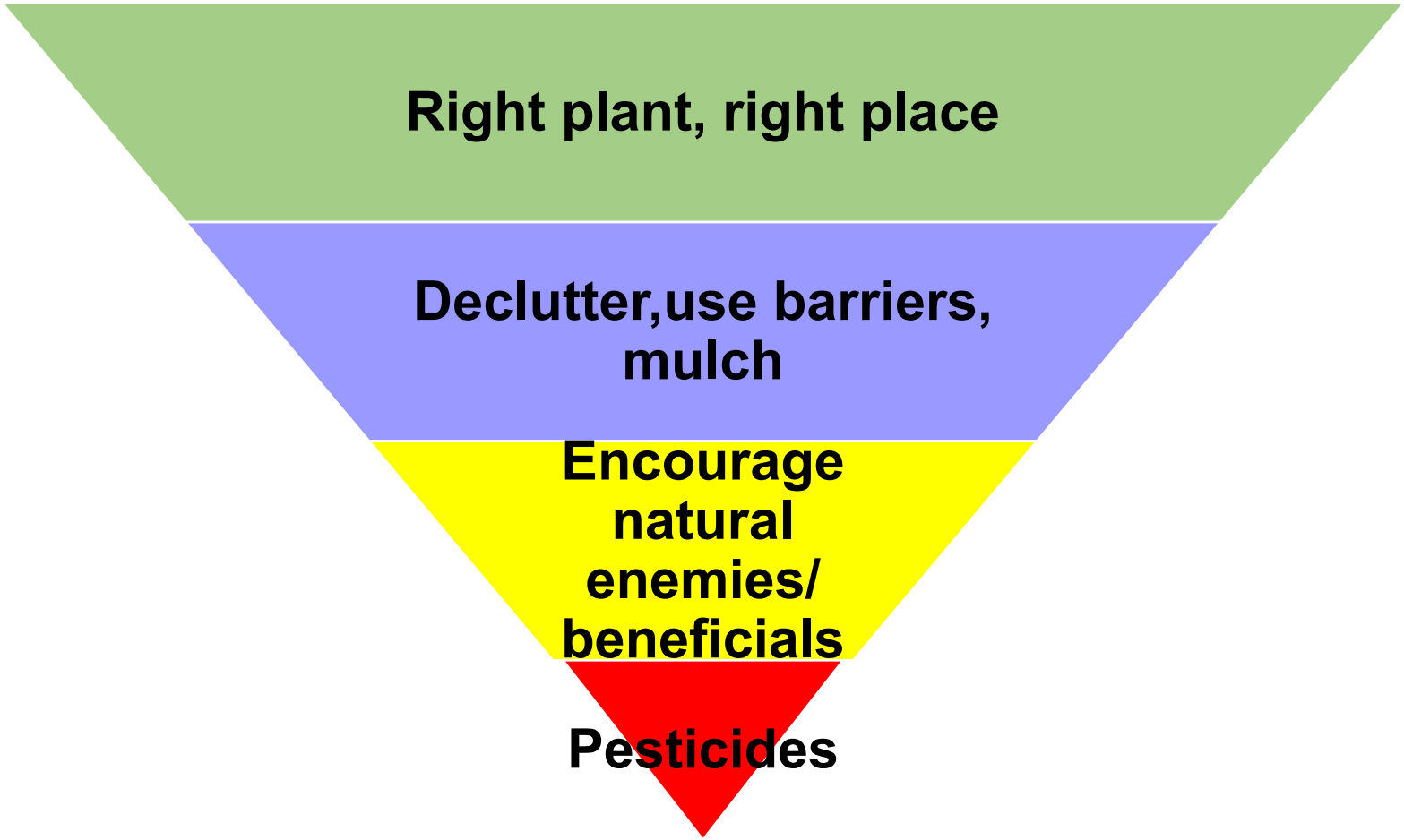
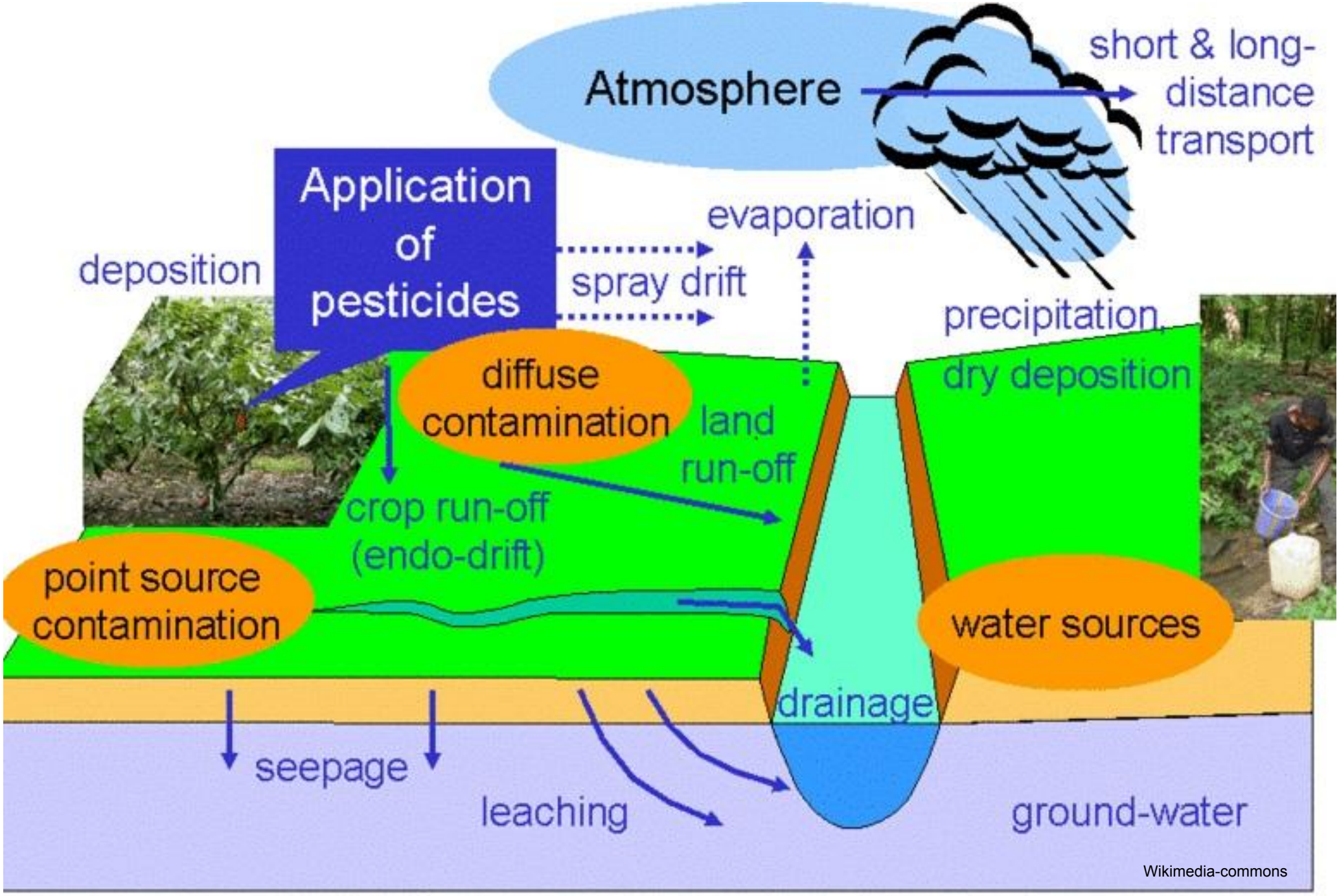
Best ways to control pests in the garden





