life histories. Winter is spent in the larval (flathead borer) stage, under the bark. They continue to grow and feed during late winter and early spring, then bore into the trunk and pupate. The adult beetles (known metallic wood borers) usually emerge between mid-May (shortly after apple bloom) and August. Adult flight peaks in the Denver area appear to be from late May through mid June.

During this period, the individual beetles remain active for several weeks and feed on leaves. They may also be commonly observed sunning themselves on the bark during the day. Mated females search the trees and lay eggs in cracks and crevices of large branches or trunks. Trees in poor vigor are preferred and most eggs are laid near areas damaged by bruising, sunscald, or other injuries. The larvae later emerge by chewing through the bottom of the egg and tunneling directly into the tree. They continue to feed for several months, becoming dormant during the cold season. There is one generation per year.

Controls: Attacks by flatheaded apple tree borer and Pacific flathead borers are concentrated around wounds, cankered areas, and on trees in generally poor health. Healthy trees are less attractive to the egg laying females and the tunneling larvae often are killed by tree defenses, such as oozing sap. By maintaining trees in a healthy, vigorous condition and preventing injuries, problems with these insects can be avoided.

Where sunscald injuries are likely, shade the lower trunk of young trees or use tree wrap to prevent this injury. Whitewashing the trunks can also reduce attacks.

Dying trees and newly cut wood should not be kept near susceptible trees, since large numbers of borers can develop in these materials.

Once the borers are in the trunk, digging them out in late summer or early fall is the only control. This is difficult to do without causing additional tree injury.

Preventive use of insecticides, applied to trunks and branches before egg laying has sometimes provided good control, although performance has been erratic in some reports. Use of fumigants (e.g., paradichlorbenzene) has not been effective.

BRONZE BIRCH BORER
Agrilus anxius Gory
Family: Buprestidae

Appearance: **Adults** - Narrow metallic coppery beetles with a somewhat flattened back, about 1/2 inch long. **Larvae** - A typical flatheaded borer; white, segmented grub with an enlarged flattened area just behind the head and no legs.

Hosts: Birch

Damage: Girdling first causes limb dieback, and trees may be completely killed. Ornamental birch

trees in poor vigor due to insufficient watering or poor site are particularly susceptible. This is the most damaging insect pest of birch in Colorado.

Adult bronze birch borer.

Related Species: Several species of *Agrilus* attack shade trees and shrubs. Among the more common is *A. difficilis* Gory, which is found in many plants, and commonly is associated with honeylocust wounds. It is a metallic purple color and similar in size to bronze birch borer. Other common species include the bronze cane girdler, *Agrilus aurichalceus* Redtenbacher, that attacks currant, rose, and raspberry and *Agrilus politus* (Say), which develops in many woody plants. Life cycle of other members of this genus is similar to the bronze birch borer.

Life History and Habits: Adults emerge in late May or early June, cutting an oval opening through the bark. They feed some on leaves and mate shortly after emergence. Females lay eggs in bark crevices, around curls of bark or in other protected sites, primarily on the unshaded areas of the trunks and branches. The emerging larvae tunnel into the cambium and feed there. They produce galleries of a zig-zag pattern in the cambium. Trees that overgrow these wounds may show evidence of tunneling as a raised trail when examining the outer bark.

Mature larvae overwinter and pupate early in the spring. There is one generation per year.

Controls: Proper siting and maintenance of birch is very important in maintaining vigor which can help resist attacks. However, in typical lawn settings in Colorado, these trees are often stressed and susceptible to attack.

Individual limbs which show evidence of dieback should be trimmed and disposed before beetles emerge in spring. Pruning should be done below the point where there is evidence of infestation. Raised areas on the bark, resulting from callus growth around borer tunnels, is a means for easily identifying much borer activity. If raised areas, or semicircular exit holes, are found on larger branches or the trunk, pruning will have little chance of rescuing the tree.

Typical meandering tunnels in the cambium produced by flathead borers. Photograph by D.A. Leatherman.

Preventive insecticide applications need to cover the trunk throughout the adult activity period when new eggs are laid. This can occur from late May through early July. Under heavy pressure by this insect, three applications may be needed.

There has been some success with injections of insecticide when applied prior to egg laying. However, these treatments are not very effective against older borers that have already damaged extensive areas of the cambium. Furthermore, wounds caused by injections can further stress the tree leading to later decline.

Some species and varieties of birch have been observed to be resistant to bronze birch borer, notably river birch. However, none of the white-barked cultivars currently sold are reliably resistant to this insect where pest pressure is high.

ROSE STEM GIRDLER/ BRONZE CANE BORER

Agrilus aurichalceus Redtenbacher
Family: Buprestidae

Hosts: Currant, gooseberry, raspberry, rose

Damage: The flathead borer stage (larva) makes meandering tunnels under the bark of rose, caneberries (raspberry, blackberry, etc.), currants and gooseberries. Characteristically a swollen area develops around the wounded area of the stem. Canes often die back or break at these wounded sites.

Adult of the bronze cane borer, a typical member of the genus agrilus. Photograph by W.S. Cranshaw.

Life History and Habits: The bronze cane borer overwinters as a nearly full grown larva under the bark of the canes or within the pith. In spring it resumes feeding and pupates within the plant. Adult stage is a bronze colored beetle which emerges in late May and June. Eggs are laid during this period, usually near the base of leaves. The larvae which emerge from eggs tunnel under the bark and move upwards in the plant. There is one generation per year.

Control: Canes that show evidence of injury should be removed before midspring to destroy the insects before they emerge.

Effective chemical controls have not been demon-strated. If attempted, they are best applied during late spring to kill adult beetles before they have laid eggs. Larvae within stems can not be controlled with insecticides.

Miscellaneous Notes: The bronze cane borer is related to the rednecked cane borer, *Agrilus ruficollis* (F.), an eastern species which causes similar injury to caneberries. *Agrilus politus* (Say) is another small flatheaded borer which can be found on a great many hosts, including currant and willow.

A more damaging borer attacking currant is the currant borer, *Synanthedon tipuliformis*, discussed above. The currant borer concentrates feeding in the crown of the plant and can kill several canes.

PIGEON TREMEX
Tremex columba (L.)
Family: Siricidae

Appearance: **Adults** - Large, thick-waisted, cylindrical wasp, about one andd one half to two inches long with brown wings, reddish head and thorax, and yellow-striped body. Females have a one half inch long "stinger" (actually the ovipositor or egg-laying organ) at the end of the body. **Larvae** - Slender, white worms with brown heads and a small point on the tip of the abdomen. They are up to 2 inches long when mature.

Hosts: Silver maple, elm and many species of hardwoods.

Damage: The larvae create meandering tunnels within the sapwood of dead and dying trees. Densely tunneled trees may be prone to wind breakage. However, damage is usually confined to dead wood or to parts of the tree suffering from severe stress. Horntails are not "aggressive" wood borers and can not develop in healthy trees.

Adult of the pigeon tremex. Photograph by D.A. Leatherman.

Life History and Habits: Adults are most common in late summer when they land on appropriate hosts to mate and lay eggs. The females insert their ovipositor through the bark and into the wood. Commonly these "horntails" are unable to retract the ovipositor and are found positioned as if stinging the tree trunk. Larvae feed on the wood, creating tortuous tunnels, and emerge the following summer. The exit holes are perfectly round. (Most

other wood borer tunnels are oval in cross section). There is one generation per year.

Related Species: Several different horntails (*Sirex* species, *Urocerus* species) are associated with conifers. Most are black or blue-black and somewhat smaller than the pigeon tremex. These horntails attack trees that are in advanced decline or recently killed. They are particularly attracted to fire killed trees. They are not a problem for landscape or forest plant protection, but can degrade lumber by their tunneling.

Controls: Large, eye-catching ichneumon wasps with spectacular ovipositors often parasitize horntails and provide natural control of this insect. (See Giant Ichneumon Wasp, *Megarhyssa macrurus*).

Problems with pigeon tremex, and other horntails are limited to wood that is dead, dying, or under severe stress. Attention to cultural conditions that create these stresses can prevent attacks.

POPLAR AND WILLOW BORER

Cryptorhynchus lapathe (L.)
Family: Curculionidae

Appearance: **Adults** - Large, chunky snout weevils, about 3/8 inch long, and rough-surfaced. They are primarily black in color except for the hind 1/3 of the wing covers which are gray. **Larvae** - Cream-colored, legless, "C"-shaped grubs about 1/4 inch long.

Adult of the poplar willow borer.

Hosts: Willow and, rarely, poplar

Damage: The larvae tunnel under the bark of trees and may kill trunks. Infested trees may become malformed because of excessive sucker growth. Young willows may have bulb-like swellings from borer attack. An uncommon species affecting landscape plants in Colorado, the poplar and willow borer is found frequently in moist sites such as along streams and ponds.

Life History and Habits: The poplar and willow borer spends the winter as a partially grown larva in the sapwood. In the spring, the larvae grow and continue boring, pushing large amounts of fibrous frass through exit holes. Pupation takes place in June and adults appear in midsummer. White eggs are deposited in small slits in the bark. There is one generation per year.

SCALE INSECTS

Scale insects suck sap from plants in a manner similar to other members of the order Homoptera, such as aphids. However, scales are characterized by their production of a protective waxy covering and many produce a waxy egg sack or covering, known as a **test**. This cover also can protect scales from effects of most insecticides.

There are several families of scale insects in Colorado, which have a range in form from the true 'hard' or 'armored scales', such as oystershell scale, to those that very much resemble aphids and mealybugs. Some of the differences between the 'armored scales' and 'soft scales' are indicated in Table 9, below.

Proper tree care, including pruning of heavily scale-infested branches, is a primary management strategy for scales. However, with certain host-plant/scale combinations supplemental controls are needed.

The armored or hard scales overwinter on the plants as eggs within a membranous **test** underneath the old mother scale covering. Other species overwinter as partially grown nymphs. These overwintering scales can be killed by use of oil sprays applied as dormant treatments in spring before bud break. However, control of hard scales is more erratic than soft scale control due to the protective covering.

Horticultural oils are also useful for scale control on many plants after new growth emerges. Hard scales are very susceptible to oils during the first few weeks after egg hatch, when the covering is relatively thin. However, on some plants these summer uses of oils are limited by phytotoxicity concerns.

Use of insecticide sprays for scale insect control require applications that coincide with scale egg hatch. The brief period after egg hatch is the **crawler** stage when the insect is mobile and has not yet produced a protective waxy coating. Occurrence of the crawler stage differs by scale species and weather. After the insect settles and secretes wax it is largely impervious to insecticides. Insecticidal soaps, summer horticultural oils, diazinon, Dursban, carbaryl (Sevin), Orthene, Tempo, Talstar, an Mavrik have labeling for control of at least some species of scale insects when applied during the crawler stage (**crawler sprays**). Repeat applications may be needed to maintain coverage through egg hatch with species that have an extended period of egg hatch.

Occurrence of scale crawler activity can be monitored in many ways. Branches known to be infested can be shaken over a collecting surface (e.g., paper, trays) and examined for the presence of the tiny crawlers. Often it helps to use a surface that is smooth and contrasts with the color of the crawler, i.e., light colored surfaces for detection of dark crawlers such as pine needle scale; darker surfaces for detection of light crawlers such as oystershell scale. Alternatively, crawlers can be trapped on double-sided sticky tape, which, if examined regularly, can also be used as a method for sampling relative scale activity.

Specific recommendations for control of scale insects appear in the supplement on control recommendations. Sections dealing with scales include: **Oystershell scale**, **Pine needle scale**, and **Soft scales (General)**.

Table 9. Comparison of General Characteristics of Armored Scales (Diaspididae) versus the 'Soft scales' (Coccidae, Asterolecaniidae, Eriococcidae).

	Armored (Hard) Scales	Soft Scales
Scale covering attached to the insect	No	Yes
Eggs laid inside a sack-like test	Yes	No
Usual overwintering stage in Colorado	Eggs	Mated female or 2nd instar
Typical occurrence of crawlers	Late April-early June	Early-June to early August
Ability to move after crawler stage	No	Limited summer movement typical from leaves to twigs
Production of honeydew	Little or none	Often produce abundant amounts of honeydew

OYSTERSHELL SCALE

Lepidosaphes ulmi (L.)
Family: Diaspididae

Appearance: **Adults** - Females are armored, light to dark brown, elongated and oyster-shaped. On some hosts the scale is covered with a fine powder of wax. **Nymphs** - Generally similar to adults, although lighter in color. The crawler stage is pale yellow.

Oystershell scale.

Hosts: Many hosts are commonly attacked by oystershell scale, making this one of the most destructive insect pests of trees and shrubs. Aspen, ash, cotoneaster, and lilac are among the most commonly damaged landscape plants.

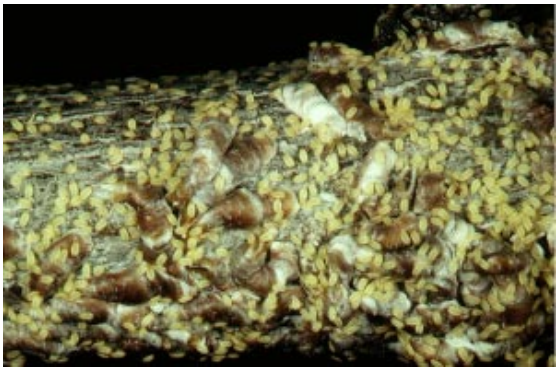
Damage: The oystershell scale feeds on the phloem of trunks and branches. Heavy infestations produce stunting, foliage yellowing, and bark cracking. Dieback of branches is common result of oystershell scale injury and infested trees are often so weakened they succumb to Cytospora canker.

Life History and Habits: There is one generation of oystershell scale per year in Colorado. Winter is spent in the egg stage under the old cover of the mother scale. The pearly white eggs hatch in late May or early June, and pale yellow crawlers emerge. The crawlers move over the bark in search of sites where they may feed. If successful in reaching the phloem, they settle and shortly afterwards molt. Following this molt the scales are legless and are immobile for the rest of their life. Oystershell scales mature in mid-July and mate. Eggs are laid in late summer and early fall. The mother scale dies at the end of the season.

Control: On smaller trees, old scale coverings and eggs can be destroyed by scrubbing the bark with a soft plastic pad. Very heavily infested branches may need to be pruned.

Vigorous plant growth, provided by proper siting and care, appears to help reduce scale infestations.

The most effective chemical controls are "crawler sprays", applied to coincide with egg hatch. Carbaryl (Sevin), chlorpyrifos (Dursban), diazinon, Orthene, Tempo, Talstar, and Mavrik are currently available crawler sprays. (Note: Aspen foliage is sensitive to liquid formulations of many insecticides.) Alternatively, insecticidal soaps or oil sprays applied in three to four day intervals during the crawler period can also provide control. Although most treatments are largely ineffective after scale crawlers have molted, summer (foliar) spray oils can control young nymphs for several weeks after they have settled on the bark.



Oystershell scale crawlers.

Effectiveness of oils applied as dormant treatments has been more erratic with oystershell scale than with many other scales. This is because the eggs are well protected by the covering produced by the mother scale. Dormant applications of oils are more likely to be effective in spring, after the scale covering has weathered.

Old scales remain in place for several years after the scales have died. In order to determine if controls are effective, old scales should be cleared from at least some of the branch, so that reinfestation can be detected. Also, when crushed, dead scales are dry and flake easily off the bark; scales covering eggs typically will produce some moisture when crushed.

SAN JOSE SCALE

Quadraspidiotus perniciosus (Comstock)
Family: Diaspididae

Appearance: **Adults** - Female is an armored, circular, flattened gray scale with yellowish or orange center. Full grown scales are approximately 1/16 inch in diameter. Males are oval and smaller than a pinhead and winged when fully developed. **Nymphs** - Armored, circular, slightly convex and almost black.

Hosts: Apple, rose, pyracantha, cotoneaster and crabapple are common hosts but many hardwood trees and shrubs in the rose family (Rosaceae) may be infested.

Related Species: The walnut scale, *Quadrispidiotus juglansregiae* Comstock), also occurs throughout much of the state. It also has a wide host range of deciduous trees and shrubs and even some evergreens.

Damage: The scales feed on the phloem and can cause serious injury to these tissues. Infested trees lose vigor with thinning and yellowing of foliage. Twig dieback can occur during heavy outbreaks, when the scale can occur as a grayish crust on the branches. A small reddish area often develops on the twigs around the feeding scale and extends internally to the xylem.

San Jose scale also may infest fruit. Fruit becomes spotted around the feeding site of the scale.

San Jose scale.

Life History and Habits: San Jose scale overwinters as second instar nymph. It remains dormant until sap flows in the spring, then continues to feed and develop. While feeding, both nymphs and adults secrete hard waxy coating (armor) over their bodies. Full-grown scales mate and females may produce hundreds of eggs and crawlers.

There are probably three generations produced during the growing season in Colorado. As the season progresses there is considerable overlap and all stages may be found during summer.

Control: Dormant oil applications can control overwintering stages. Crawler sprays are best applied against the first generation, since the populations are most synchronized at this time. The first generation crawlers often occur shortly after apple petal fall.

Pheromone traps have been developed for this insect. These capture the small, winged male scales and can be used for timing treatments after the first generation. However, since egg hatch becomes increasingly spread out as the season progresses, the value of these later treatments can be marginal.

San Jose scale is attacked by several parasitic wasps. The twicestabbed lady beetle is an important natural predator.

WALNUT SCALE

Quadrispidiotus juglansregiae (Comstock)
Family: Diaspididae

Appearance: This insect closely resembles the San Jose scale. **Adults** - Female is an armored, circular, flattened gray scale with yellowish or orange center. Full grown scales are approximately 1/16 inch in diameter. Overall color is somewhat more orange or reddish-orange than the San Jose scale. **Nymphs** - Armored, circular, slightly convex and gray or white.

Hosts: A wide variety of deciduous trees and shrubs are listed as hosts, with most Colorado infestations associated with linden. Despite its name, the only walnut species (*Juglans* spp.) that hosts this insect is Persian walnut.

Related Species: The San Jose scale, *Quadrispidiotus perniciosus* (Comstock), also occurs throughout much of the state, primarily on fruit trees.

Damage: Infested trees lose vigor with thinning and yellowing of foliage. Twig dieback can occur during heavy outbreaks.

Life History and Habits: Life history of the walnut scale in Colorado is unknown. Based on infor-

mation in other regions it probably spends the winter either as a partially developed scale in the second instar. Development continues in spring with mature females being present in late June. After mating, the females produce eggs that hatch in early July. The nymphs from these eggs mature rapidly in summer, maturing around early August and produce a second generation.

Control: Dormant oil applications can control overwintering stages. Because of the extended egg hatch period, crawler sprays may be difficult to time correctly. Crawler sampling should begin in mid to late June.

PINE NEEDLE SCALE

Chionaspis pinifoliae (Fitch)
Family: Diaspididae

Appearance: **Adults** - Almost pure white, elongated and armored. The mature female is slender at front end, widening at the rear. Males are smaller and more slender than female. **Nymphs** - Same as adults, but smaller. Crawler stage is dark purple, unarmored and mobile.

Hosts: Pine, spruce, and fir

Pine needle scale.

Damage: Pine needle scales feed by sucking sap from the needles. Feeding causes needles to discolor around the feeding site and during heavy infestations needles prematurely drop. Prolonged outbreaks can kill branches and even young trees.

On many trees, outbreaks are confined to limited areas - usually a single branch or two. Damage has been especially noticeable on mugho pine.

Life History and Habits: Pine needle scales almost always survive winter as eggs beneath the covering of the dead mother scale on needles. However, very mild conditions sometimes permit adult scales to survive the winter, which then lay eggs the following spring.

Overwintered eggs hatch in late April or early May; eggs laid in spring will hatch somewhat later. The newly hatched crawlers are reddish-brown. They move to needles to feed, often settling near the mother scale covering. Once they have settled and fed for about a week, they molt and start to produce a waxy protective covering. As they near maturity, they then begin to produce the characteristic white covering which later encloses the eggs.

A female pine needle scale pulled from the needle to expose the eggs. Photograph by W.S. Cranshaw.

The first generation nymphs mature in late June or early July. After mating the female lays eggs, typically in a batch of 20-30. These eggs hatch in late July and the second generation infests the current season needles. They mature by fall, and eggs are laid beneath the mother scale, which then dies.

Related Species: The scurfy scale, *C. furfura* (Fitch), also a closely related, white-colored scale, but restricts feeding to broadleaf trees, such as poplar.

Control: Several natural controls limit pine needle scale in Colorado. The most important biological control is the small lady beetle *Chilocorus stigma* (Say), better known as the twicestabbed lady beetle. Adults and larvae of this beetle feed on all stages of the pine needle scale throughout the year. Harsh winter temperatures also appear to kill many of the overwintering eggs.

The most effective applied controls are insecticides applied during periods of crawler hatch. This typically first occurs by early May in most locations and crawlers can be detected by shaking infested

branches over a white sheet of paper. The crawlers are very small, approximately the size of mites, and reddish-purple. The presence of crawlers indicates the best timing for treatments. The crawler stage typically lasts only one to two weeks, but can be extended if some females have survived the winter and produce additional eggs in spring. Several contact insecticides are effective for crawler control.

During outbreaks, it may be useful to similarly attempt control of the second generation, which hatches in late July.

Horticultural oils have been very effective against recently settled crawlers, those that are approximately two to three weeks old. Pine needle scale is also fairly well controlled with dormant oils. However, oil treatments can temporarily remove the bluish wax from spruce needles.

Miscellaneous Notes: Some pines, notably bristlecone or foxtail pine, naturally secrete a white wax on the needles. This may superficially resemble pine needle scale, although it does not have the regular form of scale insects.

Old scale coverings do not readily drop off. Coverings may remain on the plants for a year or two even after all eggs have hatched, until they have finally weathered off the needles.

SCURFY SCALE
Chionaspis furfura (Fitch)
Family: Diaspididae

Appearance: **Adults** - Female is armored, pear-shaped and flat, and about 1/8 inch long. Color varies from white to dirty gray. Males are similar in appearance but much smaller. **Nymphs** - Generally similar to adults, but shorter. Crawler stage is purple and mobile.

Hosts: Cottonwood, willow, elm, and other deciduous hosts

Scurfy scale infesting poplar branch. Photograph by D.A. Leatherman.

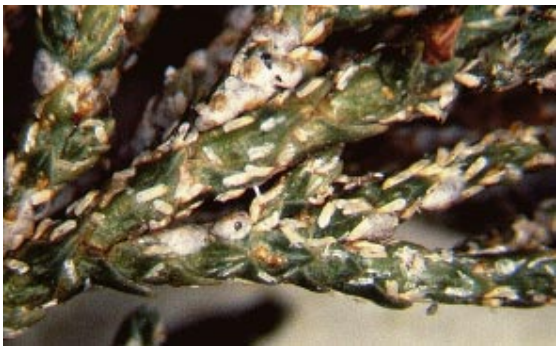
Related Species: The similar appearing and closely related pine needle scale (preceding) appears on pines and spruce.

Damage: Sap-sucking may weaken the tree and kill twigs and branches, although serious infestations in Colorado are rare.

Life History and Habits: Scurfy scale spends the winter as reddish-purple eggs beneath the coverings of the dead mother scale on tree branches and trunks. Eggs hatch in May and nymphs settle on leaves, branches and trunks to feed. Nymphs mature in late August and the adults mate, lay eggs and die. There is one generation per year.

JUNIPER SCALE
Carulaspis juniperi Bouche
Family: Diaspididae

Appearance: **Adult** - Female scales are circular, about 1/10-inch in diameter, and white. Male scales are smaller and elongated. **Nymphs** - Similar in general form to the adult but smaller. Crawler stage is yellow.



Juniper scale on juniper foliage. Males are smaller and more elongate than the females. Photograph by W.S. Cranshaw.

Hosts: Various Juniperus species, particularly pfitzer junipers.

Damage: The scales suck sap from the needles, reducing vigor and production of new growth. During heavy infestations the entire shrub takes on an off-color and may look as if dusted with snow. Decline and dieback occur during outbreaks.

Life History and Habits: This insect occurs infrequently in Colorado and has not been well-studied. Overwintering stage of the juniper scale are

eggs under the old covering of the mother. Eggs hatch in midspring, probably around early May. The newly hatched crawlers move to feeding sites, settle, and soon secrete a waxy covering. They continue to grow and molt until becoming full-grown by early summer. Mating occurs at this time and eggs are produced.

Controls: Crawler sprays should be applied before eggs hatch in spring. Horticultural oils can control young scales after settling but oils may injure some types of junipers.

BLACK PINELEAF SCALE
Nuclaspis californica (Coleman)
Family: Diaspididae

Appearance: **Adults** - Generally dark, elliptical scales. Sometimes in mature scales the dark area is surrounded by white, creating a bullseye appearance. Found on needles of pines.

Hosts: Ponderosa and other pines. Blue spruce

Damage: The scale develops by feeding on the sap from needles. High populations may contribute to chlorosis or reddening of needles and crown thinning. However, this insect is usually only abundant on trees that are previously stressed due to other factors.

Life History and Habits: This insect has not been studied under Colorado conditions. It has one, and probably two generations per season. Overwintering likely occurs as a partially developed scale that matures in late spring. Eggs and crawlers occur in June and July. If there is a second generation, egg hatch would occur in late summer.

Control: Outbreaks of this scale have often been shown to be associated with stressful growing conditions of the host plant such as root injury or compaction, drought stress or smog. Dusty conditions interfere with natural enemies of this insect.

COMMON FALSEPIT SCALE
Lecanodiaspis prosopidis Maskell
Family: Lecanodiaspididae

Appearance: **Adults** - About 1/6 inch in diameter, rounded and pale color. They are typically found in pits formed on the bark of the host in response to their feeding.

Hosts: This insect has been found on ash, mulberry, and honeylocust in southeastern Colorado. Many other tree and shrub hosts are reported elsewhere in the range of this insect.