When using pesticides be aware

Less toxic pesticides

- Pesticidal soaps
- Insecticidal oils, neem, canola
- Microbials - B.t., *Bacillus thuringiensis,*
- Botanicals- pyrethrins, garlic, hot pepper, etc.
- Spinosads
- Boric acid or borate for ants

More toxic pesticides - neurotoxins

- Organophosphates – e.g., malathion, acephates
- Carbamates – carbaryl (Sevin)
- Pyrethroids – synthetic pyrethrin like compounds, e.g., permethrin
- Neonicotinoids – imidacloprid, dinotefuran

READ THE LABEL

- Product name/ brand
- Active ingredients
- EPA number
- Signal words
- Precautions
- Storage and disposal
- First aid instructions
- Directions for use

All this Information can be found on the back of the container

Responsible pesticide use

- Use as last resort
- Use the least toxic pesticides
- Target application- narrow spray
- Apply after beneficials are gone
- Avoid systemic pesticides
- Follow all safety precautions
- Buy minimal amount
- Dispose of properly

THE DIRTY DOZEN

TWELVE PEST/DISEASES COMMON IN OUR AREA

Aphids

Rose aphids on young blossom.

Photo by Jack Kelly Clark.

Rose aphids vary in color from green to red; these fuzzy-orange aphids were killed by a fungus.

Photo by Jack Kelly Clark.

Potato aphid adults and nymphs.

Photo by Jack Kelly Clark.

Woolly apple aphids, *Eriosoma lanigerum*.

Photo by Jack Kelly Clark

Aphids-Quick management tips

Almost every plant has one or more aphid species that occasionally feed on it, but low to moderate numbers of aphids usually aren't damaging to gardens or landscape trees. Although aphids can curl leaves and produce sticky honeydew, they rarely kill plants, and can usually be washed off with water. When aphid numbers are high, natural enemies often feed on them, eliminating the need for pesticides. When pesticides are necessary, use less-toxic products such as insecticidal soaps and oils.

Aphids are common in gardens.

- Aphids like lush, new growth. Don't over fertilize; use organic or slow-release products.
- Aphids build up on flowering plums, roses, tulip trees, crape myrtles, apples, and many vegetables. Expect aphids when you grow these plants.
- Ants protect aphids from their natural enemies. Keep ants off plants to help these beneficial insects do their job.

How can I reduce aphids?

- Prune infested leaves and stems.
- Knock aphid populations off plants by shaking the plant or spraying it with a strong stream of water.
- Protect seedlings with covers or aluminum foil mulches.
- Wait for hot weather; some aphids are heat-intolerant and will be gone by mid-summer.

Are there any good bugs that will eat aphids?

Beneficial insects such as lady beetles and lacewings will visit plants naturally when aphids are abundant. Protect these natural enemies by avoiding the use of insecticides that can be toxic to them. Common natural enemies of aphids include:

- Lady beetles (ladybugs), both adults and larvae
- Lacewings
- Syrphid fly larvae
- Soldier beetles
- Tiny parasitic wasps that turn aphids into crusty "mummies"

What about pesticides?

- Use non chemical methods first to manage aphid populations.
- If insecticides seem necessary, choose the safest products, such as insecticidal oils and soaps. When properly used, these materials solve most aphid problems.
- Oils and soaps work by smothering aphids, so apply these products thoroughly. Don't apply them to drought-stressed plants or when it is very hot. Some plants are sensitive to these products.
- Apply insecticidal soaps, soap-pyrethrum mixtures, or neem oils on vegetables or small bushes such as roses.
- Narrow range horticultural oils—such as supreme or superior oils—are appropriate for larger trees.
- Oils and soaps don't kill aphids hidden within curled leaves. Prune these out. Systemic insecticides can kill hidden aphids, but they are much more toxic and might kill bees and other beneficial insects on flowering plants.

Ants

An Argentine ant, Linepithema humile, tending scale insects.
Photo by Jack Kelly Clark.

Aphid on branch tended by Argentine ants.
Photo by Jack Kelly Clark.

Adult velvety tree ants, Liometopum occidentale.
Photo by Dong-Hwan Choe.

Ants (Formicidae) are Hymenoptera closely related to bees and wasps. Of about 200 ant species known in California, only a few are commonly pests. Most species are not bothersome and rarely or never are pests. Ants can improve soil conditions and some are useful predators of pest insects.

Life cycle

Ants develop through four life stages. Most individuals are wingless workers (sterile females) that care for the pale, grublike immatures (larvae and pupae) in the nest, defend the colony from natural enemies, dig tunnels, and forage for food outside the nest.

Each colony has one or more queens (fertile females) that spend most of their time in the nest laying eggs. Males occur only during the brief mating season when males and queens develop wings and may mate in flights or swarms outside of the nest. Most species of ants nest underground or beneath buildings or rocks or other objects.

As workers returning with food meet those departing their nest, they exchange a tiny droplet (food sharing, or trophallaxis) containing communication chemicals and nutrients. Slow-acting insecticide baits take advantage of this behavior. Foraging ants collect and carry the insecticide and spread it throughout the entire colony during food sharing, thereby poisoning ants underground and queens in their nest.

Damage

Ants become pests in gardens and landscapes when they feed on sugary honeydew excreted by other insects that suck plant sap (phloem). Ants tend these aphids, mealybugs, soft scales, whiteflies and other honeydew-producing insects and harass or kill parasites and predators that might otherwise control honeydew producers. Ants can also disrupt the biological control of pests that do not excrete honeydew, such as armored scales and mites.

Ants may bite or sting or both when contacted or disturbed by domesticated or wild animals or people. Some species invade homes and other buildings seeking food, shelter, and water. Carpenter ants, *Camponotus* spp., tunnel in wood. Those that chew bark or plant parts include pavement ant, *Tetramorium caespitum*; red imported fire ant, *Solenopsis invicta*; and southern fire ant, *Solenopsis xyloni*.

Solutions

Use a combination of methods to manage ants:

- Apply an effective, enclosed, insecticide bait to poison ant colonies.
- Apply sticky material (e.g., Tanglefoot) or other effective barriers to bark, encircling trunks to exclude ants.
- Keep irrigation water, leaf litter and mulch, and vegetation at least several inches back from foundations and walls of buildings where ants are not desired inside.
- Manage the aphids, mealybugs, psyllids, scales, whiteflies, or other insects secreting the honeydew on which ants are feeding. If ripening fruit is the source of ant attraction, pick, prune, or knock that from plants and if unwanted dispose of it.
- Prune shrubs and trees back away from structures to eliminate bridges to buildings.
- Remove plants too near to structures if they consistently host ants or honeydew producers and ants coming indoors has been a problem.
- Seal crevices and gaps in buildings through which insects enter.

Adult imported cabbageworm.

Photo by Jack Kelly Clark.

Imported cabbageworm

—*Pieris rapae*

Imported cabbageworm larva.

Photo by Jack Kelly Clark.

Imported cabbageworm

—*Pieris rapae*

Cabbageworm larvae are green and very hairy, with an almost velvetlike appearance. Older larvae may be up to 1-inch long and often have one faint yellow orange stripe down their backs and broken stripes along the sides. Adults are white with one to four black spots on the wings.

Life cycle

Adult cabbage butterflies lay eggs singly on leaves. Eggs are pale yellow to orange and are shaped like a football standing on its end. Older larvae may be up to an inch long. Compared with other caterpillars, cabbageworms move slowly and are sluggish but they feed voraciously on both the outer and inner leaves, often feeding along the midrib, at the base of the wrapper leaves, or boring into the heads of cabbage. After 2 to 3 weeks of feeding, larvae pupate attached by a few strands of silk to stems or other nearby objects. Pupae are green with faint yellow lines down the back and sides; there is no spun cocoon. The cabbageworm is active throughout the year in California.

Damage

Cabbageworm larvae chew large, irregular holes in leaves, bore into heads, and drop greenish brown fecal pellets onto edible portions of the leaf.

Solutions

Handpick. Natural control by virus and parasites, such as tachinid flies, can sometimes be effective. *Bacillus thuringiensis* or spinosad are very effective. Egg laying can be prevented by using floating row covers.

Codling Moth

Adult codling moth.

Photo by Jack Kelly Clark.

Codling moth pupa.

Photo by Jack Kelly Clark.

Mature codling moth larvae in cut-open cocoons.

Photo by Jack Kelly Clark.

In deep entries, codling moth larvae bore to core and feed.

Photo by Jack Kelly Clark.

Codling Moth

Codling moth, the infamous "worm" in the apple, is difficult to manage in the home orchard. Soon after hatching, caterpillars bore into apples, pears, or walnuts and feed, leaving reddish-brown droppings (frass). Early-maturing fruit varieties are less likely to suffer damage. Use an integrated pest management (IPM) approach that combines several of the methods described below. Trees heavily infested every year require carefully timed sprays.

Codling moth life cycle:

- Mature larvae overwinter under bark in cocoons and pupate in spring.
- Adult moths emerge in mid-March to April and mate after sunset temperatures exceed 62°F.
- Tiny disc-shaped eggs are laid on fruit or leaves.
- Hatching larvae immediately bore into fruit.
- Larvae feed within fruit until mature then drop to the ground to pupate in soil or debris or under tree bark.
- Two to four generations occur per year in California.