Damage: Nymphs and adults suck plant sap through the bark of twigs and branches causing reduced growth and/or twig dieback depending on the severity of the infestation. Dead leaves cling to the twig throughout the winter.

A small depression, or 'pit' develops in the twigs under the developing scales which can distort the growing twigs.


Common falsepit scale on ash. Photograph by D.A. Leatherman.

Life History and Habits: The common falsepit scale overwinters in the eggs stage within the body covering of the mother. Eggs hatch in May and the crawlers move to the newly emerged shoots. They settle in crevices of the bark and feed at this site for several months, becoming full-grown in mid-summer. Males emerge in Augst to mate with the females and eggs are laid in late summer and early fall. There is one generation per year.

Control: Controls have not been identified. Since the eggs are held within a covering (test) under the mother scale over winter, dormant oils are not likely to be effective. Crawler sprays should be applied in late April or early May.

PINYON NEEDLE SCALE
Matsucoccus acalyptus (Herbert)
Family: Margarodididae

Appearance: **Adults** - Males are winged, fly-like, and rarely seen. Females are black, armored,

mobile scales, about 1/16 inch long. They produce a cottony mass of eggs in spring. **Nymphs** - Crawlers are minute, mobile and dark colored. Second instar nymphs are legless ('bean stage') and remain attached to needles.

Host: Pinyon.

Damage: Feeding by adult females and nymphs causes needles to turn yellow and prematurely fall. Most defoliation occurs on older needles, producing a tufted appearance with younger needles primarily persisting on infested trees. Repeated yearly attacks can kill young trees and weaken large trees, which then become susceptible to bark beetle attacks.

"Bean-stage" nymphs of the pinyon needle scale. Photograph courtesy of the USDA Forest Service.

Life History and Habits: Pinyon needle scale overwinters as a second instar nymph, which is legless and resembles a small, black bean. They resume development in early spring, molting to the mobile adult form. Mating occurs in early April. Eggs are laid in masses around collar, branch crotches, and underside of larger branches. Egg masses are covered by a white cottony wax, which can be quite conspicuous on heavily infested trees. Newly hatched nymphs settle on the previous year needles. The second stage is formed in late summer and overwinters attached to the needle. There is one generation per year.

Controls: Drenching trunk sprays of dimethoate (Cygon) are specifically registered for use of this insect. These should be applied against the adult stages in early spring before egg laying. Sprays used against other scale insects should also be effective.

STRIPED PINE SCALE

Toumeyella pini King

Family: Coccidae

Appearance: **Adults** - The adult female is hemispherical and attached to pine twigs. General coloring is dark brown or black with reddish brown or cream colored mottling. They have dark red blood. Adult females reach up to 1/4 inch in diameter. Males are much smaller and develop on the needles, producing a winged form. **Nymphs** - Generally orange/brown and globular in form. Males are more elongate and in late stages of development are enclosed in a papery light colored covering, which is later left on the needles as adults emerge. In early season, nymphs are most often observed on needles, but females later move to twigs.

Striped pine scale, overwintered adults on twig. Photograph by W.S. Cranshaw.

Hosts: Various pines, but is particularly damaging to Scots pine.

Damage: Feeding stunts needles, causing many to drop. Heavy infestation may kill branches and sometimes the tree, especially seedlings and saplings. Problems have recently greatly increased with this insect in the metro Denver area.

Striped pine scale produces abundant amounts of honeydew, which attracts scavenging wasps in fall and honeybees in spring. Black sooty mold often develops on the honeydew excreted by the insects, covering twigs and branches.

Life History and Habits: Striped pine scale spends the winter in the form of fertilized females on twigs. Feeding resumes in spring, at which time the insects are most conspicuous and produce the largest amoount of honeydew. As the females begin to

mature as many as 500 eggs, they become greatly enlarged.

Egg hatch occurs beneath the protective covering of the female and begins in late May or early June. Emergence of the crawlers can continue for a month or more, but peak activity typically follows egg laying by about two weeks. Male scales usually settle on the needles; many females occur on the twigs. Once a suitable location has been found on needles, they insert their mouthparts and remain in place for the remainder of the summer. Winged male stages are produced at the end of the summer and mating takes place at that time. The mated females remain on the twigs throughout the winter. There is one generation per year.

Control: Dormant oil sprays applied in early fall or spring can help control striped pine scale. Heavier weight oils haave been more effective for control than ultra-fine spray oils.

Crawler sprays using contact insecticides or summer oils should be first applied during early June in most locations. Because of the extended egg hatch period, a reapplication may be needed to provide control during outbreaks. Horticultural oils, Sevin, or Dursban have been moderately effective for control of summer populations. Excellent control has been achieved in Colorado State trials with soil applications of Merit.

Related Species: The pine tortoise scale, *T. parvicornis* (Cockerell), also occurs in Colorado, although it has been less abundant and damaging than the striped pine scale. Biology appears to be similar, except that male stages migrate from needles to twigs to mate. Females are slightly smaller than striped pine scale and are more uniformly colored.

COTTONY MAPLE SCALE

Pulvinaria innumerabilis (Rathvon)
Family: Coccidae

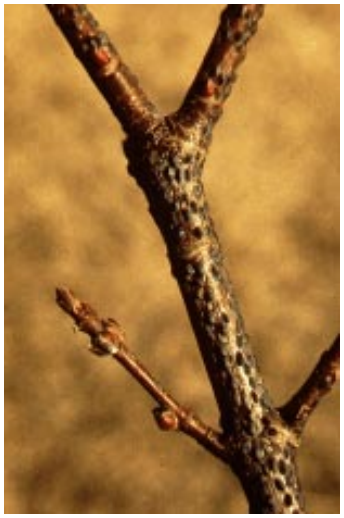
Appearance: **Adults** - Female is 1/4 inch long, soft, pale to dark brown, convex to oval, and flat. In summer, a very large marshmallow-like egg sack extends from the rear. The rarely seen male is flat winged and much smaller than the female. **Nymphs** - Following the crawler stage, the nymphs settle on leaves. They are flattened and pale brown in color.

Mature female cottony maple scales with egg sack. Photograph by W.S. Cranshaw.

Hosts: Maple, honeylocust, linden and other hardwoods.

Damage: Heavy infestation may kill twigs and branches. Sooty mold often grows on secreted honeydew, which then attracts other insects and detracts from appearance of the tree.

Life History and Habits: The cottony maple scale spends the winter as adult, mated females on twigs and branches. They continue feed with the return of warm weather in spring and grow rapidly, producing a very large egg sack. Each adult female lays several hundred eggs that hatch throughout the period from mid-June through much of July. The crawlers move to the leaves and nymphs feed on leaves until late fall, migrating to twigs and branches. In August and September, nymphs mature and mate. The males die, and females overwinter on twigs and branches. There is one generation per year.



Overwintered mated females of the cottony maple scale, prior to production of the egg sack. Photograph by S. Krieg.

Control: Abundant natural controls appear to be able to control cottony maple scale in most locations. Infestations typically are short lived even without applied controls.

Dormant oil sprays can help control cottony maple scale. Crawler sprays should be first applied during June and may need reapplication because of the extended egg hatch period.

EUROPEAN FRUIT LECANIUM
(Brown Soft Scale)
Parthenolecanium (= Lecanium) corni (Bouche)
Family: Coccidae

Appearance: **Adult** - The mature female feeds on twigs and branches. They are hemispherical in form and fairly uniform brown in color. Newly formed adults, prior to egg production, flattened and may appear similar to the nymphs. Males, which are minute and winged, may or may not be produced. **Nymphs** - Following the crawler stage, the nymphs settle on leaves. They are flattened and pale brown in color.

Hosts: This is a common scale that is found on many deciduous trees and shrubs, including many fruits. Elm is a common host in Colorado with infestations co-existing with European elm scale.

Damage: Lecanium scales feed on the sap of small branches, causing decline and dieback during outbreaks. They also produce large amounts of honeydew, which can be a serious nuisance problem and favor the growth of sooty mold.

Life History and Habits: The European fruit lecanium spends the winter as a second instar nymphs on the twigs. They molt to the adult stage in spring and develop rapidly. Most feeding, honeydew production, and injury occurs at this time.

The body of the female swells with eggs during late spring. Mating may occur but this species can reproduce asexually. The eggs hatch underneath the body of the mother scale, which usually dies by early summer. Crawlers are often produced from late July through August and they settle on the leaves to feed. Prior to leaf fall the scales return to the twigs for winter.

Controls: Although common, outbreaks of this species are rare in Colorado, presumably due to natural controls. Parasitic wasps are one of the more commonly observed natural enemies of this insect.

Applied controls, including dormant oils, are similar to those used for other soft scales.

SPRUCE BUD SCALE
Physokermes piceae (Schrank)
Family: Coccidae

Appearance: **Adults** - Mature females are reddish-brown and globular, closely resembling a bud scale.

Hosts: Spruce

Damage: Spruce bud scale sucks sap from the twigs of spruce and can cause needle drop and twig die back during outbreaks. It also produces abundant amounts of honeydew and sooty mold is commonly associated with outbreaks. Infestations tends to be concentrated on the lower branches.

Life History and Habits: Spruce bud scale spends the winter as a small, first instar nymph on the needles of spruce. In midspring they resume activity and move to the twigs where they settle and feed. Females become full-grown and swollen with eggs in June and eggs hatch during late June and July. There is one generation per year.

Control: Although this insect has not been studied in the western United States, Colorado outbreaks are rare presumably because of the activity of natural enemies such as parasitic wasps.

Crawler sprays, applied in midsummer to coincide with egg hatch, should provide some control.

KERMES SCALE
Allokermes gillettei (Cockerell)
Family: Kermesidae

Appearance: **Adults** - Females are immobile, globular, tannish scales specked with brown. They are about 1/4 inch in diameter, the largest scales present in the region, and are usually found at the base of leaf stems. The males are fly-like and seldom seen, but produce small, white cocoons that can often be observed on the bark of trunks and branches. **Nymphs** - The first instar crawlers are soft and pale in color. Older nymphs are slightly rounded, somewhat like soft brown scale.

Host: Red oak

Damage: Reduced growth and vigor of the branches results from feeding by this scale. Heavy infestations cause leaf flagging, dieback of twigs, and twig abscission. Oozing sap and a sticky wax may be produced at the site of infestations.

Yellowjacket wasps, which feed on the mature scales and eggs, can become a nuisance problem on scale infested trees.

Mature kermes scale on oak twig. Photograph by W.S. Cranshaw.

Life History and Habits: The overwintering stage of oak kermes scale is a very small, first instar nymph on branches of oak. They move from these areas in spring to the new growth and feed on sap, often settling at the base of the petioles. They continue to feed for several months becoming full-grown in late June and early July.

At maturity the females mate with the minute, winged males. The females then begin to mature eggs, becoming very large in late summer, almost the size of a small marble. The eggs hatch in September and October. Newly hatched scale "crawlers" move to the overwintering sites on the branches and trunk for shelter. There is one generation per season.

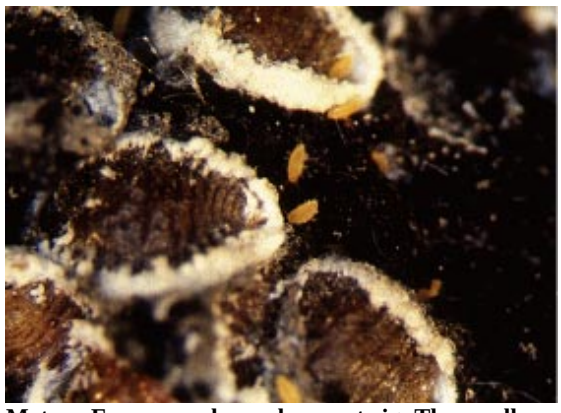
Control: Controls have not been developed for this species. Dormant oils should be effective on overwintered stages. Crawler sprays applied in early fall are also likely to be effective.

Fox squirrels and yellowjacket wasps have been observed to feed on mature female scales.

EUROPEAN ELM SCALE

Gossyparia (= Eriococcus) spuria (Modeer)
Family: Eriococcidae

Appearance: **Adults** - Female is soft and immobile. General color is olive-green to reddish-brown with a white waxy fringe around edge of the body. The male, rarely seen, is winged or wingless, reddish and "gnat-like." Before adult emergence males produce a small cocoon. **Nymphs** - The crawlers are lemon-yellow. Nymphs are generally dark, with little of the waxy fringe evident. They have red blood.



Mature European elm scale on a twig. The small elongate structures are cocoons of the males. Photograph by W.S. Cranshaw.

Hosts: Elm, particularly American and rock elm

Damage: European elm scale is one of the most widespread and destructive scale insects in Colorado. Prolonged infestations weakens branches, often producing premature leaf yellowing (**flagging**) and leaf drop. Heavy infestations cause dieback of twigs and branches.

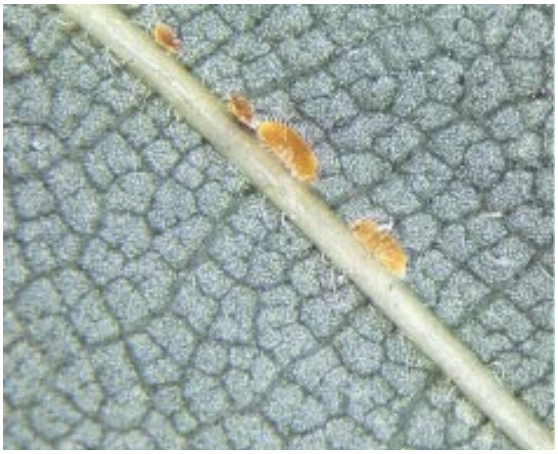
European elm scale can cause serious nuisance problems due to honeydew production. Sooty mold often grows on the honeydew, blackening tops of branches and root flares.

Associated Insects: The elm leaf aphid, *Tinocallis ulmifolii* (Monell), also is a common honeydew producer on American elm. Its biology is discussed later.

Life History and Habits: European elm scale spends the winter as second instar nymphs in cracks on twigs and smaller branches. They resume feeding on the twigs in spring, maturing in May or early June. If present, males emerge at this time from their small white cocoon and mate. European elm scale can reproduce asexually so males are not always present.

The small, yellow crawlers are produced over a period of about one and a half months, beginning in mid-late June. They move to the leaves, usually settling along the leaf veins, and feed on the phloem of the leaves all summer. In fall they migrate to the twigs to overwinter. There is one generation per year.

An unusual feature of these insects is their red blood.



Nymphs of the European elm scale primarily feed near the veins of leaves in summer. Photograph by W.S. Cranshaw.

Controls: Several species of parasitic wasps commonly kill some scales and general predators such as spiders also kill some. On Siberian elm, competition with defoliators, such as elm leaf beetle, probably kill many of the leaf inhabiting stages of the scale.

Horticultural oils, particularly more viscous formulations, can control overwintering stages. Treatments should be applied before bud break since older scales are difficult to control with oils.

Crawler stages can be controlled by applications of various insecticides made in late June, at onset of egg hatch. Repeat applications may be needed to maintain coverage through the extended period of egg hatch. Leaf feeding stages of the scale, during late July and August, as well as nymphs that are moving to twigs in late summer, can be controlled with horticultural oils and several insecticides (e.g., Sevin, Talstar). Insecticidal soaps have been minimally effective against nymphal stages.

GOLDEN OAK SCALE

Asterodiaspis quericicola (Bouche)
Family: Asterolecaniidae

Appearance: **Adults** - Mature females are generally hemispherical and settled in a depression on the twigs of oak. Typical color is golden brown, or darker, sometimes with green. A waxy fringe often develops around the scale.

Golden oak scale developing in depressions on the twigs. Photograph by W.S. Cranshaw.

Hosts: White oaks.

Damage: The golden oak scale feeds on the sap of developing twigs, and may also feed on leaves when in high density. Reduced growth, distortion and dieback of twigs may occur from severe infestations. Delays in leafing out in spring longer retention of old leaves are reported from other pit scales. Trees planted along sidewalks and under drought stress are more heavily infested by this scale. The golden oak scale is only known in the state from a single collection in Longmont.

Life History and Habits: Biology of the golden oak scale is not studied under Colorado conditions so the following description is based on related species. The golden pit scale spends the winter as mature females, on the bark of twigs. They resume feeding in spring and begin to lay eggs, which fill the covering (test) of the female. Crawlers emerge over a period of several months, with peak crawler activity in early summer. They do not move far from the mother scales, settling on first year wood of twigs. As they feed, tissues swell forming the distinctive pit in which they live. They are immobile shortly after settling. Males are unknown. There is one generation per year.

Controls: Crawler sprays should be based on surveys of crawler activity but probably will be timed for the period around mid-June through mid-July. Dormant oil treatments should be effective. For specific recommendations, see the section in the control supplement regarding Soft Scales.

Table 10. General timing of scale crawler (first instar) appearance for common Colorado scale insects.

Scale	First generation	Second generation (if present)
Oystershell scale	late May, early June	
Pine needle scale	late April, early May	mid-late July
Juniper scale	mid-May through June	
San Jose scale	May, early June (variable)	late June-July (generation 2); late summer (generation 3)
Walnut scale	late June, early July	early-mid August
Striped pine	late May through June	
Cottony maple scale	late June, July	
Golden oak scale	late June, July	
Spruce bud scale	early June through mid-July	
Soft brown scale	late June, July	
Pit scales	late June through early August	
Common falsepit scale	late April through May	
Pinyon needle scale	early-mid April	
Oak kermes scale	early September through October	
European elm scale	late June, July	

APHIDS, LEAFHOPPERS AND RELATED INSECTS

Aphids are the most widespread insects on Colorado trees and shrubs in the order Homoptera. Scores of species occur and aphids are present on most plants, generally at non-injurious levels. However, some species are significant pests, reducing plant vigor, producing leafcurl distortions of new growth, or secreting nuisance amounts of honeydew.

Aphid development can undergo several different patterns, with some species having very complex life cycles. Overwintering as an egg on a perennial plant is the norm in Colorado. All aphid forms during spring and much of the summer are females, reproducing asexually and bearing live young. However, both wingless and winged females may be produced, the latter arising following overcrowding, changes in day length, or other environmental cues.

Alternation of hosts is also a common pattern, although several species (e.g., honeysuckle witches broom aphid, giant conifer aphids) are associated with only a single host species. Alternating hosts for most aphids are an overwintering woody plant and herbaceous summer hosts. Aphids of the same species often have very different forms on these two hosts.

Most species produce males and sexual-form females late in the summer. Progeny of mating are egg-laying females that provide the overwintering eggs.

Honeydew, excreted by aphids, and/or the presence of ants attracted to honeydew may be useful for identifying aphid population developments. Natural controls, including natural enemies (lady beetles, lacewings, syrphid flies, parasitic wasps) usually bring aphid populations under control shortly after they become noticeable. Before any insecticide treatments are contemplated, a search of the aphid colonies for these natural enemies should be made. High numbers of these beneficial insects usually indicate that aphid problems are being controlled without need for intervention.

Table 11. Common Colorado Aphids That Alternate Between Woody and Herbaceous Hosts.

Aphid	Overwintering host	Summer host
Green peach aphid (*Myzus persicae*)	Peach, plum, apricot	Peppers, cabbage, potato, many garden plants
Currant aphid (*Cryptomyzus ribis*)	Currant	Motherwort, marsh betony
Black cherry aphid (*Myzus cerasi*)	Sweet cherry, sour cherry, plum	wild mustards
Rose aphid (*Macrosiphum rosae*)	Rose	
Potato aphid (*Macrosiphum euphorbiae*)	Rose	Potatoes, tomatoes and many other garden plants
Rose grass aphid (*Metalophium dirhodum*)	Rose	Grasses, corn
English grain aphid (*Sitobion avenae*)	Apple	Corn, grains
Rosy apple aphid (*Dysaphis plantaginea*)	Apple, pear, mountain-ash	Plantain
Bean aphid (*Aphis fabae*)	Euonymus, viburnum	Beans, beets, cucumber, carrots, lettuce, etc.
Leafcurl plum aphid (*Hyalopterus arundinis*)	Plum	various aster-family plants, clover, vinca, thistle
Sunflower aphid (*Aphis helianthi*)	Dogwood	Sunflower, pigweed, Four o'clock, ragweed
Carrot-willow aphid (*Cavariella aegopodii*)	Willow	Carrot, parsley, dill
Sugarbeet root aphid (*Pemphigus populivenae*)	Narrow-leaved cottonwood	Beets, many garden plants

Aphids exposed on plants can generally be well controlled by several contact insecticides. Insecticides that generally are effective for aphid control include Diazinon, Dursban, Orthene, and Safers Insecticidal Soap/M-Pede. Pyrethroid insecticides (Talstar, Mavrik, Tempo) tend to be a little more erratic in performance, but can control some species. Carbaryl (Sevin, Sevimol) is generally a poor insecticide for aphid control and may even aggravate problems. However, carbaryl is effective for control of the closely related "woolly aphids" (Families Adelgidae, Eriosomatidae). When applying any contact insecticide complete spray coverage is essential for good control.

Aphids that have already produced a leafcurl or similar protective structure can only be controlled with systemic insecticides. Orthene remains the only widely available systemic insecticide that can be foliar applied; dimethoate (Cygon) has similar effectiveness but more restrictive labelling In addition, soil applications of Metasystox-R or trunk injections (Mauget^{R}, AceCap^{R} systems) are an option for high value trees in sensitive sites where sprays cannot be used. None of the systemic insecticides used in tree and shrub can be used on food crops, including fruit trees.

Some aphids, particularly those that cause early season leaf curls, often overwinter as eggs on the plant. Dormant oil sprays can help provide control of these aphids.

Specific recommendations for control of aphids appear in the supplement on control recommendations. Sections dealing with aphids include: **Aphids (General)**, **Aphids (Leafcurling)**, and **Honeysuckle aphid**.

GREEN PEACH APHID

Myzus persicae (Sulzer)
Family: Aphidae

Appearance: **Adults** - Winged form is light green with black-tipped legs. Wingless form is pear-shaped, pale yellow to green in color, with a dark stripe along each side and down the back of abdomen. Approximately 1/10 inch long. **Nymphs** - Generally pear-shaped and usually straw colored with pale green or orange forms sometimes produced.

Leafcurling injuries on peach produced by the green peach aphid. Photograph by W.S. Cranshaw.

Hosts: Winter hosts include peach, apricot and certain cherries and plums. Summer hosts include over 200 species of herbaceous plants, including many vegetables and ornamentals. Green peach aphid is also the most commonly damaging aphid species to greenhouse crops.

Damage: Feeding on the new growth of the winter host trees is produces curling and deformations. Heavy infestation can delay the leafing of plants in spring.

Green peach aphid also may damage summer host plants by removing sap. Even more important, green peach aphid is a highly efficient vector of many plant viruses.

Life History and Habits: The green peach aphid spends the winter as shiny greenish black eggs laid near the buds. Eggs hatch following bud break to produce wingless females (first generation). As these develop they subsequently give live birth to a second generation. After two or three generations of wingless aphids on the winter host, winged forms are produced in late spring which abandon the plant and migrate to herbaceous summer host plants. Over 200 species of plants may serve as summer hosts for this insect, including peppers, potatoes, cabbage-family plants, and many weeds.

Controls: Dormant oils are highly effective and the only available treatment for fruit trees. Systemic insecticides, such as Orthene, can be used to control aphids within curled leaves on ornamental varieties.

Egg of the green peach aphid.

Related Insects: The leafcurl plum aphid, *Hyalopterus arundinis* (F.), also commonly curls the leaves of certain *Prunus*, notably plum. The alternate summer host of this aphid are various aster-family plants, clover, vinca, and thistle.

Related Injury: A common fungus disease of wild plum is plum pockets. This is produced by infection with *Taphrina communis* and results in the distortion of the leaves to form thickened, bladder-like galls.

Miscellaneous Notes: The green peach aphid is extremely adept at transmitting many virus diseases to vegetable and garden plants. It is of particular importance in areas of the state, such as the San Luis Valley, where seed potatoes are grown. Because of this there are restrictions on planting overwintering host plants of the green peach aphid or these plants are routinely treated to control this insect before it moves into nearby croplands.

HONEYSUCKLE WITCHES BROOM APHID

Hyadaphis tartaricae (Aizenberg)
Family: Aphidae

Hosts: Honeysuckle, particularly tartarian-types.

Related Species: Several other aphids also occur on honeysuckle. These may produce some yellowing and leafcurling during spring and fall but the damage is of short duration and causes no significant injury to the plant.

Damage: Honeysuckle witches broom aphid greatly distorts the emerging new growth. Symptoms of injury include leaf curling, small leaf size, release of dormant buds to produce spindly 'witches broom' growth. Damaged terminals fail to normally elongate and often die during winter. Outbreaks are common in many areas of the state and can greatly affect the appearance and vigor of honeysuckle.

Life History and Habits: The aphid spends the winter in the egg stage, on twigs of honeysuckle. Eggs hatch in midspring, shortly after the buds break. During the first few weeks populations of the aphid remain low and much of the early plant growth is relatively unaffected. However, by late May or June, aphids colonize the new growth and begin to produce leaf curling distortions.

Characteristic "witches broom" distortion produced by the honeysuckle witches broom aphid. Photograph by W.S. Cranshaw.

There are several generations produced during spring and early summer. Populations usually decline as the new growth slows or ceases in late summer.

Controls: Systemic insecticides (sprays of acephate/Orthene, soil injected Metasystox-R) can provide control for about two to three. Contact insecticides, including soaps, are ineffective against this species.

Reducing fertilization and watering cuts down on the severity of deformities by slowing the production of susceptible new growth.

Syrphid fly larvae have been the most consistently important natural control, due to their ability to enter the curled leaves. Most other general aphid predators (e.g., lady beetles) restrict feeding to exposed aphids.

Although eggs are laid in the old growth, pruning is not an effective control since this insect is so widespread and highly dispersive.

ELM LEAF APHID

Tinocallis ulmifolii (Monell)
Family: Aphidae

Hosts: Elms, particularly American elm

Related Species: The linden aphid, *Tinocallis tiliae* (L.), and western dusky-winged oak aphid, *Tinocallis alhambra* (Davidson), are also common on their associated hosts.

Damage: The elm leaf aphid produces abundant amounts of honeydew and along with the European elm scale can be a serious nuisance pest. High aphid populations cause premature leaf yellowing and drop.

Winged and wingless stages of the elm leaf aphid. Photograph by W.S. Cranshaw.

Life History and Habits: Elm is the only known host. Overwintering stage are eggs laid near buds. Eggs hatch in spring and multiple, overlapping generations are produced throughout the season. By midsummer, some winged form stages are produced that may migrate to new plants. Males and sexual stage females are present in late summer and early fall, the females giving birth to the egg-laying ovipara form.

Control: Controls are similar to those for other aphids exposed on leaves.

BOXELDER AND MAPLE APHIDS

Periphyllus species
Family: Aphidae

Appearance: **Adults** - One of the smallest aphids, only about 1/10 inch long, yellowish-green marked with brown. Most forms have abundant spine-like hairs and hairy antennae. **Nymphs** - Smaller and paler than adults.

Hosts: Most maples, including boxelder.

Damage: Copious amounts of honeydew may collect on objects beneath infested trees, accompanied by sooty mold growth. Leaves may drop early and it is not uncommon for trees to totally defoliate. However, outbreaks most often occur late in the season and cause little damage.

Life History and Habits: Over 17 different life stages and forms have been observed for this genus. In general, they overwinter as eggs on the host tree. Females reproduce without mating (asexually) bearing live young rather than eggs. Multiple, overlapping generations are produced during a season.

Control: Controls are similar to those for other aphids exposed on leaves.

GIANT CONIFER APHIDS

Cinara species
Family: Aphidae

Appearance: This group includes some of the largest Colorado aphids (up to 1/4 inch), exceeded in size only by the giant willow aphid. Adults are long-legged, generally reddish-brown to brown. Eggs are shiny and black, resembling miniature jelly beans, laid conspicuously in rows on twigs and needles.

Hosts: Most species of conifers, including pines, fir, Douglas-fir, and spruce. Many Cinara species are specific to a particular genus of tree, some even to a particular species. Winged stages are sometimes produced but no alternate hosts are known. Approximately 50 species occur in Colorado.

Damage: The giant conifer aphids feed on the sap from twigs and branches, often in large groups. Heavy infestations cause a yellowing of foliage and

needle drop. Heavy deposits of honeydew are often associated with sooty mold growth. They are often attended by ants who harvest their honeydew.

The juniper aphid, *Cinara sabinae* (Gillette and Palmer), is very common on juniper and is usually the most destructive member of this genus in the state.

Life History and Habits: In the fall, females lay several eggs each and these overwinter on the host tree. Eggs hatch in the spring. Throughout spring and summer only females are produced, which bear live young. Males and sexual-form females are produced in late summer which mate and produce the egg laying generation.

Control: Controls are similar to those for other aphids exposed on leaves.

GIANT WILLOW APHID

Tuberolachnus salignus (Gmelin)
Family: Aphididae

Appearance: **Adults** - The giant willow aphid is a distinctive, purple-black aphid which can reach a size of 2/10 inch. They primarily feed on twigs and branches, often in large colonies.

Hosts: Willow

Damage: Giant willow aphids feed on the sap from limbs of willow. They can produce large amounts of honeydew, creating a serious nuisance problem which also attracts yellowjackets and honeybees. The aphids also can create dark stains if crushed.

These aphids do not appear to substantially damage willow.

Pterocomma smithiae, a large species of aphids that feeds on the twigs of willow. Photograph by W.S. Cranshaw.

Life History and Habits: Little is known about the giant willow aphid. Eggs are laid upon the twigs of willow in fall and hatch after new growth forms on tree in spring. There are continuous, multiple generations throughout the growing season. Populations of the giant purple willow aphids are usually most abundant late in the season at which time they

Table 12. Aphids that commonly create nuisance problems with honeydew in Colorado.

Common name (Scientific name)	Host plant	Time of nuisance problem
Linden aphid (*Tinocallis tiliae*)	Linden	Usually early fall
Western dusky-winged oak aphid (*Tinocallis alhambra*)	Oak	Usually early fall
Clear-winged aspen aphid (*Chaitophorus populifoliae*)	Aspen	Late summer - early fall
Black and green willow aphid (*Chaitophorus viminalis*)	Willow	Usually early fall
Giant willow aphid (*Tuberolachnus salignus*)	Willow	Usually early fall
Black willow aphid (*Pterocomma smithiae*)	Willow	Usually early fall
Elm leaf aphid (*Tinocallis ulmifolii*)	Elm	Summer
American walnut aphid (*Monellia caryae*)	Walnut	Late summer - early fall
Black cherry aphid (*Myzus cerasi*)	Cherry	Spring
Spirea aphid (*Aphis spiraecola*)	Spirea	Spring
Currant aphid (*Cryptomyzus ribis*)	Currant	late spring - early summer

can frequently be found in masses on twigs and branches. Some winged stages are also produced in late summer, which can infest new plantings. Adults can sometimes be found in early winter, walking on the snow under infested trees.

Because of their dark pigmentation, willow aphids have been used as a source of natural dye.

Related Species: The giant conifer aphids (*Cinara* species) are quite large and extremely common on various pines, spruce, junipers, and Douglas-fir. Because of their large size, they are sometimes confused with ticks.

Another common large aphid found on twigs and branches of willow is the black willow aphid, *Pterocomma smithiae* (Monell). This species is only slightly smaller than the giant willow aphid and has distinctive orange cornicles. (Poplar and silver maple are also hosts of this insect.) Leaves of willow support many other aphid species including the small black and green willow aphid, *Chaitophorus viminalis* Monell.

LEAFCURL ASH APHID

Prociphilus fraxinifolii Riley
Family: Eriosomatidae

Appearance: **Adults** - 1/8 inch long aphid, yellow-green with brown head. They are covered with waxy threads. **Nymphs** - Pale yellow to yellow-green with brown head and appendages, and are covered with fine hairs.

Severe leafcurling injuries produced by the leafcurl ash aphid. Photograph by D.A. Leatherman.

Host: Ash

Damage: Feeding by the aphids creates very tightly rolled and thickened leaves, known as pseudo-galls, at the tips of the twigs. This injury often causes some distortion and twisting of the twig next to the damaged leaves. Expanded leaves are not susceptible to leaf curling and little damage is done.

Life History and Habits: Life history of this insect is unclear. Winter appears to be spent as eggs, on twigs of trees. Females giving birth to live young appear in May and there are continuous, overlapping generations subsequently produced. Feeding by the aphids on the growing leaves at the tips of twigs causes them to curl and thicken (pseudo-gall) within which the aphids develop. Some winged migratory forms begin to appear in July and migrating aphids may fly from ash through September.

Most species of *Prociphilus* alternate between a woody, winter host and the roots of various plants (usually conifers) in summer. No alternate plants for the leafcurl ash aphid have been identified, although the insect often is absent from ash during parts of midsummer after new growth ceases.

Controls: By midsummer, several natural controls typically curtail outbreaks, particularly after succulent new growth is no longer being produced. Earwigs and parasitic wasps are among the most commonly observed biological controls.

Systemic insecticides, such as Orthene, have been the only effective treatment identified for this insect. There seems to be a range in susceptibility among ash cultivars to damage by this insect with some (e.g., Patmore) being more commonly damaged.

WOOLLY APPLE APHID

Eriosoma lanigerum (Hausmann)
Family: Eriosomatidae

Appearance: **Adults** - Reddish-purple, about 1/16 inch long and usually completely covered by a white, waxy secretion. This gives each aphid the appearance of lint or cotton fluff. **Nymphs** - Smaller and less heavily covered with the wax.

Hosts: Apple, crabapple, mountain-ash, elm.

Damage: Feeding on elm leaves and buds in spring cause the leaves to curl into closed, stunted clusters or rosettes at the twig tips. Curled leaves en-

close colonies, protecting them somewhat from predators and insecticides. The aphids usually have left elm by late June but return and may occur in high numbers in late summer and early fall on elm leaves. On elm, they may produce large amounts of honeydew late in the season.

The more severe injury is caused by the insect feeding on the roots of apple, crabapple, and mountain-ash, resulting in large knots (galls) on the roots. Heavily-infested trees often have short, fibrous roots, and are stunted and sometimes killed. Healing wounds aboveground are also commonly infested, which inhibits healing and can produce cankers.

Colony of woolly apple aphids infesting crabapple branch.

Life History and Habits: The complete life cycle requires one year to complete, involving both a winter host of elm and summer hosts of apple, crabapple, or mountain-ash. Most Eriosoma species spend the winter as eggs in cracks and crevices of elm bark. However, in warmer locations or protected sites some nymphs can survive on the roots of apple. The eggs hatch in early spring and the young aphids move to the unfolding leaves and buds to feed and reproduce. After two wingless generations on elm, a winged generation follows, which migrates to the summer hosts (apple, crabapple, mountain-ash) where it feeds below ground on the roots and trunk or around wounds on the trunk. In the fall, a generation of males and females occur on elm which mate and produce an egg laying form. Each female lays one egg and dies. Four or more generations per year.

Related Species: Related species are common on hawthorn [*Eriosoma crataegi* (Oestlund)] and *Amelanchier* [*E. americanum* (Riley)] during the summer. These also use elm as the main winter host. On elm *E. americanum* produces a tight leaf curl that is packed with aphids.

The elm leaf aphid, *Tinocallis ulmifolii* (Monell), is another common aphid on elm. Honeydew problems on the tree area also associated with the European elm scale.

Woolly aphids may also easily be confused with the apple mealybug [*Phenacoccus aceris* (Signoret)] which also occurs on hawthorn. (See following discussion.)

WOOLLY PINE ADELGIDS

Pineus species

Family: Adelgidae

Appearance: **Adults** - Small, greenish-gray, aphid-like insects abut 1/8 inch long. They lack cornicles, the 'tail-pipes' common on the abdomen of aphids. They are almost always covered with a thick coat of white waxy filaments.

Hosts: Most pines host some species of *Pineus* in Colorado. Spruce is an alternate host of some *Pineus* species.

Pineus species of aphids are commonly associated with pines. Photograph by W.S. Cranshaw.

Damage: This is the common group of woolly aphids found on the needles of pines during late spring. Foliage of heavily-attacked trees becomes yellowish and growth is stunted. Needle and shoot feeding can cause shoots to droop and die. Infestations also can occur on bark, contributing to decline during outbreaks.

Species that have an alternate host of spruce, produce a small gall on that plant.

Life History and Habits: *Pineus* species are closely related to the Cooley spruce gall adelgid and other *Adelges* species. Similarly, they often share a complex life cycle involving alternate hosts, gall formation on the winter (primary) host, and up to six kinds of adult forms. Some species live only on one host, such as *Pineus coloradensis*. Other species have life cycles take two years to complete.

Control: Problems on pines are usually short-lived, and the aphids disperse without causing serious damage. The woolly pine adelgids are easily controlled with contact insecticides such as insecticidal soaps or carbaryl (Sevin, Sevimol).

HAWTHORN MEALYBUG (TWO-CIRCULI MEALYBUG)

Phenacoccus dearnessi King
Family: Pseudococcidae

Appearance: **Adults** - Adult females filled with eggs are generally globular in form. Their body is a dark red, but is covered with fine wax. Adult males are much smaller and winged. **Nymphs** - Generally oblong and flattened. Reddish-gray color due to the covering of wax and distinct waxy threads are present along the sides.

Hosts: Several rosaceous plants, including hawthorn and Amelanchier, are reported as hosts of this insect. In Colorado, this insect has only occurred as pest on hawthorn.

Damage: The hawthorn mealybug feeds on the sap of twigs and small branches. Heavy infestations weaken the plant and dieback can occur.

This insect primarily causes concern due to the large amounts of honeydew it excretes during feeding. Sooty mold and honeydew are often conspicuous and can greatly detract from plant appearance.

Life History and Habits: The hawthorn mealybug spends the winter in cracks on the bark as partially grown nymphs. In spring, female scales move to twigs and continue to develop, becoming full grown in May or early June. Adult males remain on the trunk, transforming to the winged adult stage in rough synchrony with females. After mating, the females swell with maturing eggs. Unlike many mealybugs, an external egg sack is not produced, as eggs hatch internally in the mother. However, newly born nymphs may remain under the protective cover of the mother for several days before dispersing onto the plant. Production of nymphs can occur from early June through early August. Peak nymphal production can usually be expected in mid June to early July.

Young nymphs feed on leaves, later moving to protected areas on twigs where they remain dormant in diapause through much of the summer. They resume feeding on leaves in late summer, aggregating commmonly in leaf folds (domatia). Later they migrate to the coarser bark of branches or the main trunk where they spend the winter.

Control: This insect has proven difficult to control, likely because it spends much of its life under loose bark and in other protected sites. In limited Colorado State trials imidacloprid (Merit), either with or without oil, has given best control. Periods in late summer or early fall when nymphs are active and exposed should be optimal for control. Dormant season applications of oils should be applied to the trunks and under surfaces of branches.

Few natural enemies appear to be associated with this insect. Larvae of an unidentified lady beetle have been seen to prey on hawthorn mealybug.

Associated Insects: Woolly aphids in the genus *Eriosoma* may be confused with the apple mealybug, being similarly covered with waxy threads. The body of the hawthorn mealybug is somewhat more compact and regularly rounded than is that of the woolly aphids.

The apple mealybug, *Phenacoccus aceris* (Signoret), may also occur in Colorado. It similarly is reported to attack a variety of rosaceous hosts, including apple and cotoneaster. Apple mealybug differs from the hawthorn bug in production of an external egg sack. Also, underneath the wax the body is greenish; the hawthorn mealybug has a reddish body.

GRAPE MEALYBUG

Phenacoccus maritimus (Ehrhorn)
Family: Pseudococcidae

Appearance: **Adults** - The adult females are about 3/16-inch long, covered with a whitish wax.

Small filaments of wax occur along the sides, becoming progressively smaller near the head. They produce a very large, loose egg sack late in the season.

Hosts: Several hosts are reported, but infestations in Colorado have only been confirmed on apple, pear, grape, and catalpa.

Cottony egg sacks produced by the grape mealybug in late summer.

Damage: The grape mealybug feeds on the sap of twigs and branches. Sustained heavy infestations can cause dieback of twigs and smaller branches. However, under Colorado conditions outbreaks are very infrequent. Problems primarily involve honeydew excreted by the insect and subsequent sooty mold growth that can reduce attractiveness of the plants. The large cottony egg sacks are also highly conspicuous.

Life History and Habits: The grape mealybug spends the winter as newly hatched nymphs within or near the cottony egg sacks produced by the mother. In spring most move to twigs and leaves where they feed and develop, becoming full grown around late June. (A few remain on older wood for their entire life.) This overwintered generation is generally not very noticeable.

Eggs are laid in early summer and the nymphs of the summer generation feed during July and August. They become full grown in late August and September, returning at this time to the older wood. There they produce their egg sacks, with egg production continuing until frost.

Control: This insect has not been well studied under Colorado conditions but apparently has numerous natural enemies that can limit populations. Egg predation by brown lacewing larvae has been observed and parasitic wasps are important natural enemies in other regions of the United States.

Physical removal of the cottony egg sacks in fall or winter should remove shelter used by nymphs to winter and physically remove large numbers from the tree. Sprays containing a wetting agent, such as insecticidal soap, also may kill many of the overwintering nymphs and help remove the old egg sacks.

Crawler sprays of insecticidal soaps or various residual insecticides should effective against young stages. These should be applied during periods of crawler activity, e.g., around early May and late June in most locations.

PEAR PSYLLA

Cacopsylla pyricola Foerster
Family: Psyllidae

Appearance: **Adult** - Small (1/10 inch), reddish-brown winged insect, similar in overall appearance to a miniature cicada. **Nymph** - Flattened, green scale-like insect typically covered with a drop of honeydew.

Pear psylla nymph under droplet of honeydew. Photograph by Gene Nelson.

Damage: Pear psylla feed on the leaves of pear, excreting conspicuous droplets of honeydew. These droplets soil the leaves and fruit of the plant. Honeydew also allows sooty mold fungi to grow on the plant which discolors fruit.

High numbers of psyllids on trees can reduce plant vigor and cause it to yield poorly. Trees suffering from 'psylla shock' may take several years to recover.

Pear psylla transmits the mycoplasma which produces a disease known as pear decline. Fortunately, this disease is uncommon in the region. Pear psylla occurs throughout the region but is most common west of the Rockies.

Life History and Habits: Pear psylla overwinter in the adult stage. During this time they hide in protected areas (under bark, plant debris on soil, other cover) in the vicinity of previously infested trees. They become active in late winter or early spring and move to pear trees. They begin to lay yellow-orange eggs as the pear buds begin to swell and the emerging nymphs then move to feed on the tender new growth.

As the psyllid nymphs feed they are first covered with the honeydew droplet that they produce. The final stage of the developing insect has conspicuous pads where wings are developing and does not live in the honeydew. They then molt to the adult stage. Later generations lay eggs on the new leaves, often concentrating on sucker sprouts late in the season. There are normally two to three generations produced during a season. At the end of the year, dark-colored winter adult forms move to shelter.

Calophya triozomima, a psyllid commonly associated with sumac. Photograph by W.S. Cranshaw.

Related Species: A very common psyllid which also creates honeydew is *Psylla negundinis* Mally, associated with boxelder. Other *Psylla* species are associated with willow and alder. These species apparently have a life history similar to that of the pear psylla. On sumac, the psyllid *Calophya triozomima* Schwarz occurs. This species overwinters on the plant in the nymph stage. Nymphs are generally black and may have a fringe of wax. There does not appear to be any serious injury associated with this insect.

Controls: During very dry weather, honeydew droplets covering the nymphs may dry and crust to kill the insects. Minute pirate bugs, lady beetles and other general predators also feed on pear psylla. A chalcid wasp is an important parasite of the pear psylla in many areas.

Pear psylla thrives on tender new growth. Remove sucker shoots during midsummer to deprive the insects of favored food sources after the main leaves have hardened.

Pear psylla is very resistant to most insecticides and is difficult to control. The best controls is to treat for the insect two to three times before bloom, killing the overwintered adult stages before they have laid eggs. These treatments are most effective if other pears in the area are also treated, limiting reinfestations.

WHITE APPLE LEAFHOPPER

Typhlocyba pomaria McAtee
Family: Cicadellidae

Appearance: **Adults** - Pale yellowish-white leafhoppers, about 1/8 inch long, with wings folded tent-like over the back. **Nymphs** - Wingless and quite pale when compared to adults.

Hosts: Apple

Flecking injuries to apple foliage produced by the white apple leafhopper. Photograph by W.S. Cranshaw.

Damage: The white apple leafhopper feeds on the leaves of apple, removing the chlorophyll and sap from the plant. Feeding sites appear white-flecked and heavily infested leaves look silvery. During early

season outbreaks the vigor and productivity of trees can be reduced. The white apple leafhopper also excretes tiny 'tobacco juice'-like droppings which can cover fruit making it unattractive.

The white apple leafhopper also occasionally damages leaves of rose, peach, plum, and cherry.

Life History and Habits: The white apple leafhopper spends the winter in the egg stage, inserted under the bark of twigs and branches. Eggs hatch in spring, generally about the time of bloom. The developing nymphs crawl to feed on the underside of older leaves. They become full-grown by early June, producing winged adult stages.

These first generation adults mate, and female leafhoppers lay eggs which produce a second generation. Peak feeding injury by these leafhoppers occurs in late July and August. Adults emerging from these produce the overwintering eggs. There are two generations per year.

The insect is easily observed on leaf undersides and will run readily away when disturbed. Even when the insect is no longer present on the leaf, the white flecking and the old, shed skins can be used to diagnose white apple leafhopper injury.

Control: Several general predators, such as green lacewings and damsel bugs, commonly eat leafhoppers. Some hunting wasps also specialize in gathering leafhopper prey to rear their young. Parasitic wasps and fungus diseases are other reported natural enemies of white apple leafhopper. These biological controls usually keep leafhopper numbers low in unsprayed orchards.

When possible, periodically hose plants to dislodge many of the leafhoppers. Watering can also soften the droppings which cover fruit, making them more easily washed off. However, hosing treatments or overhead watering should not be done where there is danger of spreading fire blight.

Pruning removes overwintered eggs which are under the bark.

Dormant season applications of horticultural oils may provide some control of overwintering eggs, although most are too well protected under the bark to be killed by these treatments. Newly hatched nymphs are susceptible to many insecticides including insecticidal soaps and carbaryl (Sevin). However, insecticide resistant strains are reported from the eastern United States. Sprays should be directed at leaf undersides where the nymphs feed.

Miscellaneous Notes: White flecking injuries on leaves of garden plants are characteristically produced by many different leafhopper species which feed on the mesophyll cells of the leaf underside. One of the most common is the rose leafhopper, *Edwardsiana rosae* (L.), which feeds on rose. Life history and control of this species is similar to the white apple leafhopper, which it also physically resembles.

Rose leafhopper. Photograph by W.S. Cranshaw.

Also common can be various leafhoppers in the genus *Erythroneura*. These include the grape leafhopper (*E. vulnerata* Fitch) which is a pest of grape in the West Slope areas of Colorado, the Virginia creeper leafhopper (*E. ziczac* Walsh) that commonly damages ivy and Virginia creeper throughout the Rocky Mountain region (discussed below), and species associated with elm and dogwood. All of these leafhopper species spend the winter in the adult stage, under loose bark and other protected sites.

VIRGINIA CREEPER (ZICZAC) LEAFHOPPER

Erythroneura ziczac Walsh
Family: Cicadellidae

Appearance: **Adults** - Colorful pale leafhoppers with red and green patterns on the wings. About 1/8-inch. **Nymphs** - Generally light orange to maroon in color with an elongate form, typically found on the leaf underside.

Hosts: Virginia creeper, grape, and related plants

Damage: Feeding by the nymphs produces characteristic white flecking injuries on the leaves due to destruction of the mesophyll. Heavily infested plants may appear gray and unsightly.

Life History and Habits: The Virginia creeper leafhopper spends the winter in the adult stage under sheltering debris in the vicinity of previously infested plants. They emerge in midspring and fly to the

vines to feed shortly after the new growth emerges. After several weeks, the females begin egg-laying, inserting the eggs just underneath the leaf surface.

Eggs hatch in one to two weeks and the nymphs feed on the mesophyll of cells on the lower leaf surface. They become full-grown in approximately three weeks. At least three generations typically occur in the region, with a fourth generation possible in warmer areas of the state. Feeding continues through early fall, with the adults leaving the plants for cover with cool weather.

Related Insects: A closely related species, *E. vulnerata* Fitch, feeds on the leaves of grape along the West Slope areas of the state.

Nymph of the honeylocust leafhopper. Photograph by W.S. Cranshaw.

HONEYLOCUST LEAFHOPPER
Macropsis fumipennis (Gillette and Baker)
Family: Cicadellidae

Appearance: **Adults** - Stout bodies, light green leafhoppers about 1/5 inch long. **Nymphs** - Smaller than adults, pale and wingless.

Hosts: Honeylocust primarily, but elm and several other deciduous trees are recorded as hosts.

Damage: Infested foliage is slightly discolored and distorted. Infestations commonly occur together with honeylocust plant bugs which also distort new growth and are much more damaging.

Honeydew is produced by this insect that can be a nuisance during outbreaks.

Life History and Habits: The life cycle of this insect is poorly understood. Overwintering stage is thought to be eggs in terminal growth. Nymphs hatch in spring and can be found feeding on new growth shortly after bud break. At least two, and probably three, generations are produced during the season as leafhoppers are present through late summer.

Related Insects: A treehopper, *Micrutalis calva* (Say), is commonly associated with honeylocust and occurs during late spring along with the leafhoppers and plant bugs. It does not appear to be damaging.

The honeylocust plant bug, discussed later, also is a small lime-green insect that occurs commonly on leaves in late spring.

Control: Rarely, if ever needed. Most controls for aphids or other shadetree insects are effective, including use of insecticidal soaps.

JUNIPER SPITTLEBUG
Clastoptera juniperina Bell
Family: Cercopidae

Appearance: **Adults** - About 1/4 inch long, rounded and brown. They jump or fly readily when disturbed and appear similar to large leafhoppers. **Nymphs** - Wingless and always buried in characteristic masses of spittle.

Host: Juniper

Juniper spittlebug spittle mass. Photograph by W.S. Cranshaw.

Damage: Unsightly spittle masses are produced which can be very unsightly during June. However, juniper spittlebug causes little or no injury to established plants, although some yellow spotting may be observed.

Life History and Habits: Eggs overwinter inserted in twig tips and hatch in the spring. Nymphs

feed on the xylem with piercing/sucking mouthparts. During feeding they continually produce clear fluid which they excrete as bubbles which completely encloses the body in the characteristic spittle mass. They reach maturity in one and a half to two months, mid to late June. Adults are winged and fly between plants, feeding and laying eggs. There is one generation per year.

Related Species: Other spittlebugs in the genus *Clasoptera* can be found on rabbitbrush, Gambel oak, aspen and alder. The species *Aphrophora irrorata* Ball is commonly associated with pines in Colorado.

Controls: Spittle masses are most commonly observed late in the life cycle, as the masses grow large. However, since the insect shortly leaves these masses, infestations typically end within two to three weeks after becoming noticeable.

Since no serious injury occurs, controls are rarely warranted. Forceful hosing with water can remove most. Care in pesticide selection can be important sinnce some insecticides used on junipers can contribute to later outbreaks of spruce spider mite, a far more serious pest.

PUTNAM'S CICADA

Platypedia putnami (Uhler)
Family: Cicadidae

Appearance: **Adults** - Large, stocky, triangular insects with bulging eyes and membranous wings, folded tent-like over the body. Depending on the species, size can range from 3/4 to 2 1/4 inches in length. **Nymphs** - Humpbacked, spiny, with claw-like digging legs.