Reduce codling moths with sanitation practices.

- Promptly remove infested fruit from trees. Look for worm entry points ("stings") marked by tiny mounds of reddish-brown frass.
- Rake up and destroy dropped fruit as soon as it falls, especially in May and June.
- Sanitation alone won't control the pest.

Bagging protects fruit without chemical sprays, even when infestations are severe.

- Bag when fruit is 1/2 to 1 inch in diameter, four to six weeks after bloom.
- Cut a 2-inch slit in the bottom of a standard lunch bag, thin fruit to one per cluster, slip the fruit through the slit, and staple the bag shut.
- Remove bags just as fruit begins ripening.

Use insecticides when infestations are severe.

- Codling moth granulosis virus (sold as Cyd-X) is a safe biological pesticide that won't harm beneficials or bees. Add 1% horticultural oil to increase effectiveness. Apply every seven days after eggs hatch, at least three or four times per generation.
- Spinosad is a low-toxicity pesticide made more effective by adding 1% horticultural oil. Apply every 10 days after eggs hatch, or about three times per generation.
- Carbaryl is effective when properly timed at 14- to 21-day intervals but is very toxic to natural enemies, honey bees, and other nontargets and can cause water quality problems.
- Combining low-toxicity insecticides with nonchemical methods is the most environmentally sound approach.

Insecticides are effective only when sprays are precisely timed to kill caterpillars just as they hatch.

- Hang a pheromone trap in your tree in March, and check it every few days for moths.
- Once moths are found and sunset temperatures exceed 62°F, start calculating degree-days following the instructions in *Pest Notes: Codling Moth.* Degree-days will help you determine when eggs will hatch or when to start looking for "stings" on fruit that indicate larvae have hatched and are entering fruit.
- Start applying insecticides as soon as degree-day calculations indicate eggs are hatching (250-300 degree-days after moths are caught in traps) or as soon as you see stings.
- Use new stings or degree-day calculations to initiate sprays for second and third generations.

Grubs

Larva of northern masked chafer.

Photo by Jack Kelly Clark.

UC Master Gardener Rebecca Jepsen

Variegated cutworm, *Peridroma saucia*, larva (caterpillar).

Photo by Jack Kelly Clark.

GRUBS

Identification

Masked chafer adults are golden brown beetles, 3/4 inch (1.9 cm) long with dark brown heads. The adult beetle is hairy on the underside of its thorax. Larvae are white, C-shaped grubs with dark stripes on their backs and brown head capsules and legs. There is also a characteristic pattern of bristles on the underside of the posterior end of the abdomen. When full grown, white grubs are about 1 inch (2.5 cm) long, much bigger than ataenius or billbug grubs.

Hosts

All turfgrass species, especially annual bluegrass (a common weed in turf), Kentucky bluegrass, and perennial ryegrass

Damage

Masked chafer grubs feed on the roots of turfgrass. Damage appears in late summer or fall as irregular patches of brown, dying grass. The ground often feels spongy, and the lawn can be rolled up if heavily infested. Skunks, moles and birds may be attracted to lawns with high grub populations.

Monitoring information

Dig around the roots in damaged areas—especially in late fall through spring and look for whitish to yellow, wrinkled, C-shaped grubs. Look for yellowish-brown adults in the early to mid summer.

Management

Aerating the lawn can kill significant portions of white grub populations if they are feeding close to the soil surface. Follow recommended irrigation and fertilization practices. A healthy lawn can tolerate some grub damage. If more than 6 grubs are found per square foot, you may need to treat. Tiphiid wasps are common parasites of masked chafers but may not provide effective control. Beneficial nematodes may be effective if applied when grubs are young. Other insecticides are available including imidacloprid. Proper timing is essential.

Scale Insects

Adult black scale females and nymphs on twig.

Photo by Jack Kelly Clark.

Greedy scale colony.

Photo by Jack Kelly Clark.

Female European fruit lecanium scale, *Parthenolecanium corni,* overturned to reveal her eggs.

Photo by Jack Kelly Clark.

Crawlers of San Jose scale, *Diaspidiotus perniciosus.*

Photo by Jack Kelly Clark.