Hosts: Many trees and woody shrubs of the plains and foothills including apple, honeylocust, maple, mountain-ash, and oak

Damage: Damage is produced not by feeding, but instead occurs when the females insert eggs into twigs. This causes a splintering and weakening of the twig, often resulting in dieback.

The most visible damage is from egg laying (oviposition) wounds. This can results in deep gouges in the bark and wood of small twigs, at times weakening them so much that they break in the wind. Nymphal damage from root feeding is not considered to be significant for any cicada species.

Putnam's cicada produces a clicking noise, likened to the striking of two dimes. Their large size and ability to produce noise results in most concerns related to this insect.

Adult of the Putnam's cicada. Photograph by W.S. Cranshaw.

Egg-laying wounds in a twig produced by a Putnam's cicada.

Life History and Habits: Life history of Putnam's cicada is poorly understood but is thought to take three to five years to complete. The entire immature stage occurs underground, with the nymphs feeding on the plant roots. When full-grown, the nymphs emerge from the soil and transform into adults, leaving behind their cast nymphal skins on the lower trunk of their host.

Adults are present for about four to six weeks from June through early July. After mating, the adult females lay eggs in slits in the twigs of various hosts. Upon hatching, nymphs drop to the ground, burrow beneath the soil surface, and spend the next two to five years feeding on the roots of plants.

Control: No controls have been developed to prevent egg laying wounds by this insect. Control of other cicadas with insecticides has been very disappointing since the adult cicadas are highly mobile and are present over an extended period (weeks).

High value plants, particularly younger trees which are still getting established, may be protected by covering with netting to exclude the adults.

Related Species: Over 30 different cicadas occur in Colorado, although the periodical cicadas (*Magicicada* species) such as the "17-year locust" are not present. Putnam’s cicada is the only species which has had associated plant damage in Colorado. The high-pitched buzzing of the dog-day cicadas often attract attention and these insects are discussed in the section Miscellaneous Insects Associated with Trees and Shrubs.

'TRUE' BUGS (HEMIPTERA)

Members of the order Hemiptera, the 'true bugs', also have specialized piercing-sucking mouthparts designed to feed on plant fluids. However, feeding is typically more destructive than with the aphids and scales (Order: Homoptera). Most true bugs feed in a manner known as 'lacerate-flush' where the mouthparts puncture and slash plant cells, followed by the production of large amounts of saliva to flush the cell contents into the mouth. As a result, areas around feeding sites usually are killed. Since most bugs also feed on tender tissues (e.g., developing leaves, fruits, flowers) these injuries may cause distortion injuries or abortion of plant parts.

Several groups of 'true bugs' are particularly important as woody plant pests. Most important in the Rocky Mountain region are the plant bugs ((Family: Miridae). Most spend the winter in the adult stage in protected sites; the honeylocust plant bug (which overwinters as an egg) being an important exception to this habit, wintering in the egg stage. Lace bugs (Family: Tingidae), a group that is important in other aras of the country, are generaly minor species in this part of the country). Many species of Hemiptera can be quite difficult to control, since this group tends to be rather resistant to most insecticides, such as the boxelder bug (*Boseia trivittatus*) a species most noted a a nusaince pest for its habit of invading homes for winter shelter, after developing on various shade trees.

HONEYLOCUST PLANT BUG

Diaphnocoris chlorionis (Say)
Family: Miridae

Appearance: **Adults** - Light green, 1/4 inch long and about three times longer than wide. **Nymphs** - Smaller, stouter and lack wings.

Host: Honeylocust.

Adult of the honeylocust bug.

Damage: Nymphs feed on the developing buds and leaves, killing the cells around the feeding site. Young leaves may be killed. Older leaves are discoloration and deformation of developing foliage. Heavy infestations may greatly retard foliage development in spring and cause twig dieback. This species has caused serious damage to honeylocust in recent years.

Related Species: Another species of plant bug, *Plagiognathus* species, occurs on honeylocust with the honeylocust plant bug. *Orthotylus ramus* Knight, causes similar injury to walnut. It has a life cycle parallel to that of the honeylocust plant bug. Plant bugs are also common on junipers but do not appear to cause noticeable injury.

The honeylocust leafhopper, discussed above, is a common lime green insect often found on leaves at the same time as the honeylocust plant bug.

Dieback and distortion of new growth results from damage by the honeylocust plant bug. Photograph by W.S. Cranshaw.

Life History and Habits: Eggs hatch in late April and nymphs begin feeding on elongating leaf shoots. They mature towards the end of May and can

be found until July. Eggs are laid into the woody tissue where they overwinter. There is one generation per year.

Controls: During outbreaks significant damage can be done by honeylocust plant bugs and controls can significantly benefit plant growth and appearance. On small trees, vigorous hosing with water can dislodge the nymphs. Insecticidal soaps and several other contact insecticides are also effective for control as sprays. Treatments should be applied during early stages of infestation, typically mid to late May and are of little benefit in early June when honeylocust plant bugs turn to the adult stage and feeding subsides naturally.

ASH PLANT BUG

Tropidosteptes amoenus Reuter
Family: Miridae

Appearance: **Adults** - Light brown "true bugs", about 3/8 inch long, with heart-shaped making on the scutellum. They resemble the shape of the common boxelder bug, having a triangular head and bulbous eyes. **Nymphs** - Generally oval and shiny yellowish or reddish brown, somewhat resembling the adults but lacking wings.

Hosts: Ash

Damage: Yellow speckling of leaves caused by the bugs' feeding with piercing/sucking mouthparts. Both nymphs and adults feed on the underside of the leaf. Heavy infestations eventually cause wilting, curling, discoloration and drying of the leaf blade. Very small black tarspots (excrement) appear near the damage.

Life History and Habits: Overwintering eggs are laid under loose bark. Nymphs hatch out in late April and May and feed on the lower leaf surfaces. Most injury occurs during this period as the nymphs begin to mature by late May. This generation of adult insects inserts eggs in the midribs of the leaves and a second cycle of feeding occurs in July and August. Adults produced by this latter generation produce the overwintering eggs.

Associated Insects: A lacebug, *Atheas* sp., also feeds on ash producing leaf spotting symptoms.

LACEBUGS

Corythucha species, *Atheas* sp.
Family: Tingidae

Appearance: **Adults** - The adult bugs are from 1/8 to 1/4 inch long, flat, with white lacy wing covers and similar lacy extensions on sides of thorax. **Nymphs** - Darker, covered with spines, and wingless.

Hosts: Lacebugs typically are specific as to host plants. Colorado species most commonly are found on oak, ash, sycamore, hackberry, and chokecherry.

Damage: Nymphs and adults feed on the underside of leaves with piercing/sucking mouthparts, causing yellowing and browning of foliage. Spots of tar-like excrement appear on the underside of leaves.

Life History and Habits: Adults overwinter in bark crevices and other protective areas. They emerge in the spring when young leaves are forming and soon deposit eggs on the underside of foliage near the midrib with a brown, sticky substance. Eggs hatch in several days, the nymphs begin feeding, and mature in about 30 days. More than one generation may occur per year, depending on climate and species.

SPIDER MITES

Mites are not insects but instead relatives in the Class Arachnida. The spider mites (Family: Tetranychidae) are generally the most damaging group of mites. These feed on plants, whipping and breaking the upper cell layers and sucking the plant saps. This produces characteristic flecking wounds and decreases the vigor of the plants.

Spider mite development typically involves five stages. Reproduction is by eggs, which hatch into a tiny, six-legged nymph stage. There follow two eight-legged immature stages (protonymph, deutonymph) and finally the adult. Males and females occur with the males being somewhat smaller.

Spider mite populations typically develop rapidly under dry conditions, since feeding rate is partly dependent on how rapidly excess water evaporates. Plants under stress are particularly susceptible to injury. Spider mite problems can also be induced through the use of certain insecticides, such as Sevin, which destroy natural insect enemies of the spider mites. Spider mites also have an extensive history of developing resistance to a wide variety of pesticides.

Proper watering and fertilization of plants is a primary means of limiting spider mite injury. Forceful hosing of foliage can be particularly useful since this can crush and dislodge many mites.

Dicofol (Kelthane), a specific miticide, has been a long-time standard for mite control. Certain broad-spectrum insecticides with some mite activity include Orthene, Mavrik, Avid and Talstar. [Note: Two selective miticides that formerly were used in landscape plant protection, hexakis (Vendex) and dienochlor (Pentac) have recently had label changes that have deleted use on outdoor ornamentals.] When heavy mite populations occur, it may be difficult to get control with any pesticide. Use of miticides during hot weather can cause some problems. Kelthane tends to have less effect at high temperatures, and other insecticides may cause plant injury when applied under high temperature conditions.

Sprays of insecticidal soaps can be used to suppress mites on plants that are not injured by the soaps. Such a treatment is best applied in spring or early summer before mite populations become too great. these are fairly selective in their effects on most beneficial species, althought soaps can adversely impact many species of predatory mites.

HONEYLOCUST SPIDER MITE

Platytetranychus multidigituli (Ewing)
Family: Tetranychidae

Appearance: Honeylocust spider mite is generally similar in form to the common twospotted spider mite. Summer forms are usually pale green. Very young mites are orange and the overwintering females are bright orange-red.

Hosts: Honeylocust

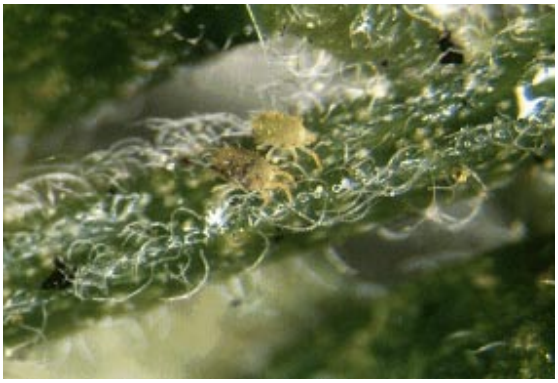
Damage: Honeylocust spider mite feeds on the leaves of honeylocust, damaging upper cell layers and removing sap. Feeding is particularly concentrated along the mid-rib of the leaf underside. During heavy infestation leaves turn an off-yellow color and the entire host tree may be discolored. This mite is also associated with premature leaf shed.

Problems with honeylocust spider mite are most common on trees planted along roads, in parking lots and in similar hot, dry sites.

Associated Insects: An eriophyid mite is commonly associated with honeylocust spider mite on leaves of honeylocust.

Life History and Habits: The honeylocust spider mite survives winters in the stage of adult females. They seek out protective sites such as bark crevices and under bud scales. Egg laying begins in spring as soon as young leaves are present. Eggs hatch and the immature nymphs feed on the leaves, molting two times before reaching the adult form. Time from egg stage to adult ranges from 8 to 17 days, depending on temperature.

Populations build very rapidly in early-summer and usually decline by mid-August. Uninfested new



Honeylocust spider mite causes a general yellowing of the foliage in mid-summer.

growth may then appear at the branch tips.

Control: Few natural enemies have been observed attacking honeylocust spider mite. Minute pirate bugs, *Stethorus* lady beetles, and predatory thrips apparently provide some control.

Honeylocust sited and maintained in a manner that prevents drought stress will suffer fewer problems with this mite.

Honeylocust spider mite has been easier to control with insecticides than have other mites.

SPRUCE SPIDER MITE

Oligonychus ununguis (Jacobi)
Family: Tetranychidae

Appearance: Small (1/25 inch) green mites with some orange markings. During heavy infestations they may produce a fine netting of silk on needles.

Hosts: Most conifers but injury is particularly common on spruce and junipers. Douglas-fir is also a reported host.

Damage: Sap is removed and tiny light colored flecks remain at feeding site. Infested trees become brownish gray and may be defoliated. Spruce spider mite is extremely common and damaging to spruce and junipers in Colorado.

Related Species: The Banks grass mite, *Oligonychus pratensis* (Banks), is a common pest of grasses, including corn and drought-stressed turfgrasses.

Life History and Habits: Spruce spider mite spends the winter in the egg stage, attached near the base of needles. Eggs at the base of needles which hatch in midspring. The early stage larva has only six legs but soon grows and molt to the later, eight-legged nymph and adult stages. All stages feed on the sap of conifer needles. Early in the season older growth is fed on; later attacks shift to the newly produced needles. Development can be completed in about two weeks. There are continuous, overlapping generations.

Spruce spider mite tends to like conditions somewhat cooler than 'typical' spider mites. Peak populations often occur in spring, although heavy late season damage does sometimes occur.

Spruce needles showing a range of leaf flecking injuries due to feeding by the spruce spider mite. Photograph courtesy of the Oregon State University Department of Entomology.

Control: The most common natural enemy are the small black lady beetles known as 'spider mite destroyers' (*Stethorus* species). Excessive use of some insecticides have been linked to some outbreaks of this mite.

Miticides should be applied when sampling detects high mite populations. Spruce spider mite populations are best monitored by firmly tapping the branches over a sheet and checking for the presence of mites and predators.

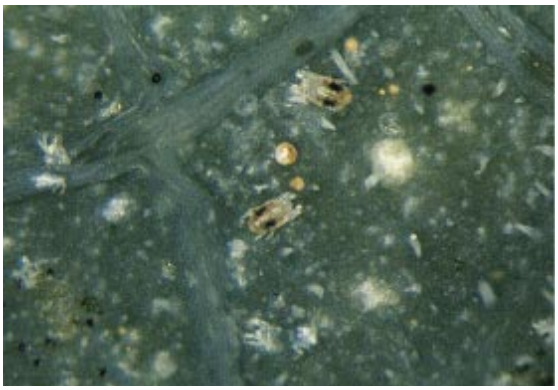
TWOSPOTTED SPIDER MITE

Tetranychus urticae Koch
Family: Tetranychidae

Hosts: Rose, pear, apple, raspberry, and many bedding plants

Damage: The twospotted spider mite pierces plant cells and feeds on the sap. Small white flecking injuries are typical around feeding sites. More generalized discoloration, typically bronzed-colored, occurs as infestations progress. Vigor of plants may be seriously reduced. Premature leaf drop occurs on heavily infested plants.

Life History and Habits: Life cycle of the twospotted spider mite is similar to the species described above. Under favorable conditions of warm temperature and low humidity, the generations are completed in as little as 10 days. Adult females may lay up to five eggs per day over the course of two to three weeks. During periods when temperatures are unfavorable or food is absent, twospotted spider mites temporarily change to a less active non-feeding stage. At these times it changes to a red or reddish-brown color ("red spider" mite).



Adults and eggs of the twospotted spider mite. Photograph by W.S. Cranshaw.

Control: Several organisms prey on spider mites in field settings; minute pirate bugs and predatory species of mites are among the most important. The bandedwinged thrips are also sometimes important predators of spider mites.

Watering and water management are very important in controlling twospotted spider mite. Overhead watering - and purposeful hosing of plants with water in a garden setting - can dislodge and kill many spider mites. Providing adequate water for plant growth needs is also important in managing spider mites. Drought and fluctuating wet/dry soil conditions can stress plants in a manner that can cause spider mite populations to increase.

The twospotted spider mite is often the most difficult mite to control with chemicals. High levels of resistance have developed in many populations. Early season applications of Kelthane or Talstar are among the more effective treatments in most settings. Avid can be used in nursery settings.

INSECTS THAT FEED ON FRUIT, SEEDS, CONES

CONIFER SEED BUGS

Leptoglossus occidentalis Heidemann
Leptoglossus phyllopus (L.)
Family: Coreidae

Appearance: **Adults** - Reddish-brown to a dark gray in color and light marking on abdominal margins (3/8 to 1/2 inches long). These bugs possess an enlarged hind tibia that is broad and flat, thus the name leaffooted bugs is often given to them.

Hosts: Douglas-fir, dogwood, pines and other plants.

Conifer seed bugs feed on the seeds of many woody plants and occasionally enter nearby homes for winter shelter. Photograph by T.W. Koerber, U.S. Forest Service.

Damage: Conifer seed bugs primarily feed and develop upon developing seeds. Conifer seeds are preferred but developing seeds and fruits of a wide variety of plants may be fed upon. Occasionally they do minor damage to fruits, causing pitting, and can be serious pests where pine is grown for seed.

Conifer seed bugs most commonly attract attention when they move into homes for winter shelter, particularly at higher elevations.

Life History and Habits: Conifer seed bugs overwinter in the adult stage under cover, often moving into homes. Eggs are laid in the spring in rows on needles. Nymphs and adults feed on developing cones and seeds. There is one generation per year.

Related species: Another species of *Leptoglossus* is associated with prickly pear cactus.

BOXELDER BUG

Boisea (= Leptocoris) trivittata (Say)
Family: Rhopalidae

Appearance: **Adults** - Brownish-black bugs with three red lines on the head, and a bright red abdomen beneath the wings, which are black rimmed with red and half membranous. About 1/2 inch long. **Nymphs** - Generally resemble adults but are smaller, wingless and primarily red in color.

Hosts: Boxelder, sometimes silver maple

Boxelder bug, adult. Photograph by W.S. Cranshaw.

Damage: Nymphs and adults usually feed on sap from seeds, flowers and leaves, but cause little damage to trees. Occasionally they feed on developing fruits, such as apples, and can produce puckered 'catface' injuries to these plants.

The major "damage" from these insects is their appearance in nuisance numbers on the windows and porches of homes. This is occurs most often in the spring and fall.

Related Species: The western boxelder bug, *Boisea rubrolineata* Barber is recorded from Utah and several other western states and may occur in southwestern Colorado. Another common black and red bug that may be confused with the boxlder bug is the small milkweed bug, *Lygaeus kalmii* Stal. *L. kalmii* belongs to the seed bug family (Lygaeidae).

Life History and Habits: Boxelder bugs overwinter in the adult stage in protected sites, often including homes. They emerge in midspring and lay eggs near fallen seeds of boxelder, ash, and silver maple. The first generation nymphs feed on these

seeds, as well fruit trees, various low growing plants and, occasionally, dead insects. They become full-grown in early summer.

Boxelder bug eggs. Photograph by W.S. Cranshaw.

A second generation occurs during late summer. Eggs are laid almost entirely on boxelder, particularly seeds produced by female trees. The nymphs develop on these seeds often into October, if weather permits. After frosts, boxelder bugs move to winter shelter.

Controls: Only adult stages survive the winter and many nymphs which fail to complete development are killed by early frosts or shorter growing seasons.

Boxelder bugs do not require controls for protection of trees. However, treatments are often made to reduce nuisance movements into homes. Boxelder bugs are quite resistant to most insecticides. Diazinon, Tempo, Mavrik, and Talstar are fairly effective.

LYGUS BUGS

Lygus species
Family: Miridae

Appearance: **Adults** - Generally oval in shape, being about twice as long as wide, and 1/4 inch in length. Most common species of *Lygus* in Colorado are pale green, but brownish and mottled forms occur. **Nymphs** - More rounded in general form and usually dark green, often with dark spotting.

Damage: Lygus bugs feed on developing leaves, fruits and flowers, killing the areas around the feeding site. This can cause abortion of young flowers, seeds, or buds. Older tissues may continue to grow but be deformed. Leaf curling and corky 'catface' injuries to fruit are common distortions due to lygus bug feeding injury. Peach, apricot, strawberry, and beans are among the garden plants most commonly damaged.

Some flower abortion of most plants is normal and lygus feeding injuries have little effect on plant yields unless the insects are abundant.

"Catfacing" injury to peach fruit caused by feeding of a Lygus bug. Photograph courtesy of Clemson University.

Related Species: Several species of lygus bugs occur in the region including the tarnished plant bug [*Lygus lineolaris* (Palisot de Beauvois)] and pale legume bug (*Lygus elisus* Van Duzee). In addition, other plant bugs, stink bugs, and even boxelder bugs occasionally damage fruit in a similar manner.

Life History and Habits: Lygus bugs spend the winter in the adult stage, under the cover of piled leaves, bark cracks or other sheltered sites. They emerge in early in spring and feed on emerging buds of trees and shrubs. Most then move to various weeds and other plants, and females insert eggs into the stems, leaves, and buds of these plants. The young hatch, feed and develop on these plants becoming full-grown in about a month. There are several generations produced during the year.

Controls: Legumes, particularly alfalfa, are important host plants for lygus bugs. If these plants occur around a garden, they should not be cut during times when fruits and vegetables are in susceptible stages, such as fruit set. Cutting can force migrations of lygus bugs.

Clean up weeds and other debris in orchards to reduce overwintering shelter and survival of lygus. However, most small yards have plenty of other sheltering sites.

Plant bugs can be trapped with sticky white cards. This is most useful for detecting when plant bugs have moved into a planting, rather than for control.

Lygus bugs, and most other 'true bugs' are fairly difficult to control with insecticides. Since most injury occurs during early fruit development, insecticide sprays are best timed either immediately before flowering and/or immediately after petal fall. Insecticides should never be sprayed during flowering to avoid killing beneficial pollinating insects.

Lygus bugs also occasionally feed on insects, and can contribute to the biological control of aphids and other small, soft-bodied species.

CODLING MOTH

Cydia pomonella (L.)
Family: Tortricidae

Appearance: **Adults** - A small moth (wingspan about 1/2 inch) with dull gray wings marked by a coppery patch at the wing tips. **Larvae** - Creamy white to pinkish caterpillars, with a brown to black head and a brown to black area behind the head. They are commonly found in the developing fruit of the host tree and are about 1/2 inch long when mature.

Hosts: Apple, pear, some crabapples

Damage: Larvae tunnel into the fruit of apples, pears, and crabapple. (It is almost always the "worm" in a wormy apple.) Less commonly it also may damage other fruits, including apricot and peach. It is the single most important insect pest of tree fruits in the western US.

Life History and Habits: Codling moth larvae spend the winter inside a silken cocoon attached to rough bark or other protection locations around the tree. With warm spring weather, they pupate and later begin to emerge around blossom time as small (about 1/2-inch), grey moths. The spring appearance of this adult stage may primarily occur over the course of one or two weeks, but can be much more prolonged if weather is cool.

During periods when early evening temperatures are warm (above 60 degrees F) and not windy, the moths lay small, white eggs on the leaves. The larvae hatching from the eggs may first feed on the leaves but then migrate to the fruit, usually entering the calyx (flower) end. They tunnel the fruit, feeding primarily on the developing seeds. After about three to four weeks, the larvae become full grown, leave the fruit, and crawl or drop down the tree to spin a cocoon and prepare to pupate.

Frass on the skin of an apple characteristic of infestation by larvae of the codling moth. Photograph by Harold Larsen.

After about two weeks most, but not all, of the pupae develop to produce a second generation of moths. The remaining moths remain dormant, emerging the following season. (For example, in western Colorado only about 2/3 go on to produce a second generation and fewer than 50 percent of their progeny go on to produce a third generation.) These moths lay eggs directly on the fruit and damage by the larvae to fruit is greatest at this time. Becoming full-grown, the larvae emerge from the fruit and seek protected areas to pupate.

Larva of the codling moth.

In the warmer, southern parts of the region, a small third generation is produced in late summer. This generally causes much less damage to apples and pears than the earlier generations.

Codling moth has many natural enemies, although these biological controls often are not

adequate to provide control. Birds will sometimes feed on the larvae and pupae in cocoon. Perhaps most important, codling moth larvae and pupae are often killed by several types of parasitic wasps. The activity of these wasps has been improved in some areas by the presence of nearby flowering plants which provide alternative foods. Codling moth larvae also are attacked by several general predators such as ground beetles and earwigs.

Keeping loose bark scraped from trees and removing debris from around the tree can eliminate shelter used by the insects when they pupate. This will cause them to be more exposed to birds and other natural controls.

Since caterpillars often need some leverage to help them cut into the fruit, many larvae enter where two fruits are touching. Thinning apples to prevent this can reduce the survival of the delicate young larvae.

Adult moths can be attracted to baits and trapped. A typical design might be a gallon jar baited with a pool of fermenting molasses and water (1:10 to 1:15 dilution is suggested). This attracts both male and female moths. (Pheromone traps only capture male moths.)

Pupal stages of the moth can be concentrated by placing bands of corrugated cardboard or burlap around the trunk. They can then be easily collected and destroyed from such sites.

Insecticides should be applied during periods of peak egg laying by the adult moths. Two damaging generations of codling moth are common, one in late spring (after petal fall) and the other in midsummer. Feeding by the larvae of the latter causes most fruit damage.

Use of pheromone traps containing the sex attractant of the female moth can improve treatment timing. Using this technique, insecticides are most efficiently used 10 to 14 days after peak flights are detected in pheromone traps.

Light oil sprays can assist in controlling the egg stage, which is laid on leaves and fruit. However, this treatment may cause russeting of fruit.

Experimental work indicates that pheromones may be effectively used in the 'male confusion' method for control of codling moth. This involves permeating the air with the sex attractant used by the female to attract males, reducing successful mating. In backyard settings, this would only be effective if apple and pears were well isolated from other sources of mated codling moth (including crabapple), since this species is quite migratory. At present, pheromones are only being test marketed with commercial growers on an experimental basis.

SPECKLED GREEN FRUITWORM

Orthosia hibisci (Guenee)
Family: Noctuidae

Appearance: **Adults** - Generally light brown in color with some darker markings but difficult to distinguish from other noctuids (cutworms, etc.). **Larvae** - Lime-green caterpillars, with scattered white spotting. When full grown they reach a size of about 1 1/2 inches.

Larva of the speckled green fruitworm. Photograph by Frank Peairs.

Hosts: Several dozen trees and shrubs may be fed on by speckled green fruitworm. Apple, oak, and willow are among the more common hosts. Caterpillars sometimes damage rose buds in late spring.

Damage: The caterpillars primarily feed on leaves but cause little injury. However, on fruit trees, they often chew on developing fruits. Damaged fruit may drop from the tree or overgrow the damaged areas and produce distorted 'catfaced' fruit.

This insect also feeds on leaves of trees, although is never abundant enough to be a significant defoliator. Outbreaks of it on oak have been most conspicuous.

Life History and Habits: Speckled green fruitworm spends the winter as a pupa. Moths emerge very early in spring to mate and lay eggs.