Scale Insects

Scales are immobile insects that suck plant juices from many types of trees, shrubs, and houseplants. Scale infestations can cause yellowing or premature dropping of leaves, sticky honeydew, and blackish sooty mold. Plant parts can distort or die back, depending on the species and abundance of scales. Management includes proper plant care, conserving natural enemies, and applying less toxic insecticides when needed. Most plants tolerate low to moderate numbers of scales.

What does scale damage look like?

- Damage resembles that of aphids and whiteflies
- Abundant sticky honeydew excreted by soft scales and certain other species
- Black sooty mold growing on the honeydew
- Discolored, distorted, or dying leaves, twigs, or branches, especially with armored scales

What do scales look like?

- As adults, scales are immobile with coverings that are 1/25 to 1/4 inch long. Immature scales are small slow-moving bodies called crawlers that have legs which eventually drop off.
- Adults may appear as circular, elongate, or oval discolorations or raised areas on bark, leaves, or fruit.
- Scales lack an obvious head or legs and don't resemble most other insects.

Distinguish the two most common types of scales—armored and soft.

- **Armored scales** are tiny and flat, have covers that usually can be removed from the body, and don't secrete sticky honeydew. Common species include San José scale and California red scale.
- **Soft scales** are larger, excrete honeydew, and are more rounded and convex with covers that don't lift off. Common species include black scale, lecanium scale, and brown soft scale.
- Consult the UC IPM website to help identify the species or family of scale insects so you can learn effective controls.

To reduce problems, use an integrated program.

- Provide plants with proper cultural care, especially irrigation.
- Monitor plants to look for scale predators such as lady beetles or lacewings and parasite emergence holes in scale covers.
- Use sticky barriers or insecticide baits to selectively control scale-tending ants.
- Consider replacing problem-prone plants. Most scales are highly specific to certain plants.

What about pesticides?

- Insecticides are not necessary unless damage from scales is intolerable.
- Avoid insecticides that injure natural enemies.
- For fruit trees and smaller plants, make a well-timed and thorough spray using horticultural oil during the dormant season or when scale crawlers are active in the growing season.
- For intolerable soft scale problems, especially on large trees, consider soil-applied imidacloprid. This material is not effective against some scales, including armored scales, and may cause outbreaks of cottony cushion scale. Always read the label.

Snails & Slugs

Brown garden snail.

Photo by Jack Kelly Clark.

Adult white garden snail, *Theba pisana.*

Photo by David Rosen.

Gray garden slugs, *Deroceras reticulatum,* and shiny mucous.

Photo by Jack Kelly Clark.

A tawny slug on a ripe strawberry.

Photo by Jack Kelly Clark.

Snails & Slugs

Snails and slugs rank among our most despised garden pests. These slimy mollusks emerge from hiding at night and chew holes in leaves and flowers of many succulent garden plants and fruit. Slugs and snails are similar in structure and biology, except slugs lack the snails' external spiral shell. Management requires a vigilant and integrated approach that includes eliminating moisture and hiding spots, trapping, setting up barriers, and handpicking. Baits can be helpful but by themselves don't provide adequate control in gardens that contain plenty of shelter, food, and moisture.

How do you know snails and slugs are causing damage?

- Because they feed at night and hide during the day, you might not observe these pests at first. Go out at night or in the early morning to view them in action.
- Other pests can cause holes in leaves, flowers, and fruit. Look for the shiny slime trails slugs and snails leave behind.

What can be done to reduce snails and slugs?

- Remove daytime hiding places such as ivy, weedy areas, debris, and boards.
- Place your garden in the sunniest spot possible. Remove garden objects, plants, or ground cover that can serve as shady shelter.
- Reduce moist surfaces by switching to drip irrigation or by running sprinklers in the morning rather than later in the day.
- Make sure the garden is mollusk-free before planting, then erect a copper barrier around it. Use a 4- to 6- inch-wide band of copper, buried an inch below the soil and bent over at the top or attached around the edge of a raised bed.
- Consider snail-proof plants such as impatiens, geraniums , lantana, nasturtiums, and other plants with stiff leaves and highly scented foliage such as sage, rosemary, and lavender.

How can I manage snails and slugs without using pesticides?

- Regularly remove snails from shelters such as fence ledges, undersides of decks, and meter boxes.
- Build a trap using a board raised off the ground by 1-inch runners. As mollusks collect under the board, scrape them off and destroy daily.
- Place beer traps in your garden and dispose of trapped snails and slugs daily.