The developing larvae are a type of 'climbing cutworm' but remain permanently in the tree to feed. When they are full-grown, they wander from the food plant and pupate in protected locations in the vicinity.

Related Species: Caterpillars of several other species of "climbing cutworms" occasionally are associated with trees during mid to early spring. Among these are the humped green fruitworm (*Amphipyra pyramidoides* Guenee) and *Lithophane georgii* Grote. Biology of these differ somewhat from the speckled green fruitworm.

Control: Speckled green fruitworm cause little fruit injury. Predation by birds, attacks by tachinid flies and other natural enemies usually maintain adequate control. Chemical controls are not recommended.

WESTERN CHERRY FRUIT FLY

Rhagoletis indifferens Curran
Family: Tephritidae

Hosts: Cherries, occasionally apple

Damage: The adult female flies 'sting' the cherry fruit with her ovipositor, producing small puncture wounds. Eggs are often laid in the punctures and the immature maggots chew through the flesh of the fruit. Infested berries are misshapen, undersize, and mature rapidly.

In most areas, the western cherry fruit fly limits damage to cherry, including wild types. However, strains have developed in some regions (e.g., Utah) which attack and tunnel into apple.

Related Species: The western cherry fruit fly is closely related to the apple maggot (*Rhagoletis pomonella* Walsh), a serious apple pest in the eastern United States. Although the apple maggot is sometimes found within the region (e.g., parts of Denver, Colorado Springs), damage to apples is rare and it generally favors native plants, such as hawthorn. Controls are similar to western cherry fruit fly. Another related species, the walnut husk fly (*Rhagoletis completa* Cresson), is widespread in western North America, primarily feeding on walnuts. Rarely it may develop in late ripening varieties of peach.

Apple fruit damaged by the apple maggot. The dark streaking is caused by the tunneling larvae. Photograph by W.S. Cranshaw.

Life History and Habits: The western cherry fruit fly spends the winter in the pupal stage around the base of previously infested trees. In late June, the flies emerge and feed on aphid honeydew and other fluids, including oozing sap from wounds made by fruit punctures. The females then insert eggs into the fruit.

The immature maggots feed on the fruit, particularly the area around the pit. They become full-grown in two to three weeks and drop to the ground to pupate. In most areas there is one generation per year. However, a few flies may emerge and produce a second generation if susceptible fruit is available.

Control: Adult flies are easily trapped by yellow sticky cards or sticky red spheres. However, it has not been shown that trapping can adequately control the western cherry fruit fly.

Prematurely ripening cherries, often infested with developing fruit flies, should be picked and destroyed before the insects drop to the soil.

Control of aphids, which produce honeydew fed on by the flies, can reduce egg laying.

Where possible, tilling around the base of the trees in fall can kill many of the overwintering pupae.

The western cherry fruit fly can be controlled by several insecticides applied during periods when the adults are mating and beginning to lay eggs. Yellow cards or red spheres with a sticky covering can be used to determine when adult flies are present.

Table 13. Key to the adult Rhagoletis fruit flies known from Colorado. (Key adapted from J.L. Welch and B.C. Kondratieff.)

1. Color of body predominantly yellow or light brown 2
   Color of body predominately black 3

2. Wing pattern as shown in Fig. 1, accessory wing band (ab) present . . . . . R. basiola
   Hosts: rose hips (Rosa spp.)
   Wing pattern as in Fig. 2, accessory wing band (ab) absent . . . . . R. completa
   Hosts: walnut, rarely peach (Walnut husk fly)

3. Wing pattern as shown in Fig. 3, subapical crossband (sb) near apex of wing . . . . . R. striatella
   Host: husk tomato (Physalis spp.)
   Wing pattern as in Figures 4-8, sub-apical crossband (sb) near middle of wing 4

4. Wing pattern as in Fig. 4, apical band (apb) forming a fork and upper arm of apical fork often broken . . . . . R. indifferens
   Hosts: wild and cultivated cherries (Prunus spp.), rarely apples (Western cherry fruit fly)
   Wing pattern as in Figures 5-8; apical band (apb) entire 5

5. Wing pattern as in Fig. 5, apical and subapical band forming a F-shaped pattern; apical, sub-apical, and medial bands fused . . . . . R. pomonella, R. zephyria
   Hosts (R. pomonella): hawthorn, apple, Prunus spp. (Apple maggot)
   Hosts (R. zephyria): snowberry
   Wing pattern as in Figures 6-8, medial band (mb) not joined to either apical (ab) or subapical (spb) band 6

6. Wing pattern as in Figure 8; basal and medial bands distinctly separate basally . . . . . R. ribicola
   Hosts: currants and gooseberries (Gooseberry maggot)
   Wing pattern as in Figures 7-8, basal and medial bands fused, often obscurely 7

7. Back surface of head almost entirely black; dorsal surface of thorax with sparse white hairs . . . . . R. tabellaria
   Hosts: dogwood berries (Cornus spp.); blueberries (Vaccinium spp.)
   Back of head hellow or light brown; dorsal surface of thorax with dense yellow hair . . . . . R. juniperina
   Hosts: juniper berries (Juniperus spp.)

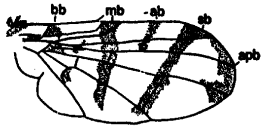


Figure 1.

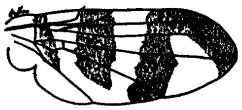


Figure 2.

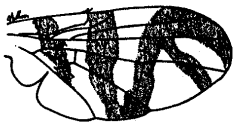


Figure 3.

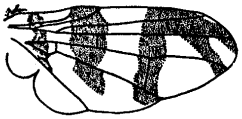


Figure 4.

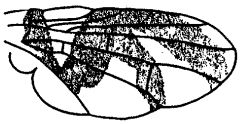


Figure 5.

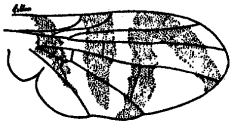


Figure 6.

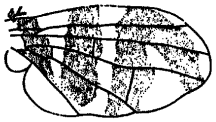


Figure 7.

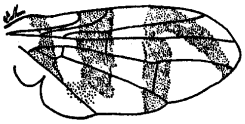


Figure 8.

Wing patterns of Rhagoletis fruit flies.

CHOKECHERRY GALL MIDGE
Contarinia virginianae (Felt)
Family: Cecidomyiidae

Appearance: **Adults** - Small gnat-like fly. **Larvae** - Bright orange-red maggots found within the cavity of galled chokecherry fruit.

Hosts: Chokecherry

Damage: The developing larvae feed on and distort developing chokecherry fruit causing them to enlarge and become hollow.

Fruit distorted by the chokecherry gall midge.

Life History and Habits: Winter is spent in the pupal stage, around the base of previously infested chokecherries. Adults emerge in early spring, around the time of blossoming, and females lay eggs in the flowers. After eggs hatch the young maggots tunnel into developing chokecherry fruit, causing it to become enlarged and hollow. The maggots feed within the fruit until midsummer. After they have finished feeding, they drop to the ground and pupate. There is one generation per year.

Control: Damage by this insect is negligible. No insecticides are registered for use on chokecherry grown for edible fruit. Thoroughly hand-picking infested fruit before the maggots emerge should reduce populations the subsequent season.

ROSE CURCULIO
Merhynchites bicolor (F.)
Family: Curculionidae

Appearance: **Adults** - Red "snout beetles" approximately 1/4-inch long, with the mouthparts and underside marked with black. **Larvae** - Legless "grubs" found within the buds of rose.

Hosts: Rose, particularly wild rose

Rose curculio on a rose bud. Photograph by W.S. Cranshaw.

Damage: The rose curculio damages roses by making feeding punctures into flower buds, resulting in ragged flowers. During periods when the buds are not common, the feeding occurs on the tips of shoots, killing or distorting the shoot. A "bent neck" condition of rose appears to often be caused by feeding rose curculio feeding wounds in developing stems.

Life History and Habits: The adult stage of the rose curculio is a red snout beetle (weevil) with a black "beak". They become active in late spring and lay eggs in developing flowers. The larval (grub) stage feeds on the reproductive parts of the flower. Blossoms on the plant, including those clipped off by a gardener, are suitable for the insect to develop. When full grown, the grubs fall to the soil and form an underground cell; pupating the following spring. There is one generation per year.

Control: Regular hand picking, and removal, of spent blossoms will prevent populations from developing. However, other brambles are hosts and can serve as additional sources of the insect.
Adult weevils drop readily from plants and feign death. Where plantings allow, shake plants over a collecting container to speed hand collection of rose curculio. Rose curculio can be controlled with most insecticides, applied during late May and June.

CHERRY CURCULIO
Anthonomus consors (Dietz)
Family: Curculionidae

Appearance: **Adult** - A small (1/8 inch) brown 'snout weevil' with numerous lumps on the wing covers. **Larvae** - Pale, legless grubs which develop in the pit of cherries.

Hosts: Sour cherry, chokecherry

Cherry curculio on a cherry fruit. Photograph by W.S. Cranshaw.

Damage: The adults chew small holes in the base of flowers and cause abortion of developing fruit. Larger fruit are pitted by this injury. Eggs are inserted into fruit and larvae tunnel the fruit, ultimately feeding on the pit.

Life History and Habits: The cherry curculio spends the winter as an adult snout beetle ('weevil') around trees infested the previous season. They fly to tree in spring as flower buds form and feed on the buds and flowers. After several weeks, the developing fruits appear and females insert eggs into them. The young larvae feed and hollow the pit. They then pupate within the pit and leave as the cherries as they ripen. There is one generation per year.

Related Insects: Related species of small weevils attack plum [the plum gouger, *Coccotorus scutellaris* Leconte)]) and apple [the apple curculio, *Anthonomus quadrigibbus* (Say)], but rarely cause serious injury to these plants. The plum curculio [*Conotrachelus nenuphar* (Herbst)], a fruit infesting weevil that seriously damages plums, apples, and apricots in eastern states, does not occur in the Colorado.

The apple curculio feeds on *Amelanchier* (serviceberry, shadbush) and apple. They are difficult to detect since they remain motionless, with beaks raised, when disturbed and closely resemble bud scales or dried petals. The apple curculio makes small holes in leaves and feeding punctures in fruit. Fruit injuries made in late spring heal over by late season feeding and result in dry, sunken areas on the fruit. Similar to the cherry gouger, the females excavate holes to lay eggs. Larvae and pupae within the apple develop only within the shed apples (growing apples kill them.) Only some varieties of apples are susceptible, including Delicious. Cleaning up June drop apples can control the insect, although not eliminate spring feeding damage during the first year.

Oozing from feeding puncture by the plum gouger. Photograph by W.S. Cranshaw.

The plum gouger feeds on hard types of plums. Adult weevils make numerous feeding punctures in the developing fruit, many of which result in a flow of clear ooze from the wound. Eggs are laid in some of the punctures and the larvae develop within the pit. This species apparently spends the winter as an adult within the pit. Removal of damaged fruit should help control this species.

Controls: Several types of parasitic wasps commonly attack the cherry curculio.

The adult weevils can be shaken from trees and collected on sheets. However, they are difficult to see and 'play dead' when disturbed. To prevent the insect from developing, damaged fruit should be picked and destroyed as it is observed. Little work has been done on the chemical control of this insect. Effective insecticides, applied before flowering, should provide control.

MISCELLANEOUS INSECTS ASSOCIATED WITH COLORADO TREES AND SHRUBS

ROUGH STINK BUG

Brochymena sulcatus Van Duzee
Family: Pentatomidae

Hosts: This stink bug is commonly found resting on the bark of a wide variety of trees where it blends in very well with the background color.

A rough stink bug. Photograph by W.S. Cranshaw.

Damage: No damage is associated with the insect, although it may feed some by sucking sap from leaves and developing seeds. Primarily, this insect is a predator of other insects.

Life History and Habits: Although a common species in Colorado, little is known of the biology of this insect. Winter is spent in the adult stage, and it often enters homes for shelter during the cold months. The insect has been collected from several kinds of plants. Although it feeds primarily on insects, it also sometimes feeds on leaves of many deciduous trees.

Other members of this genus have one generation per year. Eggs are laid in late spring and nymphs develop on their host plants through much of the summer. First generation adults are present by late August.

Related species: Other stink bugs are associated with trees and shrubs, most notably those that are predators of insects such as elm leaf beetles. These are discussed under the section on beneficial insects.

DOG-DAY CICADAS

Tibicen dorsata (Say)
Tibicen dealbata Davis
Family: Cicadidae

Life History and Habits: Immature stages (nymphs) of the dog-day cicadas develop by feeding upon sap from the roots of various trees. Boxelder and cottonwood trees in fairly loose, moist soils are common hosts. Development takes a few years years to complete.

A dog-day cicada. Photograph by W.S. Cranshaw.

A cicada adult emerging from the nymphal skin. Photograph by L.B. Bjostad.

When full-grown the immature nymphs emerge from the soil and climb onto a nearby upright object. This typically occurs form mid-July to mid-August. There they molt and change to the adult form. After a brief period, during which the newly emerged adults darken and harden, they fly and feed upon the

sap of leaves and twigs. Mating occurs in the trees and the females insert their eggs into twigs. Males of the dog-day cicadas produce a high pitched buzzing noise which is used to attract the female cicada. Females do not produce noise. Cicadas are harmless to humans, although they often startle people by their buzzing and flight when disturbed.

Related Species: Approximately 30 species of cicadas occur in Colorado. None are considered seriously damaging to trees, although some egg laying wounding has been associated with Putnam's cicada, *Platypedia putnami* (Uhler). A very large hunting wasp, the cicada killer [*Sphecius speciosa* (Drury)], hunts dog-day cicadas and carries them back to nests they build in holes in the ground. The cicada killer appears similar to a giant yellowjacket wasp.

BUFFALO TREEHOPPER
Stictocephala bisonia Kopp and Yonke
Family: Membracidae

Appearance: **Adults** - Generally triangular-shaped with the sides of the front developed into small points. They are grass-green colored and about 3/8 inch long. **Nymphs** - Pale-green and spiny, found feeding onf various herbaceous plants.

Oviposition (egg-laying) scars on a peach twig produced by the buffalo treehopper. Photograph by W.S. Cranshaw.

Damage: The buffalo treehopper inserts eggs into twigs. Small scars form at the slits, usually in rows and damaged areas may become scabby looking. Although very heavy infestations could check plant growth and weaken limbs, they are primarily a curiosity under Colorado conditions.

Life History and Habits: The buffalo treehopper overwinters in the egg stage, under the bark of twigs. The eggs hatch in late spring and the nymphs usually feed on grasses and broadleaf weeds around the base of trees on which eggs were laid. They become full-grown in late July or August and females lay eggs during from August until a killing frost occurs. In the process of egg laying, the female cuts two slightly curved slits in the bark and lays a group of up to one dozen eggs under the loosened bark.

ARID-LAND SUBTERRANEAN TERMITE
Reticulitermes tibialis Banks
Family: Rhinotermitidae

Damage: As with other termite species, the arid-land subterranean termite feeds on cellulose materials, including wood. It is a common scavenger of brush, wood, and animal manures in natural areas of the state and may be found in dead parts of living trees. It can feed on wooden structures but is considerably less damaging than are other termites, such as the eastern subterranean termite.

Workers of the arid-land subterranean termite found under a board. Photograph by W.S. Cranshaw.

Life History and Habits: The arid-land subterranean termite is a social insect that produces a permanent colony underground. Separate castes occur in the colony including workers, soldiers, reproductive females (queens), and reproductive males (kings).

Colonies are initiated by winged reproductives. These emerge during late winter or early spring during mating flights and the paired queen and king attempt to initiate a colony. Very few are successful in the effort to create a colony and most die out

within a few weeks after the mating flights. However, if successful the queen produces eggs and pale, flightless worker termites are produced. The colony slowly increases in size over a period of years and ultimately may later produce reproductive stages that disperse.

The workers are the stage that forage for cellulose-containing products. They avoid light and are very sensitive to drying so they remain underground or within the food (wood, cattle manure, etc.). Workers can not reproduce but may survive for months outside the colony. (Note: Firewood is not a means of acquiring a termite infestation.)

Related Species: The eastern subterranean termite, *Reticulitermes flavipes* (Kollar), has moved into eastern Colorado in recent decades and has become a serious pest of structures in parts of the state. The eastern subterranean termite has a highgher moisture requirement than does the arid-land subterranean termite and its spread has likely been favored by irrigated landscapes.

BROADWINGED KATYDID
Microcentrum rhombifolium (Saussure)
Family: Tettigoniidae

Damage: Although katydids feed on leaves, this damage is insignificant. However, they lay unusual eggs which may attract attention. Eggs are flattened and laid in overlapping rows on twigs.

Clicking and rasping noises made by katydids during their mating "songs" also attract attention.

The broadwinged katydid. Photograph by W.S. Cranshaw.

Appearance: These are large insects, with some at least two inches from the head to the tip of the wings. They are pale-green color and blend in well with foliage.

Life History and Habits: Several katydids are found in Colorado. They are never abundant enough to damage plants, but their loud 'songs' attract attention and sometimes disrupt sleep. these insects are also quite large and produce distinctive eggs.

The overwintering stage of katydids are eggs. Eggs are laid on twigs of plants and appear as overlapping rows of pale scales. The eggs hatch the following spring and the young katydids develop during the season, becoming full grown in late summer. In addition to feeding on plants, small insects are sometimes eaten.

Eggs of the broadwinged katydid laid on a twig. Photograph by F.B. Peairs.

Singing to attract mates occurs in late summer, lasting several weeks. Songs may be a rustling noises or a loud 'lisps' and 'ticks'. Only the males produce the noises which are used to attract mates. Females lay eggs by roughening the bark and gluing the eggs to the plant. There is one generation per year.

PRAIRIE WALKING STICK
Diapheromera velii velii Walsh
Family: Heteronemiidae

Appearance: **Adults** - Very elongate, wingless insects up to six inches long. The females are typically light green and more heavy-bodied than are the brownish males.

Life History and Habits: The walkingstick spends the winter in the egg stage, in sandy washes where the female dropped them. Spring rains flood and move the eggs, often causing them to collect in pockets where the water flow slows. This typically results in highly localized abundance of walking-sticks. Walkingsticks are found in many areas of eastern Colorado, particularly the southeastern counties.

Eggs hatch in late spring and the young walkingsticks feed on various shrubby plants and grasses. Several legumes are most commonly eaten, but prairie grasses (*Andropogon*) are also reported as foods. Almost all feeding occurs at night after dark.

The walkingsticks develop rapidly and adults can be found by late June and early July. They can often be found mating at this time and the sexes are readily distinguished: females tend to be green and larger than the brown males. As the female feeds, she periodically drops single eggs, which fall to the ground. Walkingsticks can continue to be found until a killing frost.

A prairie walkingstick. Photograph by W.S. Cranshaw.

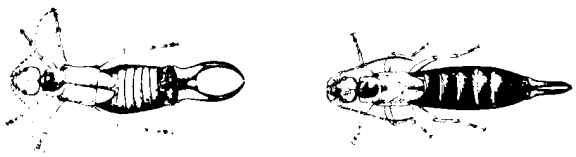
Related Insects: The closely related walkingstick *Diapheromera femorata* (Say) has been collected from northeastern Colorado. This walkingstick is much more common in the Midwest, where it occasionally has damaged oak forests.

EUROPEAN EARWIG

Forficula auricularia L.
Family: Forficulidae

Appearance: Adults reach a size of about 3/4 inches and are dark brown with short wing covers. The most distinguishing characteristic are the forceps, or pincers, at the tip of the abdomen. Those of the male are more bowed than the female.

Damage: Earwigs feed on a wide variety of plant and animal materials. Although they can damage soft plant parts, such as flowers and seedlings, on trees and shrubs they primarily feed on insects. They are important predators of many pest species including leafcurling aphids and elm leaf beetles.



The European earwig. The pincers of the males are more bowed than those of the females.

Life History and Habits: The adult earwigs spend the winter under rocks or similar protected sites and may become active during warm periods in winter. The females live within a small chamber they create and lay their eggs during these winter. Eggs are laid in groups, numbering around 40 to 60, and the mother carefully guards them.

Eggs hatch in early spring, around the time that fruit trees start to blossom. During the early stage of their life the mother continues to care for the young, periodically leaving the nest to collect food. Only after the nymphs have molted do they leave the nest, although they often continue to return to it for several weeks. The females often then produce a second, smaller group of eggs.

Earwigs are active at night and feed on a wide variety of foods. Soft parts of plants, such as corn silks and flower petals, are common foods and garden plants may be damaged. However, earwigs primarily feed on other insects and can be important natural controls of many garden pests. During the day they seek cover, preferring tight, dark locations. This includes existing holes in bark or fruit or curled leaves and galls.

Most of the overwintered earwigs die by late spring. The young earwigs become full grown in about two months and continue to be active throughout the summer. There is one generation a year, although nymphs may be found for much of the season since many overwintered females rear a second brood.

GIANT ICHNEUMON WASP

Megarhyssa macrurus (F.)
Family: Ichneumonidae

Appearance: **Adults** - Large wasps, up to two inches long from head to tip of abdomen, females have extremely long ovipositors, making them look even larger. **Larvae** - Cream colored, worm-like parasites, found only with their host.

A giant ichneumon wasp, parasitoid of the pigeon tremex. Photograph by S. Krieg.

Hosts: The giant ichneumon wasp is not a tree pest, but instead is a parasitoid of the pigeon tremex horntail, a minor pest species that tunnels the wood of many species of hardwood trees.

Damage: The giant ichneumon wasp causes no damage to trees or people. However, they can attract considerable interest because of their rather frightening appearance.

Life History and Habits: The giant ichneumon wasp overwinters as a full grown larvae on its devoured host, within the tree. They pupate in spring and the adults emerge in mid-summer. The wasps are most common from late June through early August.

The females are capable of detecting the presence of developing larvae of the pigeon tremex within wood. They then drill through the wood and lay an egg on or near the young horntail larva. The emerging wasp larva soon kills and devours the horntail.

CICADA KILLER

Sphecius speciosus (Drury)
Family: Sphecidae

Distribution: The cicada killer is primarily found in southern and southeast Colorado, along with its prey the dog day cicadas. It is also present in the eastern plains areas.

A cicada killer subduing a dog-day cicada.

Life History and Habits: Adult cicada killers are most abundant in late July and August at which time they search for adult cicadas and prepare nests. Nests are dug out of the ground in sandy soils and typically to a depth of about of a foot or more. Nests are located in loose sandy soils that are sun exposed. Several chambers (an average of around 16) are excavated in each nest. After provisioning with the cicada prey the female lays an egg, seals the chamber and prepares a new cell. The young wasps develop on the cicadas, completing development in early summer of the following year.

Cicadas are captured by the wasps and immobilized with a paralyzing sting, then carried back to the nest in a series of short flights. Usually only the larger, egg-filled female cicadas are used by the cicada killer. Because the cicada prey weighs more than the wasp, often it is dragged up trees or buildings to allow the adult wasp to make short gliding flights to the nest. The cicada is then pulled into the nest hole and an egg laid upon it.

Two cicadas are used when the wasp rears a female; one cicada is sufficient for the food needs of the smaller male wasps. The young wasps feed on the paralyzed cicada becoming full-grown in a few weeks. The overwintering stage of the wasp is as a

diapausing larva within a cocoon. There is one generation of the insect per year.

Female cicada killers will sting if handled. The sting is painful but the pain passes more quickly than a bee sting.

Related Insects: The family Sphecidae contains a large number and wide variety of hunting wasps and members occur throughout Colorado.

BALDFACED HORNET
Dolichovespula maculata (L.)
Family: Vespidae

Damage: Baldfaced hornets do not harm trees and are usually nonaggressive. However, they can produce a painful sting and will defend nests vigorously. Accidental stings can occur when work is done in trees where nests occur.

Hornets and many species of yellow jackets (*Vespula* species) frequently visit trees in late summer to collect honeydew produced by aphids and other insects. The large numbers of these stinging wasps can be a significant nuisance.

Related Species: A slightly smaller hornet, known as the aerial yellowjacket [*Dolichovespula arenaria* (L.)], also occurs in Colorado. Habits are similar to the baldfaced hornet although nests are somewhat smaller. This species has the yellow and black coloration more commonly associated with yellowjackets (*Vespula* species), wasps which similarly construct paper nests in trees similar to the but occur in wall voids, underground in abandoned rodent burrows, or similar sites. Yellowjackets most commonly visit trees in late summer and fall to feed on honeydew produced by aphids and soft scales.

Life History and Habits: Life history is similar to that of other social wasps such as yellowjackets (*Vespula* species) and *Polistes* paper wasps. Overwintering stage is a fertilized female wasp that seeks protected locations for shelter. In spring the queens become active and seek sites to initiate colony nests. Trees and shrubs are commonly used nesting areas.

Nest construction is made of paper-like materials produced from ground bark and wood mixed with saliva. Nests take the coloration of the wood used for construction and often are strikingly banded in colors ranging from light gray to reddish brown.

The overwintered queen produces a few cells and rears her young on a diet of various insects such as caterpillars that she collects. The first wasps produced are small and infertile females. They assist with further colony development and food collection. Subsequently reared wasps are feed improved diets due to better food collection and wasps produced late in the season are full-sized and fertile. Colony and nest size grow continually becoming football-sized or larger by the end of summer. At the end of the season some male wasps are also produced. Mating occurs at this time. The old queen, males, and early worker wasps die at the end of the season. Fertilized queens disperse for overwintering sites. Colonies are abandoned and are not reused.

Aerial paper nest produced by a bald-faced hornet or aerial yellowjacket.

CARPENTER ANTS
Camponotus species
Family: Formicidae

Damage: Carpenter ants excavate wood for nest construction. Although nest building is concen-trated in wood that is already softened due to decay, they can structurally weaken trees and increase the chance of breakage.

Various species of carpenter ants can be found throughout Colorado. However, the most common and largest species are typically found above 6500 feet elevation, in mountainous forested areas of the state.

Life History and Habits: Typical carpenter ants form nests inside rotting wood, although the species most common in the eastern Plains areas will nest in the soil. Unlike termites, the wood is not eaten and sawdust piles will be dumped at colony entrances.

Worker ants (incompletely developed females) collect food (insects, honeydew, etc.) and return it to the colony. Several hundred ants may occur within a carpenter ant colony.

Fully developed and fertile female "queens" are produced. These queens are winged and emerge and periodically fly from colonies, usually in late June or July. The smaller winged males, also produced by the colony, also fly at this time and mate with the females. New colonies are then individually started by these mated female queens. Shortly after finding a suitable site for beginning a colony, the females shed their wings.

THE TWOTAILED SWALLOWTAIL
THE WESTERN TIGER SWALLOWTAIL
Papilio multicaudatus Kirby
Papilio rutulus L.
Family: Papilionidae

Appearance: **Adults** - Large, strikingly colored butterflies marked with yellow and black. **Larva** - Variable, the younger stages being black splotched with white, resembling a bird dropping. Older larvae are lime green or generally brown, marked with conspicuous "eye-spots" on the back. When disturbed, they can evert a pair of fleshy horns from behind the head.

Larva of a swallowtail with defensive "horns" everted. Photograph by F.B. Peairs.

Damage: Although the caterpillars do feed on the leaves of certain trees and shrubs, they never occur in numbers sufficient to cause plant injury.

Life History and Habits: Overwintering stages of swallowtails are as pupae which form a grayish chrysalis that colors and camouflages with the background color on which it is formed. Adults emerge in May and June, mate, and lay eggs on the plants fed upon by the caterpillar stage. Green ash and chokecherry are host plants of the twotailed swallowtail caterpillar; willow, cottonwood, and chokecherry are fed upon by the western tiger swallowtail.

Adult of a tiger swallowtail butterfly. Photograph by W.S. Cranshaw.

Young swallowtail larvae often look somewhat like bird droppings. Older larvae of the twotailed swallowtail turn a more general orange-brown color and have striking "eyespot" markings; older larvae of the western tiger swallowtail are green. All swallowtail larvae are capable of extruding a pair of smelly orange "horns" (osmeteria) when disturbed. Adult butterflies feed on nectar. There is one generation per season.

BUMBLE FLOWER BEETLE
Euphoria inda (L.)
Family: Scarabeaidae

Appearance: **Adults** - Broadly oval beetles, 1/2 - 5/8 inches long, and yellowish brown with black spots. The underside is dark and densely hairy. **Larvae** - Cream colored C-shaped grubs with a blunt abdomen, found in manure or compost.

Hosts: The adult beetles feed on a wide variety of sweet or fermenting liquids. They are commonly attracted in late summer to the bacterial ooze produced by infection of many trees. They also may

occasionally damage ripening corn, ripe apples, grapes, melons, and peaches. The pollen and nectar of flowers such as sunflower, strawflower, and daylily may also be food plants.

Damage: This beetle primarily attracts interest and concern when it appears in great numbers on the wet bacterial ooze produced from infected trees, such as cottonwood, elm, and willow. Despite its occurrence at the site of this ooze, it is not involved in transmission of any diseases to woody plants.

Bumble flower beetles feeding on bacterial ooze. Photograph by D.A. Leatherman.

On rare occasions, the bumble flower beetle has damaged day lily and strawflower. There is also some evidence that they can transmit disease organisms which can cause wilting in strawflower.

Life History and Habits: The overwintering stage is the adult beetles. These are broadly oval, about 1/2 to 5/8 inches long and densely cover with yellowish-brown hairs. In spring the beetles usually lay eggs in fresh manure (particularly horse manure), rotten wood or compost, and the C-shaped grubs develop in the decaying organic matter. As they feed, they form small, packed chambers in which they later pupate. The grubs are commonly found in gardens fertilized with manure or compost, but do not feed on roots.

The adults emerge in mid- to late summer and feed on a wide variety of sweet or fermenting liquids. They are commonly attracted in late summer to the bacterial ooze produced by infection of many trees. They may occasionally feed on certain vegetables and flowers. There is one generation per year.

Control: Controls are not needed for protection of woody plants, since this species does not damage healthy tissues and limits feeding to bacterial ooze and other fermented materials. Larvae in manure or compost similarly do not pose a threat to garden plants, unlike some other species of white grubs.

THE TENLINED JUNE BEETLE

Polyphylla decimlineata (Say)

Family: Scarabaeidae

Distribution: Throughout Colorado, but most common at lower elevations in the southern half of the state.

Appearance: **Adult** - Beetles are large, about 1-inch in length and generally greenish-brown with ten silvery-white stripes. **Larva** - A C-shaped, cream-colored grub found feeding on plant roots.

Hosts: Adult beetles feed on the leaves of various trees and shrubs; larvae feed on plant roots.

Damage: The larvae have been reported as occasional pests of tree nurseries, damaging the plants by feeding on the roots. However, problems are very uncommon in the state and the tenlined June beetle primarily is notable to to its large size and conspicuous coloration.

A tenlined June beetle. Photograph by W.S. Cranshaw.

Life History and Habits: The tenlined June beetle is a type of "May" or "June beetle" that is active at night during late spring and early summer. Occasionally they attract attention when they bang into screens while attracted to light. The adult beetles then feed on leaves of various trees and shrubs.

The eggs are laid in the ground by the adult females during midsummer. Larvae develop as a type of "white grub", feeding on the roots of various trees and shrubs. Occasionally they can do serious injury to young trees. The life cycle from egg to adult is assumed to take three years.

Related Species: *Polyphylla hammondi* LeConte is closely related to the tenlined June beetle and is similar in size, but has wing covers of reddish-brown coloring. (Both species have variable striping.) *P. hammondi* is an occasional turf pest in southwestern Colorado.

VERTEBRATE DAMAGE THAT IS SIMILAR TO INSECT INJURIES

WOODPECKERS

Yellow-bellied Sapsucker [*Sphyrapicus varius* (L.)];
Red-naped Sapsucker [*Sphyrapicus nuchalis* Baird];
Williamson's Sapsucker [*Sphyrapicus thyroideus* Cassin)];
Downy Woodpecker [*Picoides pubescens* (L.)]

Appearance: All are medium-sized birds with a basic red, black and white color scheme. They have long, chisel-like bills and cling on the sides of trees, using their stiff tails as a brace. All three sapsucker species, in both adult and immature plumages, are distinguished from other Colorado woodpeckers by the presence of a large white shoulder patch.

Hosts: (see discussion below)

Damage: All four species are known to peck holes in live tree trunk and branch bark and to drink the resulting sap flow. However, sapsuckers are best known for this habit and they sometimes create enough holes to permanently damage their hosts.

Sapsucker injury appears as regular rows of shallow holes in trunks or branches. Photograph by D.A. Leatherman.

Pecking injuries, which might be confused with boring insect exit holes, are usually just physical wounds which will be covered over in time. Occasionally, various stain and decay-causing fungi are introduced via these wounds and, in coniferous hosts, the wounds can attract attack by the pitch-mass borer moths in the genus *Dioryctria*.

Many other species of birds, mammals, and insects, the majority considered desirable (for example hummingbirds), utilize sap wells as a food source. It should also be pointed out that the downy woodpecker's normal association with trees is visiting dead trunks and branches to feed on bark beetles and borers under the bark. This activity is considered largely beneficial.

Life History and Habits: The downy woodpecker is resident in Colorado all year in a variety of habitats from 4000-10,000 feet elevation. The sapsuckers are migratory. Rednaped and Williamson's sapsuckers are present in the mountains of Colorado from May through October. The yellowbellied sapsucker is a winter species in Colorado, usually restricted to lower elevations.

All three sapsuckers utilize trees in the same manner. They drill characteristics 1/4" x 1/4" rows of holes, called sap wells", to encourage sap flow. These are revisited on a daily basis and particularly productive wells are reworked to allow sustained flow. This reworking enlarges the hole and in severe cases can effectively girdle branches or trunks, causing foliage discoloration and dieback.

The Williamson's sapsucker is fond of ponderosa pine and Douglas-fir. The rednaped sapsucker particularly utilizes willow and aspen. The yellow-bellied shows a preference for ornamental Scots, Austrian, and ponderosa pines. All can and do drill many other tree species on occasions (e.g., Siberian elm, fruit trees).

Control: Only rarely is woodpecker damage to live trees seriously damaging. In the great majority of cases their activities should be tolerated and appreciated as mostly beneficial. These birds are protected by law and as such cannot be shot or trapped. Most legal "controls" involve discouraging their presence or mechanical exclusion. Such things as owl decoys, flutters and mesh coverings over favored feeding areas haver met with mixed success.

SQUIRRELS

Eastern Fox Squirrel [*Sciurus niger* (L.)]
Other arboreal mammals such as Red Squirrel [*Tamiasciurus hudsonicus* (Erxleben)],
Abert's (=Tassel-eared) Squirrel [*Sciurus aberti* Woodhouse], Chipmunk species (*Eutamias* spp.),

Rock Squirrel [*Citellus variegatus* (Erxleben)] and Golden-mantled Ground Squirrel [*Citellus lateralis* (Say)]

Appearance: The eastern fox squirrel has a ten to 15-inch long body with a bushy tail about equally as long. Its body is rusty yellowish with a yellow to orange belly and a rusty brown tail.

Hosts: The fox squirrel debarks many species of deciduous trees, with elms, hackberry, honeylocust, and Russian olive being common hosts. Twig clipping follows a similar pattern. Both deciduous and coniferous fruits and cones are eaten, particularly oak acorns, walnuts, elm seeds, fruit tree fruits, and honeylocust pods, plus pine and spruce cones. The red squirrel strongly favors conifers in Colorado and mostly feeds on fleshy fungi and spruce and pine cones. The Abert's squirrel relies heavily on ponderosa pine for shelter and food. Chipmunks and the other ground squirrels spend most of their time on the ground but often can be seen feeding on various types of tree bark or fruits and cones.

Damage: The feeding habits of these mammals, particularly the fox squirrel, are quite variable according to location, season and food availability. Squirrel damage to trees could be confused with that of insect in three cases: when they debark branches or trunks, clip twigs, or feed on fruits/cones. With debarking, incisor marks on the outer wood are characteristic. Squirrel clipped twigs littering the ground usually show missing parts, such as chewed buds. Squirrel damage to fruit and cones is usually indicated by teeth marks and the season in which it occurs (fall/winter).

Life History and Habits: The fox squirrel generally has two broods per year. they spend most of their time in trees, traveling between trees or burying food items gathered from trees. Being very opportunistic, their feeding is strongly tied to food available at the time. Thus, in spring they commonly feed on swelling flower and foliage buds. Later in spring, seeds are commonly eaten. In summer all manner of food items are taken including insects, eggs, and plant parts including bark/phloem tissue. In fall, fruits and cones are heavily relied on. In winter its back to buds, bark and stored items from fall foraging activities.

Control: This can be a controversial issue. Squirrels are loved and even imported by some tree owners, despised by others. Live-trapping and relocation can be a lifelong operation as new squirrels often fill in as fast as problem animals are removed. Seamless metal skirts can be wrapped around trunks to prevent squirrel access to tree crowns, provided the target trees do not have branches within jumping distance of adjacent trees.

With bird feeders often being a source of attraction to rodents, converting to squirrel-proof designs may be helpful. Squirrel-killed branches should be pruned to prevent human hazard and breeding by the smaller European elm bark beetle, vector of Dutch elm disease. Most squirrel damage is of a minor nuisance or cosmetic nature and should be tolerated.

BIOLOGICAL CONTROLS OF INSECTS ASSOCIATED WITH TREES AND SHRUBS

LADY BEETLES

Family: Coccinellidae

Often called "ladybugs" or "ladybird beetles", lady beetles (Coccinellidae) are the most familiar insect predator to most people. Although dozens of species occur in Colorado, they are all typically a round-oval shape. Most are also brightly colored and often spotted.

Females periodically lay masses of orange-yellow eggs. The eggs are quite distinctive, although they somewhat resemble those produced by elm leaf beetle. Eggs are usually laid near colonies of insects (aphids, scales, etc.) which will later be fed on by the larvae.

Twospotted lady beetle laying an egg mass. Photograph by W.S. Cranshaw.

During the summer eggs hatch in about five days. The immature or larval stages look very different from the more familiar adults and often are overlooked or misidentified. Lady beetle larvae are elongated, usually dark colored and flecked with orange or yellow. They can crawl rapidly over plants, searching for food.

Adult and larval lady beetles feed on large numbers of small soft-bodied insects such as aphids. Lady beetles also eat eggs of many insects. Pollen, nectar and honeydew are other common foods.

One group of very small black lady beetles, aptly dubbed the "spider mite destroyers" (*Stethorus*) are also very important in controlling spider mites. Another unusual species is the small, twicestabbed lady beetle [*Chilocorus stigmata* (Say)], one of the most important predators of scales. Larvae of some lady beetles, e.g., those which specialize on aphids within leaf curls or feed on mealybugs, produce waxy threads which cover their body.

A typical lady beetle larva. Photograph by W.S. Cranshaw.

Many lady beetle larva that feed on mealybugs or leafcurling aphids often are covered with waxy threads. Photograph by W.S. Cranshaw.

Lady beetles reproduce rapidly during the summer and can complete a generation in less than four weeks under favorable conditions. As a result, they often overtake a pest outbreak, controlling many potential insect problems.

Unfortunately, lady beetles tend to be ’fair weather’ insects that are slow to arrive in the spring and often leave the plants by late summer. (A few kinds along the Front Range even ’head for the

hills', spending the cool seasons at high elevations, protected under the snow.) As a result, late season 'blooms of aphids sometimes occur, as they continue to feed and escape their natural enemies.

CLERID BEETLES
Family: Cleridae

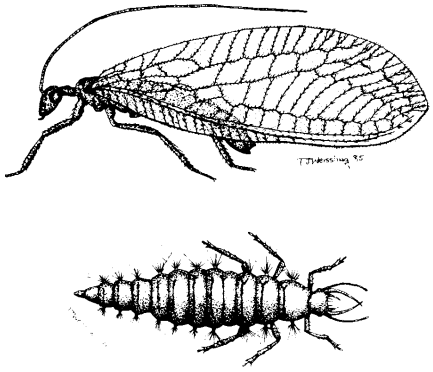
Clerid beetles, or checkered beetles, are usually brightly colored insects that are generally elongate in form and somewhat flattened. Several species are important predators of bark beetles and other wood boring insects. The immature clerid beetles are commonly found in tunnels of bark beetles.

GREEN LACEWINGS
Family: Chrysopidae

Several species of green lacewings commonly are found on trees and shrubs. The adult stage is a pale green insect with large, clear, highly-veined wings that are held over the body when at rest. They are delicate and very attractive insects that primarily feed on nectar. The females lay a distinctive stalked egg, approximately one half inch in height. They may be laid in small groups or singly on leaves of plants throughout the yard.

Green lacewing eggs with their characteristic stalk.

Lacewing larvae emerge from the egg in about a week. These larvae, sometimes called aphid lions, are voracious predators capable of feeding on small caterpillars and beetles as well as aphids and other insects. In general shape and size, lacewing larvae are superficially similar to lady beetle larvae. However, immature lacewings usually are light brown and have a large pair of viciously hooked jaws projecting from the front of the head. Whereas lady beetles often are limited to smaller insects such as aphids, the green lacewings are capable hunters that can easily kill insects larger than themselves. Several generations of lacewings occur during the summer, and a green-brown cold tolerant species can be found late into fall.



Green lacewing adult and larva.

BROWN LACEWINGS
Family: Hemerobiidae

The brown lacewings are closely related to the green lacewings with generally similar habits, being predators of insects in both their adult and larval stages. Aphids and mealybugs are the most common prey of these insects. Brown lacewings are almost always associated with trees and shrubs.

Adult brown lacewings are somewhat smaller than green lacewings with light brown wings. Mouthparts of the larvae are designed to pierce and capture prey, but are not as pronounced as the green lacewings. Egg stages are not stalked.

SYRPHID FLIES
Family: Syrphidae

Syrphid flies, also called flower flies or hover flies, are common brightly colored flies. Typical markings are yellow or orange with black, and they may look like bees or yellowjacket wasps. However, syrphid flies are harmless to humans. Usually they can be seen feeding on flowers.

Adult of a brown lacewing feeding. Photograph by W.S. Cranshaw.

A typical syrphid fly adult. Photograph by W.S. Cranshaw.

It is the larval stage of the syrphid fly that is an insect predator. Variously colored, the tapered "maggots" crawl over foliage and can daily down dozens of aphids. Syrphid flies are particularly important in controlling aphid infestations early in the season when its still too cool for lady beetles and other predators.

A few species of syrphid flies, such as the narcissus bulb fly, develop by feeding on and tunnelling plant tissues. These plant feeding syrphid flies often develop into large, stout-bodied flies that may resemble bumblebees.

Syrphid fly larva feeding on aphids.

PREDATORY STINK BUGS

Family: Pentatomidae

Although stink bugs include many species which feed on plants, particularly fruit or seeds, some are predators. Stink bugs, whether plant feeders or predators, are characterized by their distinctive shield-like body and ability to produce an unpleasant 'perfume' when disturbed. Predatory stink bugs feed by piercing the prey with their very narrow mouth parts and sucking out body fluids. Stink bugs also produce very unusual egg masses, which appear as clusters of small barrels fringed with spines at the top.

A stink bug feeding on an elm leaf beetle larva. Photograph by W.S. Cranshaw.

One of the most common predatory stink bugs is the twospotted stink bug [*Perillus bioculatus* (F.)] a large red and black species with a distinctive horseshoe band on the back. It is primarily a predator of beetle larvae such as the elm leaf beetle. Also

common is the spined soldier bug [*Podisus maculiventris* (Say)], which prefers caterpillars.

ASSASSIN BUGS
Family: Reduviidae

Assassin bugs are equally capable predators, that can subdue large insects such as caterpillars and beetles. Most assassin bugs are elongate in form, have a pronounced 'snout' on the front which is the base for the stylet mouthparts, and are spiny. Despite their prodigious ability to dispatch most garden pests, they rarely become very abundant since they in turn have too many enemies of their own (mostly egg parasites).

An assassin bug.

PREDATORY MITES
Family: Phytoseiidae

Many types of mites are predators of plant-feeding spider mites. Typically, these predatory mites are little larger than spider mites and faster moving than their prey. Predatory mites can often provide good control of spider mites, but most are slowed down by dry weather - they like it hot and humid. The predatory mites are also more susceptible to insecticides than are plant-feeding species.

SPIDERS
Order: Araneida

Although hardly a favorite of most, spiders are often the most important predators of insects found on trees and shrubs. All spiders feed only on living insects or other small arthropods.

Most people primarily observe the many web-making spiders, such as the yellow and black banded argiope. However there are many other spiders (wolf spiders, crab spiders, jumping spiders) which do not build webs. These spider moves about the plants and hunt their prey on soil or plants. These less conspicuous spiders can be very important in controlling insect pests such as beetles, caterpillars, leafhoppers and aphids.

A crab spider (Family: Thomisidae), a type of spider that is common on woody plants.

HUNTING WASPS
Families: Sphecidae, Vespidae

Many wasps prey on insect pests and feed them to their young. These hunting wasps build nests out of mud or paper. Other hunting wasps construct nests by tunnelling into soil or pithy plant stems, such as rose or raspberry. The adult wasps then capture insect prey and take them back to the nest, whole or in pieces, to feed to the immature wasps.

Most hunting wasps are solitary wasps. The females construct the entire nests, working alone. The females then search for prey which they immobilize

with a paralyzing sting and carry back to the nest. The young wasps develop by eating the food the mother wasp has provided.

The solitary hunting wasps (Sphecidae) have very specialized tastes which cause them to search only for selective types of prey. For example, some develop on leafhoppers; others attack caterpillars; beetles are prey for some hunting wasps. The largest hunting wasp is the cicada killer, which resemble a giant yellow jacket and kills the dog-day cicada. Despite their often fearsome appearance, the solitary hunting wasps rarely sting and do not contain the potent venom of the social wasps.

Other hunting wasps, such as the paper wasps and yellow jackets (Vespidae), are social species where many individuals work together and there are a variety of specialized castes (queen, drone, workers) in a colony. These make nests of a papery material that they form by chewing wood, cardboard or other materials. The nests are constructed under eaves, in trees, or underground in holes around building foundations or abandoned rodent burrows. These social wasps create new colonies every year and colonies may be aggressively defended by stinging guard wasps. However, most social wasps rear their young on a diet of caterpillar paste or other insects and some are very useful for control of pests such as fall webworm. At the end of the season, the nests of the social wasps are abandoned.

TACHINID FLIES

Family: Tachinidae

Tachinid flies develop as parasites inside other insects. Tachinids are about the size of a house fly, generally gray or brown, and covered with dark bristles. They are rarely seen but often leave their ’calling card’, a white egg laid on various caterpillars, beetles and bugs, usually near the head. Douglas-fir tussock moth, tent caterpillars, and fall webworm are among the insects commmonly attacked by tachinid flies.

The eggs hatch within the day and the young fly maggots tunnel into their host. There they feed for about a week (carefully avoiding the vital organs until the end), eventually killing the host insect.

Tachinid fly eggs laid near the head of hornworm caterpillars. Photograph by J.L. Capinera.

BRACONID AND ICHNEUMONID WASPS

Families: Braconidae, Ichneumonidae

The parasitic wasps, including the braconid and ichneumonid wasps, are a diverse group of wasps which develop as insect parasites. Some are very small and rarely observed, attacking small insects such as aphids. Others even live in the eggs of various pest insects. Larger parasitic wasps attack caterpillars or larvae of the wood boring horntails.

There is often little external evidence of parasitic wasp activity since the young wasps develop inside the host insect from eggs that were inserted by the mother wasp. However, parasitized insects may be somewhat different in form. For example, aphids that are parasitized by these wasps are typically small and discolored, and called "aphid mummies." Other common braconid wasp species spin conspicuous yellow or white pupal cocoons after emerging from a host.

Parasitized aphid "mummies" with developing wasp exposed on left. Photograph by W.S. Cranshaw.

CHALCID WASPS

Superfamily: Chalcidoidea

There are hundreds of species of chalcid wasps which attack and kill other insects. However, most chalcid wasps are very small and are rarely observed. Like the braconid and ichneumonid wasps, chalcid wasps do not sting and are harmless to humans.

Some of the more important chalcid wasps attack aphids and various caterpillars such as the fall webworm.

INSECT DISEASES

Although less often observed, insects and mites often suffer from disease. Periodically, waves of disease caused by fungi, bacteria, protozoa, or viruses may sweep through an insect population. Although the classes of organisms that cause human disease are the same for many other animals and plants (e.g., viruses, bacteria, fungi), it is important to keep in mind that insect diseases are very specific in their effects. Insect diseases do not infect mammals or birds, restricting their effects to the arthropods. Furthermore, most insect diseases are so specific in their effects that they only can infect a few insect species.

Viruses are most commonly found among the caterpillars and sawflies. One particularly gruesome group of these viruses (nuclear polyhedrosis viruses) cause the 'wilt disease'. Caterpillars infected by these viruses are killed rapidly, their virus filled bodies hanging limply by their hind legs. At the slightest touch, the insects rupture, spilling the virus particle on the leaves below them to infect other insects. One type of wilt virus commonly infects Douglas-fir tussock moth.

Other types of viruses cause less spectacular infections. Most are slower acting than the wilt viruses. External evidence of these viruses may be a chalky color of the insects and a general listlessness.

Although virus diseases of insects are widespread in nature, rarely have they been adapted for applied biological control. Much of this is due to problems in registering these as insecticides. Regulatory agencies have had difficulty in deciding how to insure the safety of such mysterious particles as viruses. Manufacturers have also been leery of developing viruses due to problems in production (they need live cells to develop) and because the selectivity of viruses allows them to only be used against a few insects.

Bacteria have received more attention, due almost entirely to the successful adaptation of Bacillus thuringiensis. Several manufacturers have produced and marketed various strains of this famous bacteria. Bacillus thuringiensis, and most other bacterial diseases of insects, work by disrupting the 'gut' lining of susceptible insects, ultimately killing them by a type of blood poisoning. Infected insects shrivel and darken.

Caterpillars killed by an application of Bacillus thuringiensis.

Fungi produce some of the more spectacular diseases of insects. A wide variety of insects succumb to fungus disease around the yard and garden. Fungus killed insects and mites become stiff and often are tightly attached to a leaf or stem. When conditions are right they become covered with a white, light green or pink 'fuzz', the spores of the fungus.

GLOSSARY OF TERMS

Abdomen - the posterior of the three main body divisions in an insect; the posterior of the two main body regions in a mite, spider or other arachnid

Adelgid - a family of insects closely related to aphids known as "woolly aphids"

Alternate host - a plant required by the insect to complete its life cycle other than the primary host. This habit is very common among certain insects groups, notably aphids.

Brood - individuals that hatch from the eggs laid by one mother

Bud break - time at which dormant buds begin expanding and opening

Canker fungi - disease causing fungi that often cause sunken areas to develop on trunks, branches and twigs of woody plants

Caterpillar - the larva of a butterfly, moth, or sawfly

Complete metamorphosis - a pattern of metamorphosis used by many insects (e.g., beetles, moths/butterflies, sawflies, flies) which involve eggs, followed by immature nymphs, a transition pupal stage, and finally adults. Adult and immature stages often have very different habits and appearance among insect groups with this metamorphosis. Also called holometabolous metamorphosis.

Cocoon - silken case in which the pupal stage of many insects is formed

Crook - a bending of the terminal growth of a plant, often caused by injury

Defoliation - the loss of leaves as that occurring in natural shedding, or from the feeding activities of insects and other plant feeders

Diapause - a period of dormancy in which many insects undergo to avoid adverse conditions (e.g., winter cold) that can only be terminated by certain stimuli such as day length or a prescribed length of exposure to cold.

Dieback - the decline and dying of the upper or terminal growth of a plant.

Dorsal - the back or upper side.

Epidermis - the exterior cellular layer of the body which produces the protective cuticle of an insect, other animal or plant.

Erineum - a change in plant growth, or gall, where plant hairs are produced in great abundance creating a felty patch on a leaf surface. Many eriophyid mites cause such changes in leaf growth.

Exoskeleton - a skeletal structure that is formed on the external surface of an animal, such as occurs with insects, mites, and other arthropods.

Eyespots - prominent markings resembling eyes on the wings of certain insects

Femur - the upper part of the leg

Finger galls - abnormal growth forms in the shape of fingers, such as are produced by eriophyid mites on certain plants (e.g., wild plum, cherry)

Forewings - the pair of wings closest to the head of an insect

Frass - solid insect excrement typically consisting of a mixture of chewed plant fragments

Gall - the abnormal growth of plant tissues, caused by the stimulus of an animal, microorganism, or wound

Gregarious - living in groups

Head capsule - the structure which contains the head and the appendages attached to it

Hibernation - winter dormancy

Hibernaculum - a tiny cocoon spun by first or second instar caterpillars for overwintering shelter. (Plural: hibernaculae)

Honeydew - the sugary, liquid excrement produced by certain aphids, scales and other insects that feed in the phloem of the plant

Host - the plant on which an insect feeds; the animal on which a parasite develops

Instar - the stage of an insect between periods when it molts

Larva - the immature stage, between egg and pupa of an insect with complete metamorphosis; i.e. caterpillars, maggots, grubs. (Plural: larvae)

Lateral - directed to the side. Used to described markings on the sides of an insect

Leafminer - an insect which has the habit of developing by feeding on internal leaf tissues which it chews as it mines the leaf. Insects which tunnel needles in a similar manner are called **needleminers**.

Litter - accumulated plant debris on the ground, typically composed of leaves or needles in various stages of decomposition

Longitudinal - lengthwise; extending along the long axis

Metamorphosis - changes in form undergone by insects as they grow and develop

Mine - to form a burrow or excavate a tunnel. Used to describe the activities of insects that live or feed within a leaf or needle

Molt - the shedding of the exoskeleton by an insect in the process of development

Needlesheath - protective structure at the base of needles

Nymph - an immature stage of an insect with simple metamorphosis; e.g., aphids, bugs, grasshoppers

Oviposition - the process of laying an egg by an insect

Ovipositor - the egg laying apparatus of a female insect

Parasite - an organisim that lives at the expense of another. (The term **parasitoid** is often used to described parasitic insects that kill the host in which they develop.)

Petioles - the leaf stem or stalk that attaches to a twig

Pitch - a resinous material exuded by conifers either naturally or in response to a wound

Predator - an animal that moves and hunts smaller animals (**prey**)

Pupa - the transitional stage, between larva and adult, of insects with complete metamorphosis. In moths the pupal stage usually takes place in cocoons.

Sap wells - holes produced in plants by sapsuckers and other birds to produce a flow of sap on which they then feed

Scutellum - small plates (sclerites) found on the back of the thorax

Segment - a subdivision of the body or of an appendage

Serpentine - winding, twisting pattern typically used to describe the shape of certain leaf mines

Sheath - a covering or protective envelope

Simple metamorphosis - a pattern of metamorphosis used by many insects (e.g., true bugs, aphids,

grasshoppers, earwigs) which involve eggs, followed by immature nymphs, and finally adults. Adult and immature stages usually feed in the same manner and are primarily differentiated by the adult features of sexual maturity and (usually) wings. Also called gradual metamorphosis or hemimetabolous.

Skeletonized - describes the feeding pattern of certain leaf-feeding insects that avoid feeding on the the main veins of the leaf, and often a leaf surface leaving a "skeleton" of the leaf surface

Sooty mold - a dark, typically black, fungus growing on insect honeydew

Tents - protective shelter constructed of silk, spun by certain caterpillars

Terminal growth - typically new growth or buds at the end of a branch or twig

Thorax - the middle section of an insect body where the legs and wings are attached

Transverse - across, at right angles to the longitudinal axis

Tubercles - a rounded protuberance found on many insects, particularly caterpillars

Ventral - the underside of the body

Wingspan - the measurement between tips of the extended forewings of an insect

HOST PLANT INDEX OF INSECT PESTS

ALDER
- Affecting leaves
  - Leaves mined
    - Fenusa dohrnii
  - Small pits chewed in leaves
    - Flea beetles
- Affecting twigs
  - Producing frothy spittlemass
    - Spittle bugs

APPLE (see CRABAPPLE)

ASH
- Affecting leaves
  - Leaves chewed
    - Cankerworms
    - Forest tent caterpillar
    - Fruittree leafroller
    - Cecropia moth
    - Brownheaded ash sawfly
    - Great ash sphinx
    - Twinspot sphinx
    - Swallowtail butterflies
  - Smooth semicircular cuts made on leaf edge
    - Leafcutter bees
  - "Shothole" feeding wounds in leaves
    - Brownheaded ash sawfly (young larvae)
  - Leaves mined
    - Lilac leafminer
  - Leaflets being distorted and/or killed back
    - Ash plant bug
  - Flecking wounds on leaves
    - Ash plant bug
    - Lacebug
  - Small pouches on leaves, with dense hairs on underside
    - Eriophyid mites
  - Leaflets thickened and curled at midrib
    - Ash midrib gall midge
  - Leaves tightly curled, generally distorted
    - Leafcurl ash aphid
- Affecting twigs and smaller branches
  - Twig die-back with small exit holes or ventillation holes visible
    - Ash bark beetle
  - Tunneling young twigs
    - Unidentified caterpillar (Tortricidae)
  - Scales
    - Oystershell scale
    - Common falsepit scale
    - European fruit lecanium
- Affecting trunk and larger branches
  - Tunneling trunk
    - Lilac/Ash borer
    - Ash bark beetle
    - Carpenterworm
    - Redheaded ash borer
    - Banded ash borer
  - Masses of caterpillars resting on bark
    - Forest tent caterpillar
- Distorting flowers
  - Ash flower gall mite

ASPEN
- Affecting leaves
  - Leaves chewed
    - Forest tent caterpillar
    - Western tent caterpillar
    - Large aspen tortrix
    - Nevada buck moth
    - Redhumped caterpillar
    - Poplar dagger moth
    - Cottonwood leaf beetle
    - Sawflies
  - Masses of dark, spiny caterpillars on leaves
    - Spiny elm caterpillar
  - Leaves folded, mined
    - Large aspen tortrix
  - Leaves generally distorted, thickened
    - Poplar vagabond aphid
  - Edged of leaf folded into a series of ridges
    - Eriophyid mites
  - Leaves tunneled
    - Aspen leafminer
  - Underside with small depressions with patches of brown leaf hairs
    - Eriophyid mites
  - Red, thickened folds along leaf veins
    - Gall midge (unknown species)
  - Sucking insects on leaves

- Clear-winged aspen aphid
- Leafhoppers
- Affecting branches, trunks
  - Swellings in twigs
    - Poplar twiggall fly
  - Swellings in branches, trunk
    - Poplar twiggall fly
    - Poplar gall saperda
  - Tunnelling with coarse sawdust
    - Poplar borer
  - Regular rows of holes in trunk
    - Sapsuckers
  - Meandering tunnels under bark
    - Agrilus species
  - Scales on bark
    - Oystershell scale

BASSWOOD (see LINDEN)

BIRCH
- Affecting leaves
  - Leaves generally chewed
    - Cecropia moth
    - Polyphemus moth
    - Acronicta leporina
    - Twinspot sphinx
  - Leaves with blotchy mines
    - Birch leafminer
- Affecting branches, trunk
  - Tunneling of cambium, dieback
    - Bronze birch borer

BOXELDER
- Affecting leaves
  - Leaves chewed
    - American dagger moth
  - Leaves curled, chewed
    - Boxelder leafroller
  - Leaves mined
    - Boxelder leafminer
  - Leaves thickened around midrib
    - Gouty veingall midge
  - New growth small, distorted
    - Eriophyid mites
  - Sucking on leaves, honeydew often present
    - Psylla negundinis
    - Boxelder and maple aphids
  - Small cottony indentations on leaf underside
    - Eriophyid mites
  - Masses of reddish eggs on leaves
    - Boxelder bug
- Affecting seeds
  - Feeding on seeds
    - Boxelder bug

CARAGANA
- Affecting leaves
  - Masses of soft-winged beetles chewing leaves
    - Caragana blister beetle
  - Leaves chewed irregularly
    - Grasshoppers
  - Sucking insects
    - Aphids (unidentified)

CATALPA
- Affecting twigs, branches
  - Cottony masses on twigs, branches
    - Grape mealybug
- Affecting leaves
  - Sucking insects
    - Aphids (unidentified)

CHERRY, CHOKECHERRY
- Affecting leaves
  - Leaves chewed
    - Fall webworm
    - Redhumped caterpillar
    - Uglynest caterpillar
    - False unicorn caterpillar
    - Swallowtail caterpillars
    - Eastern tent caterpillar
    - Whitemarked tussock moth
    - Hemileuca eglanterina
    - Pearslug
    - Wild cherry sphinx
  - Leaves with small, circular holes
    - Coryneum blight (a fungus)
  - Top of leaf surface skeletonized (sweet cherry)
    - Pearslug
  - Leaves with small, red finger galls
    - Eriophyid mites
  - New leaves curled
    - Green peach aphid
    - Black cherry aphid

- Dark aphids on leaves
  - Black cherry aphids
- Affecting branches, trunk
  - Girdling wounds made at or near soil line
    - Peach tree borer
  - mall pinhead-sized exit holes in branches
    - Shothole borer
  - Gumming
    - Peach tree borer
    - Shothole borer
    - Cytospora canker (a fungus disease)
- Affecting fruit
  - Puncture wounds in fruit
    - Cherry curculio
    - Bird damage
  - Chokecherry fruit enlarged, hollow
    - Chokecherry gall midge
  - Maggots in cherry fruit
    - Western cherry fruit fly
    - Chokecherry gall midge
  - Grub in pit
    - Cherry curculio

COTONEASTER
- Affecting leaves
  - Skeletonizing upper leaf surface
    - Pearslug
- Affecting branches, twigs
  - Brown or grayish crust on wood
    - Oystershell scale
    - San Jose scale
  - Cottony insect on twigs
    - Apple mealybug

COTTONWOOD, POPLAR
- Affecting leaves
  - Leaves chewed
    - Cottonwood leaf beetle
    - Spiny elm caterpillar
    - Fall webworm
    - Nevada buck moth
    - Acronicta leporina
    - Giant poplar sphinx
    - Columbia Basin sphinx
    - Twinspot sphinx
  - Tents produced
    - Fall webworm
    - Western tent caterpillar
    - Malacosoma incurvatum discoloratum
  - Small holes chewed in leaves
    - Flea beetles
    - Poplar blackmine beetle (adult feeding)
  - Leaves tunnelled
    - Poplar blackmine beetle
    - Tentiform leafminer
  - Leaf petioles, veins with swelling
    - Petiole-gall aphids
  - Leaves folded along edge
    - Poplar leaffolding sawfly
  - Leaves generally distorted and thickened
    - Poplar vagabond aphid
- Affecting twigs, small branches
  - Hollow swellings form on new shoots
    - Petiole-gall aphids
  - Terminal leaves distorted into thickened mass
    - Poplar vagabond aphid
  - Tunneling twig terminal
    - Cottonwood twig borer
  - Twigs shredded in irregular row
    - Cicada oviposition injury
  - Swellings in twigs, small branches
    - Poplar twiggall fly
    - Poplar gall borer
    - Hail (upper surface only)
  - Scales on twigs, branches
    - Oystershell scale
    - Scurfy scale
  - Buds distorted
    - Poplar budgall mite
- Affecting trunk, large branches
  - Masses of caterpillars resting on bark
    - Forest tent caterpillar
  - Tunneling trunk
    - Cottonwood borer
    - Poplar borer
    - Carpenterworm
    - American hornet moth
  - Visiting oozing sap from trunk
    - Bumble flower beetle
    - Sap beetles
    - Flies (various families)
- Affecting catkins
  - Gross, distortion and enlargement
    - Cottonwood catkin gall mite

CRABAPPLE, APPLE
- Affecting leaves
  - Chewing large holes in leaves
    - Fruittree leafroller
    - Redhumped caterpillar
    - Forest tent caterpillar
    - Fall webworm
    - Whitelined sphinx
    - Fall cankerworm
    - Spring cankerworm
  - Skeletonizing leaves
    - Altica species
  - Producing raised leafmines
    - Spotted tentiform leafminer
  - Producing rusty blisters on leaves
    - Apple leaf blister mite
  - Twisting new growth in spring
    - Rosy apple aphid
    - English grain aphid
  - Small scales
    - San Jose scale
- Affecting twigs, small branches
  - Tent constructed
    - Fall webworm
  - Twigs shredded by a line of multiple punctures
    - Cicada oviposition wounds
    - Buffalo treehopper
    - Hail (restricted to upper surface)
  - Scales on twigs
    - San Jose scale
    - Oystershell scale
    - European fruit lecanium
  - Cottony insects on twigs
    - Woolly apple aphid
    - Apple mealybug
    - Grape mealybug
  - Twig dieback, interior tunneled
    - Peach twig borer
- Affecting trunk
  - Boring into trunk
    - Flatheaded appletree borer
    - Redheaded ash borer
  - Cottony insects on trunk, roots
    - Woolly apple aphid
- Affecting fruit
  - Tunneling fruit
    - Codling moth
  - Scales, with reddened area on fruit
    - San Jose scale
  - Scarring wound on fruit
    - Speckled green fruitworm
    - Fruittree leafroller
    - Hail injury

CURRANT, GOOSEBERRY
- Affecting leaves
  - White flecks in leaves
    - Leafhoppers
    - Twospotted spider mite
  - Leaves puckered, may be thickened
    - Currant aphid
  - Leaves chewed
    - Imported currantworm
    - Currant spanworm
    - Blepharida rhois
  - Hollow swelling in leaves
    - Gall-making sawfly
- Affecting stems, branches
  - Tunneling stems, branches
    - Currant borer
    - Bronze cane borer

DOGWOOD
- Affecting leaves
  - Leaves chewed
    - Polyphemus moth
    - Cecropia moth
    - Sawfly
  - Leaves with small white flecks
    - Leafhoppers
  - Leaves curled
    - Sunflower aphid
- Affecting twigs
  - Scales
    - Oystershell scale

DOUGLAS-FIR
- Affecting buds
  - Buds tunneled
    - Western spruce budworm
- Affecting needles
  - Newer needles being chewed
    - Douglas-fir tussock moth
    - Western spruce budworm

- Associated tent making by caterpillars
  - Lophocampa ingens
- Needles bent, twisted
  - Cooley spruce gall adelgid
  - Cold injury
- Woolly aphids on needles
  - Cooley spruce gall adelgid
- Whole tree fades, reddens
  - Douglas-fir beetle
- Affecting smaller branches
  - Bark beetle
    - Douglas-fir pole beetle
- Affecting trunk and larger branches
  - Large, dark aphids
    - Giant conifer aphids
  - Sawdust associated with tunneling of trunk, branches
    - Douglas-fir pole beetle
    - Pine sawyers
    - Douglas-fir beetle
    - Ponderous borer
- Affecting cones
  - Flowers tunneled
    - Western spruce budworm
  - Woolly aphids on cones
    - Cooley spruce gall adelgid
  - Sucking on developing cones
    - Conifer seed bugs
  - Cones tunneled
    - Douglas-fir cone moth

ELDER, GOLDEN
- Affecting canes
  - Canes tunneled, wilt
    - Elder shoot borer
- Affecting leaves
  - Leaves chewed
    - Cecropia moth

ELM
- Affecting leaves
  - Leaves skeletonized, primarily on leaf underside
    - Elm leaf beetle (larvae)
  - Holes chewed through leaves
    - Elm leaf beetle (adults)
    - Cankerworms
  - Leaves irregularly chewed
    - Spiny elm caterpillar
    - Question mark butterfly
    - Fruittree leafroller
    - Cecropia moth
    - Forest tent caterpillar
    - Cankerworms
    - Fall webworm
    - Elm sphinx
    - Twinspot sphinx
  - Masses of dark, spiny caterpillars on leaves
    - Spiny elm caterpillar
  - Meandering mines in leaves
    - Elm leafminer
  - New leaves small, twisted
    - Eriophyid mites
  - Leaves curled, thickened
    - (Eriosoma spp.)
  - Leaves with white flecks
    - Leafhoppers
  - Sucking insects on leaves, often with associated honeydew
    - European elm scale
    - Elm leaf aphid
  - Leaves prematurely yellow in fall
    - Scale "flagging" (European elm scale)
    - Dutch elm disease
- Affecting twigs
  - Scales
    - European fruit lecanium
    - European elm scale
  - Twigs chewed
    - Fox squirrels
- Affecting branches, trunk
  - Borers
    - Carpenterworm
    - Pole borer
    - Elm borer
    - Flatheaded appletree borer
    - Pigeon tremex
  - Bark beetles in branches
    - Smaller European elm bark beetle
  - Visiting oozing sap from trunk
    - Bumble flower beetle
    - Sap beetles
    - Flies (various families)

EUONYMUS
- Affecting leaves
  - Notches cut in edge of leaves
    - Black vine weevil
  - Leaves mined, edge curled with webbing
    - Lilac leafminer
  - New leaves curled, thickened
    - Bean aphid
  - White scales on leaves
    - Euonymus scale (not known to occur in state)
- Affecting roots
  - Chewing roots
    - Black vine weevil

FIR
- Affecting needles
  - New needles being chewed
    - Douglas-fir tussock moth
    - Western spruce budworm
  - Needles being mined
    - White fir needleminer
  - Tent-making associated
    - Lophocampa ingens
  - Aphids on needles
    - Giant conifer aphids
    - Pineus species
  - New needles distorted
    - Balsam twig aphid
    - Cold injury
- Affecting buds
  - Buds tunneled
    - Western spruce budworm
- Affecting twigs and smaller branches
  - Large aphids on branches, twigs
    - Giant conifer aphids
- Affecting trunk and larger branches
  - Bark beetles
    - Fir engraver
    - Balsam bark beetle (Dryocoetes confusus)
  - Borers
    - Pine sawyers
  - Large aphids on branches, trunk
    - Giant conifer aphids

HACKBERRY
- Affecting leaves
  - Leaves being chewed
    - Hackberry butterfly
    - Fruittree leafroller
    - Spiny elm caterpillar
    - Ashgray blister beetles
  - Leaves with leaf mines
    - Lithocolletis sp. (a leafminer)
  - Leaves with white flecking
    - Lacebugs
  - Leaves with large, conspicuous raised areas
    - Hackberry nipplegall maker
  - Leaves with small, raised areas
    - Hackberry blistergall maker
  - Petiole folded, swollen
    - Pachypsylla venusta
- Affecting buds
  - Buds irregularly swell
    - Hackberry budgall psyllid
- Affecting branches
  - Small raised area on branches
    - Pachypsylla species
  - Boring into branches, trunk
    - Flatheaded appletree borer
  - Twigs deformed into dense witches broom
    - Eriophyid mites

HAWTHORN
- Affecting leaves
  - Leaves chewed
    - Fall webworm
    - Forest tent caterpillar
    - Cecropia moth caterpillar
    - Common clearwing sphinx
  - Leaves chewed on upper surface, skeletonized
    - Pear slug
- Infesting twigs, branches
  - Small "woolly" insects
    - Apple mealybug
    - Woolly aphids
  - Scale
    - San Jose scale

HONEYLOCUST
- Affecting leaves
  - Caterpillars chewing on leaves
    - Fall cankerworm
    - Fruittree leafroller

- Leaflets being killed back and distorted
  - Honeylocust plant bug
- Leaflets being distorted into thickened pods
  - Honeylocust podgall midge
- Leaves chewed by masses of black or gray beetles
  - Ashgray blister beetle
- Honeydew appearing on leaves
  - Honeylocust leafhopper
  - Micrutalis calva
  - Cottony maple scale (nymph stage on leaves)
- Leaves turn bronze, may prematurely drop
  - Honeylocust spider mite
  - Eriophyid mites

Affecting twigs and smaller branches

- Tips of twigs thickened
  - Honeylocust podgall midge (severe injury killing growing points)
- Large cottony insect on twigs
  - Cottony maple scale
- Twigs with small splintering wounds
  - Cicadas (egg laying wounds)
- Chewing injuries on branches
  - Fox squirrels

Affecting trunk and larger branches

- Meandering tunnels made under bark, concentrated at wounds/cankers
  - Agrilus difficilis

HONEYSUCKLE

Affecting leaves

- Leaves tightly curled, associated bunchy growth
  - Honeysuckle witches broom aphid
- Early season leaves curled, yellow
  - Aphids (unidentified)
- Leaves chewed
  - Common clearwing sphinx

Affecting stems, branches

- Borers
  - Agrilus species

JUNIPER

Affecting needles

- Larvae chewing on needles
  - Juniper sawfly
  - Lophocampa argentata subalpina
- Frothy masses on needles
  - Juniper spittlebug
- Needles chewed and fragments tied with webbing
  - Juniper webworm
- Webbing covering crown of tree
  - Lophocampa argentata subalpina
- Aphids on needles
  - Giant conifer aphids
- Needles become grayish, with small flecks
  - Spruce spider mite
- White scales on needles
  - Juniper scale

Affecting twigs and smaller branches

- Tips of twigs distorted into rosette gall
  - Juniper tip midge
- Twigs tunneled
  - Western cedar bark beetles
- Large aphids on branches, twigs
  - Giant conifer aphids

Affecting trunk and larger branches

- Bark beetles
  - Western cedar bark beetles
- Large aphids on branches, trunk
  - Giant conifer aphids
- Wood under bark is deeply sculptured by tunnels
  - Callidium texanum
  - Juniper borer

Affecting berries

- Berries infested with maggots
  - Rhagoletis juniperina

LILAC/PRIVET

Affecting leaves

- Leaves with blotchy mines
  - Lilac leafminer
- Edges of leaves curled
  - Lilac leafminer
- Leaves chewed
  - Cecropia moth
  - Great ash sphinx
- Edge of leaves cut in semicircle
  - Leafcutter bees
- Edge of leaves notched
  - Black vine weevil

- Affecting stems, branches
  - Scales
    - Oystershell scale
  - Borers
    - Lilac/ash borer

LINDEN (Basswood)
- Affecting leaves
  - Leaves being chewed
    - Fruittree leafroller
    - Linden looper
  - Small pouch galls form on leaf surface
    - Eriophyid mites
  - Aphids
    - Linden aphid
- Affecting twigs, small branches
  - Large cottony insect develops in late spring
    - Cottony maple scale
  - Small crust-like growth on twigs
    - Walnut scale

LOCUST, BLACK
- Affecting leaves
  - Leaves chewed
    - Ashgray blister beetle
  - Leaves with fingerlike mining
    - Locust leafminer
- Affecting trunk, branches
  - Tunnels riddle woody growth
    - Locust borer

MAHONIA
- Affecting leaves
  - Leaves chewed
    - Barberry looper

MAPLE
- Affecting leaves
  - Leaves chewed
    - American dagger moth
    - Fruittree leafroller
    - Boxelder leafroller
    - Cecropia moth
    - Polyphemus moth
    - Linden looper
  - Leaves cut at petiole
    - American dagger moth
  - White flecks on foliage
    - Leafhopper
  - Patches of reddish hairs (Rocky Mountain maple)
    - Eriophyid mites
  - Sucking insects on leaves, often honeydew
    - Boxelder and maple aphids
    - Cottony maple scale (nymphs)
- Affecting twigs, small branches
  - Twigs with row of irregularly shredded punctures
    - Cicada injury
  - Large cottony insect on twigs
    - Cottony maple scale
- Affecting trunks, branches
  - Boring into trunk, larger branches
    - Flatheaded appletree borer
    - Pacific flathead borer
    - Pole borer
    - Carpenterworm
    - Pigeon tremex

MOUNTAIN-ASH
- Affecting leaves
  - Chewing leaves
    - Fruittree leafroller
  - Aphids
    - Rosy apple aphid
  - Nipplegalls on leaves
    - Eriophyid mites
- Affecting twigs
  - Twigs with irregular splintering
    - Cicadas (oviposition injury)
  - Cottony objects on twigs
    - Apple mealybug
    - Woolly aphids

OAK
- Affecting leaves
  - Leaves chewed
    - Sonoran tent caterpillar
    - Oak leafroller
    - Speckled green fruitworm
    - Hemileuca diana
    - Linden looper
    - Lambdina punctata
  - Leaves tied together with silk

- Oak leafroller
- Aphids
  - Western dusky-winged aphid
- Small balls on leaves
  - Gall wasp
- Cottony growth on leaves
  - Gall wasp

Affecting twigs
- Woody, dark rounded objects on twigs
  - Rough bulletgall wasp
- Twigs dieback in late summer
  - Oak kermes scale
- Oozing sap at terminal, near scale
  - Oak kermes scale
- Scales settled in small depressions
  - Golden oak scale
- Twigs shredded by multiple punctures
  - Cicada oviposition injury

Affecting branches
- Branches distorted into mass of twigs (witches broom)
  - Powdery mildew (fungus disease)

Affecting acorns
- Grubs feeding in acorn
  - Acorn weevils

PEAR

Affecting leaves
- Upper surface of leaf chewed
  - Pearslug
- Edges of leaf chewed
  - Forest tent caterpillar
  - Fall webworm
  - Sawflies (unknown species)
- Sticky honeydew droplets on leaves
  - Pear psylla
- New leaves curled
  - Rosy apple aphid
- Rusty blisters on leaf
  - Pear leaf blister mite
- Leave turns bronze and may die
  - Twospotted spider mite

Affecting twigs, branches
- Cottony insect
  - Grape mealybug

Affecting fruit
- Sticky honeydew on fruit
  - Pear psylla
- Fruit skin russetted
  - Pear russet mite

PEACH

Affecting leaves
- Leaves chewed
  - Fall webworm
  - Redhumped caterpillar
- Leaves with small "shothole" injuries
  - Coryneum blight (a fungus)
- New growth curled
  - Green peach aphid

Affecting branches, trunk
- Scales
  - European fruit lecanium
  - San Jose scale
- Tips of branches dieback
  - Peach twig borer
- Small exit holes in bark
  - Shothole borer
- Branches gouged by borer
  - Peach tree borer
- Clear ooze from bark
  - Cytospora canker (a fungus)
- Base of trunk gouged, ooze mixed with sawdust
  - Peach tree borer
- Borers
  - Peach tree borer
  - Redheaded ash borer

Affecting fruit
- Fruit tunneled
  - Peach twig borer
  - Oriental fruit moth
  - Walnut husk fly
- Fruit with sunken, corky areas
  - Lygus bug
  - Boxelder bug

PINYON

Affecting needles
- Needles being chewed
  - Tiger moth
  - Conifer sawfly
  - Pine butterfly
- Webbing covering crown of tree

- Tiger moth
- Lophocampa argentata subalpina
- Needles being mined
- Pinyon needleminer
- Needles galled
- Pinyon spindlegall midge
- Pinyon stunt needlegall midge
- Aphids on needles
- Pineus spp.
- Giant conifer aphids
- Scales on needles
- Pine needle scale
- Striped pine scale (nymphs)
- Pinyon needle scale (bean stage)
- Row of small dark objects on needle
- Aphid eggs
- Affecting twigs and smaller branches
- Twigs tunneled
- Twig beetles
- Pinyon tip moth
- Pinyon pitch nodule moth
- Twigs chewed
- Red squirrel
- Cottony aphids on twigs
- Pineus spp.
- Scales on twigs
- Striped pine scale
- Large sucking insects feeding on twig
- Cicadas
- Affecting trunk and larger branches
- Oozing pink/yellow pitch from trunk
- Pinyon "pitch mass" borer
- Dioryctria spp. (unidentified)
- Sawdust tunneling of trunk, branches
- Engraver beetles
- Pine sawyers
- Cottony masses on trunk in spring
- Pinyon needle scale

PINES (excluding Pinyon)

- Affecting needles
- Older needles being chewed
- Tiger moth
- Conifer sawfly
- Bull pine sawfly
- Pandora moth
- Pine butterfly
- Older needles chewed and mixed with webbing, pellets
- Web-spinning sawflies
- Tetralopha sp. (pine webworm)
- Newer needles being chewed
- Pine budworm
- Webbing covering crown of tree (ponderosa pine)
- Tiger moth
- Needles being mined
- Pine needle sheath miner
- Ponderosa pine budworm (young larvae)
- Ponderosa pine needleminer
- Needles galled
- Stubby needlegall midge (ponderosa pine)
- Aphids on needles
- Pineus spp.
- Giant conifer aphids
- Scales on needles
- Pine needle scale
- Striped pine scale (males)
- Black pineleaf scale
- Conspicuous blue/black weevil observed
- Magdalis weevil
- Whole tree fades, reddens
- Mountain pine beetle
- Affecting twigs and smaller branches
- Twigs tunneled
- Twig beetles
- Southwestern pine tip moth
- Rhyacionia bushnelli
- Petrova metallica
- Terminal killed back (Lodgepole)
- Pissodes terminalis
- Oozing small pockets of sap
- Gouty pitch midge
- Cottony aphids on twigs
- Pineus spp.
- Scales on twigs
- Striped pine scale
- Large insects sucking on sap
- Cicadas
- Affecting trunk and larger branches
- Oozing pink/yellow pitch from trunk
- Pinyon "pitch mass" borer
- Tunnels oozing popcorn-like white pitch, often near crotches

- Zimmerman pine moth
- Regular rows of holes
  - Woodpecker
- Sawdust associated with tunneling of trunk, branches
  - Pine sawyers
  - Blackhorned pine borer
  - Chalcophora spp.
  - Buprestis spp.
  - Ponderous borer
- Bark beetles
  - Engraver beetles
  - Mountain pine beetle
  - Red turpentine beetle
  - Twig beetles
- Chewing off twigs
  - Abert's squirrel (ponderosa pine), red squirrel (lodgepole pine)

Affecting cones
- Cones tunneled by caterpillars
  - Coneworms (Dioryctria spp.)
  - Cone beetles (Conophthorus spp.)
  - Cone weevil
- Sucking on developing cones
  - Conifer seed bugs

PLUM

Affecting leaves
- Upper surface of the leaf skeletonized
  - Pearslug
- Leaves irregularly chewed
  - Fall webworm
  - Polyphemus caterpillar
  - Cecropia caterpillar
  - Wild cherry sphinx
  - Redhumped caterpillar
  - Uglynest caterpillar
  - Western tent caterpillar
  - Plum web-spinning sawfly
- Webbing associated with chewing
  - Fall webworm
  - Uglynest caterpillar
  - Western tent caterpillar
  - Plum web-spinning sawfly
- Leaves curled
  - Leafcurl plum aphid
  - Green peach aphid
  - Plum pockets (a fungus)
- Underside of leaves with finger projections
  - Eriophyid mites

Affecting branches, trunk
- Scales
  - Oystershell scale
  - San Jose scale
  - European fruit lecanium
- Small holes in bark
  - Shothole borer
- Clear ooze from bark
  - Cytospora canker (a fungus)
- Gouging wounds with ooze and sawdust
  - Peach tree borer

Affecting fruit
- Ooze from fruit
  - Plum gouger

RABBITBRUSH

Affecting leaves
- Leaves chewed
  - Rabbitbrush beetle
  - Rabbitbrush webbing moth
  - Snailcase bagworm

Affecting stems
- Frothy mass on stems
  - Spittlebug
- Cottony balls on stems
  - Rabbitbrush gall flies
- Green flowerlike swellings
  - Rabbitbrush gall flies

ROSE

Affecting leaves
- Upper leaf surface skeletonized
  - Roseslug
- Leaf generally discolored, bronzed
  - Twospotted spider mite
- White flecks on leaves
  - Rose leafhopper/White apple leafhopper
- Leaves irregularly chewed
  - Sawflies (unknown species)
  - Hemileuca eglanterina annulata
- Edge of leaf cut in semicircular fashion
  - Leafcutter bees
- Red balls form on leaves
  - Rose gall wasps

- Affecting stems
  - Scales
    - San Jose scale
  - Canes girdled, may die back
    - Bronze cane girdler
  - Interior of pith excavated
    - Leafcutter bees
    - Small carpenter bees
    - Stem-boring sawfly
  - Large reddish aphids on stems
    - Rose aphid
    - Potato aphid
    - Rose grass aphid
  - Ball or mossy growths on stems
    - Rose gall wasps
  - Tip of canes bent at swollen area
    - Rose curculio
- Affecting flowers, buds
  - Buds riddled, emerged flower ragged
    - Rose curculio
  - Flower buds are killed before emergence
    - Rose midge
  - Caterpillar eating flowers
    - Speckled green fruitworm

SPIREA
- Affecting leaves
  - New growth twisted, distorted
    - Spirea aphid

SPRUCE
- Affecting needles
  - New needles being chewed
    - Douglas-fir tussock moth
    - Western spruce budworm
  - Needles chewed and fragments tied with webbing
    - Spruce needleminer
    - Web-spinning sawfly
  - Needles being mined
    - Spruce needleminer
  - Aphids on needles
    - Giant conifer aphids
    - Balsam twig aphid
  - Needles become grayish, with small flecks
    - Spruce spider mite
  - White scales on needles
    - Pine needle scale
  - Black scales on needles
    - Black pineleaf scale
- Affecting twigs and smaller branches
  - Twigs distorted into cone-like gall
    - Cooley spruce gall adelgid
    - Pineus pinifoliae
  - Woolly aphid on underside of twigs in spring
    - Cooley spruce gall adelgid
  - Twigs tunneled
    - Twig beetles
  - Small bud-like scales on twigs
    - Spruce bud scale
  - Large aphids on branches, twigs
    - Giant conifer aphids
- Affecting trunk and larger branches
  - Bark beetles
    - Engraver beetles
    - Spruce bark beetle
  - Borers
    - Pine sawyers
    - Neoclytus muricatulus
    - Synanthedon novaroensis
    - Horntails
  - Large aphids on branches, trunk
    - Giant conifer aphids
- Affecting top terminal
  - Terminal dies back
    - White pine weevil

SUMAC
- Affecting leaves
  - Leaves chewed
    - Hemileuca neumoegeni
    - Blepharida rhois
  - Sucking insect
    - Calophya triozomima
- Affecting overwintering twigs
  - Calophya triozomima

VIBURNUM
- Affecting leaves
  - Leaves chewed
    - Cecropia moth
  - Leaves curled in spring
    - Viburnum (Snowball) aphid
- Affecting stems

- Scoring bark near base of plant
  - Viburnum borer

VIRGINIA CREEPER
- Affecting leaves
  - Leaf edge cut in semicircle
    - Leafcutter bees
  - Leaves chewed
    - Achemon sphinx
  - Leaves with white flecking
    - Zic-zac leafhopper
  - Leaves with meandering silver tunnels
    - Antispila isabella (larva of a leafmining moth)
- Affecting lower stems, crown
  - Tunneling crown
    - Albuna fraxini

WALNUT
- Affecting leaves
  - Aphids
    - American walnut aphid
  - New growth killed or distorted in patches
    - Plant bugs
- Affecting twigs, branches
  - Scales
    - Walnut scale
    - Oystershell scale

WILLOW
- Affecting leaves
  - Leaves chewed
    - Spiny elm caterpillar
    - Redhumped caterpillar
    - Nevada buck moth
    - Cecropia moth
    - Hyalophora gloveri gloveri
    - Polyphemus moth
    - Speckled green fruitworm
    - Western tent caterpillar
    - Eastern tent caterpillar
    - Fall webworm
    - Acronicta leporina
    - Snailcase bagworm
    - Twinspot sphinx
    - Columbia Basin sphinx
    - Giant poplar sphinx
    - Cottonwood leaf beetle
    - Chrysomela aeneicollis
    - Willow flea beetles (Disonycha sp.)
  - Masses of dark, spiny caterpillars on leaves
    - Spiny elm caterpillar
  - Edges of leaves curled over
    - Poplar leaffolding sawfly
  - Leaves with reddish, hollow swellings
    - Willow redgall sawfly
    - Aphids (unidentified species)
  - Leaves with irregular raised pouch galls
    - Eriophyid mites
  - Leaves skeletonized by beetle larvae
    - Willow flea beetles
    - Cottonwood leaf beetle
    - Chrysomela aeneicollis
  - Sticky honeydew on leaves
    - Black willow aphids
    - Carrot-willow aphid
    - Little green and yellow willow aphids
- Affecting twigs
  - Thickened swellings in twigs
    - Willow stemgall sawflies (Euura spp.)
  - Large aphids on twigs
    - Giant willow aphid
    - Black willow aphid
  - Scales
    - Oystershell scale
    - Scurfy scale
  - Cone-like gall at end of twig
    - Willow cone gall midges
  - Large beetles chewing bark
    - Cottonwood borer
- Affecting trunk and branches
  - Tunneling into wood
    - Poplar and willow borer
    - Flatheaded appletree borer
    - Cottonwood borer
    - Bronze cane borer and related species
  - Regular rows of holes in trunk
    - Sapsucker
  - Visiting oozing sap from trunk
    - Bumble flower beetle
    - Sap beetles
    - Flies (various families)

APPROXIMATE TIMING OF IMPORTANT EVENTS RELATED TO INSECTS AFFECTING TREES AND SHRUBS

EARLY MARCH		
Bull pine sawfly	Ponderosa pine	Larvae feeding on older needles
Tiger moth	Ponderosa pine, pinyon, juniper	Tent construction and feeding becomes conspicuous
Poplar twiggall fly	Aspen	Pupae emerge from old galls
LATE MARCH		
Bull pine sawfly	Ponderosa pine	Larvae feed on older needles, become full-grown
Tiger moth	Ponderosa pine, pinyon, juniper	Peak feeding by caterpillars
Pinyon needle scale	Pinyon	Females produce egg sacks, typical crawler emergence
Southwestern pine tip moth	Most pines	Adult emergence ends
EARLY APRIL		
Poplar twiggall fly	Aspen	Initiation of egg laying by females in emerging twigs
Pinyon needle scale	Pinyon	Crawler emergence (late)
Conifer sawflies	Pines, juniper	Adult emergence, egg laying
Engraver beetles	Pines, spruce	Adult emergence and egg laying can be expected throughout spring
LATE APRIL		
Cooley spruce gall adelgid	Spruce	Initiation of egg sack production; often optimal time to control overwintered females
Poplar twiggall fly	Aspen	Peak egg laying by females in emerging twigs
Spiny elm caterpillar	Aspen, elm	Larval feeding initiated
Malacosoma incurvatum discoloratum	Cottonwoods (West Slope)	Peak feeding, tent construction
Most tent caterpillars (other Malacosoma species)	Ash, fruit trees, oak, mountain-mahogany, aspen, etc.	Egg hatch and initiation of feeding
Pine needle scale	Pines, spruce	Onset of egg hatch/crawler stage (early)
Pinyon tip moth	Pinyon	Time for sprays to kill overwintered larvae prior to tunnelling of terminal growth
White pine weevil	Spruce	Adults return to terminals to lay eggs; treatment timing for many areas
Zimmerman pine moth	Pines	Spring treatment timing for control of overwintered larvae, prior to trunk tunnelling
Smaller European elm bark beetle	American elm	Preventive sprays should be completed by this time
Lilac/ash borer	Ash, lilac, privet	Onset of adult flights (early areas)
Douglas-fir beetle	Douglas-fir	Beginning of adult emergence (doesn't become significant until late May)
EARLY MAY		
Spiny elm caterpillar	Aspen, elm	Peak larval feeding
Most tent caterpillars (various Malacosoma species)	Ash, fruit trees, oak, mountain-mahogany, aspen, etc.	Typical period of peak feeding injury
Pine needle scale	Pines, spruce	Egg hatch/crawler stage (late)
White pine weevil	Spruce	Adults return to terminals to lay eggs; treatment timing for high altitude/cool season areas

Lilac/ash borer	Ash, lilac, privet	Onset of adult flights (most areas of state)
Brownheaded ash sawfly	Ash	Initiation of leaf feeding (pinhole feeding wounds)
Imported currantworm	Currant, gooseberry	Egg laying and onset of feeding (pinhole feeding wounds)
Conifer sawflies	Pines, juniper	Peak feeding injury by larvae
Elm leaf beetle	Elm	Adult feeding on new leaves, some egg laying may begin
Rabbitbrush beetle	Rubber rabbitbrush	Egg hatch and onset of feeding by the larvae
Oystershell scale	Aspen, lilac, ash, cotoneaster, willow, many other plants	Onset of egg hatch/crawlers (early areas)
Hackberry nipplegall maker	Hackberry	Oviposition on new leaves; gall initiation; optimal treatment timing
Honeylocust podgall midge	Honeylocust	Galling from first generation begins on new growth
Honeylocust plant bug	Honeylocust	Young nymphs begin to feed on new growth
Western spruce budworm	Douglas-fir, spruce, fir	Larval feeding begins with mining of old needles an/or invasion of swellingn buds and flowers
Southwestern pine tip moth	Many pines	Time to make preventive treatments
	LATE MAY	
Most tent caterpillars (various Malacosoma species)	Ash, fruit trees, oak, mountain-mahogany, aspen, etc.	Peak feeding passes; typical period when infestations end
Brownheaded ash sawfly	Ash	Peak feeding period
Imported currantworm	Currant, gooseberry	Peak feeding period
Elm leaf beetle	Elm	Peak oviposition period (generation one)
Rabbitbrush beetle	Rubber rabbitbrush	Peak feeding injury
Oystershell scale	Aspen, lilac, ash, cotoneaster, willow, many other plants	Onset of egg hatch/crawlers (most areas)
Honeylocust plant bug	Honeylocust	Peak feeding injury by older nymphs
Douglas-fir tussock moth	Spruce, Douglas-fir, fir	Onset of egg hatch (most areas)
Barberry looper	Mahonia	Peak feeding injury
Birch leafminer	Birch	Egg laying by generation one adults
Juniper borer	Juniper	Adult feeding and egg laying
Bronze cane girdler	Currants, raspberries, etc.	Adult emergence initiated
Leafcurling aphids (various)	Fruit trees, snowball viburnum, honeysuckle, etc.	Initiation of leafcurling distortion of the new growth
Douglas-fir beetle	Douglas-fir	Peak flight off adults that overwintered as adults. Egg hatch and early larval injury.
	EARLY JUNE	
Brownheaded ash sawfly	Ash	Feeding injuries end
Striped pine scale	Scots and other pines	Egg hatch, crawler period
Elm leaf beetle	Elm	Egg hatch and early larval injury
Cottonwood leaf beetle	Cottonwood, poplars, willow	Egg laying by generation one adults
Oystershell scale	Aspen, lilac, ash, cotoneaster, willow, many other plants	End of crawler period
Honeylocust plant bug	Honeylocust	Injury ends as nymphs develop to the adult stage
Douglas-fir tussock moth	Spruce, Douglas-fir, fir	Egg hatch/young larvae present
Barberry looper	Mahonia	Peak feeding injury
Birch leafminer	Birch	Initiation of mines in leaves
Pine butterfly	Pines	Egg hatch and early larval injury

Bronze cane girdler	Currants, raspberries, etc.	Peak period of adult activity, egg laying
Leafcurling aphids (various)	Fruit trees, snowball viburnum, honeysuckle, etc.	Leafcurling distortions become prominent
Leafrollers	Oak, fruit trees, various trees and shrubs	Peak feeding on foliage
Western spruce budworm	Douglas-fir, spruce, fir	Time to treat outbreaks at most elevations
Lilac leafminer	Lilac, euonymus, privet	Leafrolling, feeding is evident (generation one)
Shothole borer	Prunus species	Adult emergence and egg laying
Currant borer	Currant, gooseberry	Adult emergence and egg laying
Bronze birch borer	Birch	Adult emergence and egg laying
Bronze cane girdler	Currant, raspberry, etc.	Peak adult activity and egg laying
	LATE JUNE	
Fall webworm	Cottonwoods, poplars, chokecherry, etc.	Egg hatch and initiation of colonies
Redhumped caterpillar	Crabapple, fruit trees, etc,	Peak feeding injury to foliage
Douglas-fir tussock moth	Spruce, Douglas-fir, fir	Peak feeding injury (most areas)
Leafrollers	Oak, fruit trees, many other hardwood trees and shrubs	Peak feeding injury (generation one)
Pine butterfly	Pines	Peak larval feeding
Ash-gray blister beetle	Honeylocust, locust, other leguminous trees and shrubs	Masses of adults appear on foliage
Elm leaf beetle	Elm	Peak larval injury (most areas); full-grown larvae descend the trunk to pupate
Blackvine weevil	Euonymus, other shrubs	Adult emergence, onset of leaf notching injuries
Pearslug	Sweet cherry, cotoneaster, pear	Onset of larval leaf feeding injury (generation one)
Poplar blackmine beetle	Cottonwood	Adult feeding on foliage; egg laying
Pinyon spindlegall midge	Pinyon	Adult emergence; egg laying
Pinyon pitch mass borer	Pinyon, ponderosa pine	Adult emergence; onset of egg laying
Peach tree borer	various Prunus species	Adult emergence and egg laying
Bronze birch borer	Birch	Adult emergence and egg laying continues
Flatheaded appletree borer	Maple, apple, fruit trees, etc.	Adult emergence and egg laying
Mountain pine beetle	Pines	Best timing for preventive sprays on green trees prior to beetle emergence from infested trees; spraying of infested logs should be completed
	LATE JULY	
Fall webworm	Cottonwoods, poplars, chokecherry, etc.	Peak injury begins
Redhumped caterpillar	Crabapple, fruit trees, etc.	Peak feeding injury to foliage
Douglas-fir tussock moth	Spruce, Douglas-fir, fir	Peak feeding injury (Colorado Springs and later areas)
Western spruce budworm	Douglas-fir, spruce, fir	Adult flight and egg laying
Ash-gray blister beetle	Honeylocust, locust, other leguminous trees and shrubs	Masses of adults appear on foliage
Black vine weevil	Euonymus, other shrubs	Peak period of adult activity and leaf injury
Pearslug	Sweet cherry, cotoneaster, pear	Peak injury (generations one)
Poplar blackmine beetle	Cottonwood	Initiation of leafmining
Pinyon spindlegall midge	Pinyon	Egg laying ends; rescue treatments still possible

Peach tree borer	various Prunus species	Typical period for optimal timing of trunk sprays to prevent subsequent larval damage
Flatheaded appletree borer	Maple, apple, fruit trees, etc.	Adult emergence and egg laying continues
Mountain pine beetle	Pines	Adult emergence may begin, particularly in lodgepole pine at higher elevations
Douglas-fir beetle	Douglas-fir	Emergence off adults that overwintered as larvae
Pinyon tip moth	Pinyon	Peak adult emergence and egg laying begins
Pinyon pitch nodule moth	Pinyon	Onset of adult emergence
Leafcutter bees	Rose, ash, lilac, fruit trees, etc.	Adults cut leaves to produce cells for larval rearing
Elm leaf beetle	Elm	Second generation adults present
Pine needle scale	Pines, spruce	Second generation crawler period
Honeylocust spider mite	Honeylocust	Peak populations present
EARLY AUGUST		
Fall webworm	Cottonwoods, poplars, chokecherry, etc.	Peak injury continues; full-grown larvae may wander from trees
Douglas-fir tussock moth	Spruce, Douglas-fir, fir	Feeding injuries decline (Colorado Springs and later areas)
Poplar blackmine beetle	Cottonwood	Large dark mines are visible
Pinyon pitch nodule moth	Pinyon	Peak period of adult emergence and egg laying
Leafcutter bees	Rose, ash, lilac, fruit trees, etc.	Adults cut leaves to produce cells for larval rearing
Elm leaf beetle	Elm	Onset of generation two larval feeding injury
Honeylocust spider mite	Honeylocust	Foliage yellowing on street trees often very visible; populations decline
Zimmerman pine moth	Pines	Adult emergence and egg laying; optimal treatment timing
Mountain pine beetle	Pines	Peak adult emergence and flight
Pine butterfly	Pines	Adult flight begins
LATE AUGUST		
Fall webworm	Cottonwoods, poplars, fruit trees, chokecherry, etc.	Feeding continues; declines in most areas; peak period of larvae wandering from host
Hornets, aerial yellowjackets	Silver maple, elm, other trees	Paper nests rapidly increase in size
Polyphemus, cecropia, Io moth	Dogwood, lilac, various trees and shrubs	Full-grown caterpillars wander from host plants
Horntails	Elm, maple, other hardwoods	Adults are present around dead and dying limbs
Dagger moth	Maple	Defoliation and petiole cutting become obvious
Pearslug	Cotoneaster, sweet cherry, pear, etc.	Defoliation by second genration larvae begins
Locust borer	Black locust	Adult activity and egg laying begins
Pine sawflies	Pines	Peak larval feeding by certain species
EARLY SEPTEMBER		
Polyphemus, cecropia, Io moth	Dogwood, lilac, maple, various trees and shrubs	Full-grown caterpillars wander from host plants
Pine butterfly	Pines	Adult flight and egg laying ends
Ponderosa pine needleminer	Ponderosa pine	Peak egg laying period
Pearslug	Cotoneaster, sweet cherry, pear, etc.	Defoliation by second genration larvae begins
Locust borer	Black locust	Peak period of adult activity and egg laying
Elm leaf beetle	Elm	Peak feeding by second generation larvae

Ash bark beetles	Ash	Adults begin to cut overwintering chambers in the trunks of ash
European elm bark beetle	Elm	Peak second generation adult flight
	LATE SEPTEMBER	
Oak kermes scale	White oak	Egg hatch, crawler emergence onset
Aphids (many species)	Oak, willow, linden, maple, many other woody plants	Overwintering forms return to woody plants to feed and produce overwintering eggs; peak period of honeydew production and nuisance problems on many plants
	EARLY OCTOBER	
Oak kermes scale	White oak	Peak period of egg hatch, crawler emergence
Aphids	Willow, maple, oak, linden, many other plants	High populations continue to be present until killing frost occurs
	LATE OCTOBER	
Oak bulletgall wasp	Bur, swamp white oak	Adult emergence and egg laying

RELATED PUBLICATIONS

The following publications related to care and maintenance of trees and shrubs are available from most county Extension offices and the Colorado State University Bulletin Room. There is typically a nominal charge.

5.506 Dutch elm disease
5.507 Spider mites: characteristics and control
5.511 Aphids: characteristics and control on ornamentals
5.513 Oystershell scale: characteristics and control on ornamentals
5.514 Pine needle scale: characteristics and control on evergreens
5.519 Apple and pear insects: control in home plantings
5.520 Stone fruit insects: control in home plantings
5.521 Elm leaf beetles: characteristics and control
5.522 Boxelder bugs: characteristics and control
5.528 Mountain pine beetle and related beetles
5.529 Pine tip moths: characteristics and control
5.530 Shade tree borers: characteristics and control
5.534 Cooley spruce galls: characteristics and control
5.542 Douglas-fir tussock moths
5.543 Western spruce budworms
5.544 Ponderosa pine needle miners
5.547 Use of soaps and detergents for insect control in Colorado
5.548 Leafmining insects: characteristics and control
5.550 Beneficial insects and other arthropods in the yard and garden
5.556 Use of Bacillus thuringiensis for insect control in Colorado
5.557 Insect and mite galls of woody plants
5.558 Ips beetles: characteristics and control
5.560 Pear slugs: characteristics and control
5.562 Use of insect pheromones for insect control in Colorado
5.563 Firewood and House log insects in Colorado
5.566 Peach tree borer: characteristics and control
5.567 Ponderosa pine budworm
Aspen: A Guide to Common Problems in Colorado