What about pesticides?

- Pesticide baits will not be very effective unless you also remove shelter, food, and moisture.
- Iron phosphate baits are safe for use around dogs, children, and wildlife.
- Ferric sodium EDTA is a newer active ingredient that works similar to iron phosphate. This product is not organically acceptable.
- Metaldehyde baits are especially poisonous to dogs and birds. Metaldehyde also loses its effectiveness rapidly in sunlight and after rain or irrigation.
- Irrigate before applying bait and apply in the evening on warm days when mollusks are active.
- Scatter, don't pile, bait around sprinklers and in moist, protected areas where mollusks travel. Always read pesticide labels before applying the product.

Spider Mites

Strawberry spider mite.

Photo by Jack Kelly Clark.

Western predatory mites, *Galendromus (=Metaseiulus) occidentalis* (top and bottom), and a twospotted spider mite, *Tetranychus urticae* (center), and its eggs.

Photo by Jack Kelly Clark.

Potato leaf heavily infested with spider mites, showing webbing and yellow blotches.

Photo by Jack Kelly Clark.

Spider Mites

Spider mites are common pests of fruit trees, vegetables, berries, vines, and ornamental plants. Mites are tiny and difficult to see. Although related to insects, mites are arachnids just like spiders and ticks. If leaves are stippled with white dots or have webbing, check the undersides to see if spider mites are present. Sprays of water, insecticidal oils, or soaps can be used for management. Spider mites have many naturally occurring predators that often limit their numbers.

What to look for:

- To the naked eye, spider mites look like tiny, moving dots. Use a magnifying lens to see them.
- Adults are less than 1/20 inch long and have eight legs, an oval body, and two colored eyespots near the end of the head.
- Spider mites live in colonies, mostly on the under surfaces of leaves; a single colony can contain hundreds of mites.
- When numbers are high, dense webbing can cover leaves, twigs, and fruit.

Mites cause damage by sucking cell contents from leaves.

- A small number of mites isn't usually cause for concern, but very high populations can be damaging, especially to annual plants.
- Often, damage first appears as a stippling of light dots on the leaves; sometimes leaves turn a bronze color. Heavily infested leaves can turn yellow and drop off.
- Damage is usually most severe in hot, dusty conditions and on water-stressed plants.

Protect predators of spider mites.

- Spider mites have many predators or "natural enemies", which prevent them from becoming plant pests, especially when undisturbed by pesticide sprays.
- Key predators include predatory mites, which are about the same size as plant-feeding mites but have longer legs and are more active.
- Other common natural enemies include thrips, lacewings, and minute pirate bugs.
- Keep dust down. Plant ground covers, use mulches, and irrigate regularly.
- Avoid using insecticides that kill natural enemies.

How do I control spider mites?

- Water plants sufficiently to avoid drought stress, which increases mites and mite damage.
- Most woody plants can tolerate low to moderate mite populations, and natural enemies are often abundant.
- If plants are infested, apply a water spray or mist to the undersides of leaves at least once a day.
- If you wish to use an insecticide, a good choice is an insecticidal oil or soap (or a combination of the two) applied so you completely cover the undersides of leaves. Be sure mites are present before treating. Don't spray when plants are water-stressed or if it is very hot.
- Spider mites frequently become a problem after applying persistent insecticides such as carbaryl or pyrethroids. These insecticides are not very effective against mites and often kill off natural enemies and stimulate mite reproduction.

What about pesticides?

- If an insecticide is needed, use an insecticidal oil or insecticidal soap (or a combination of the two), applied so you completely cover the undersides of leaves. Be sure mites are present before treating. Don't spray when plants are water-stressed or if it is very hot.
- Spider mites frequently become a problem after applying persistent insecticides such as carbaryl or pyrethroids. These insecticides are not very effective against mites and often kill off predators and stimulate mite reproduction.

Thrips

Adult western flower thrips, *Frankliniella occidentalis.*

Photo by Jack Kelly Clark.

Leaves injured by bean thrips.

Photo by Jack Kelly Clark.

Black adult and yellow nymphs of greenhouse thrips, *Heliothrips haemorrhoidalis*.

Photo by Jack Kelly Clark.

Thrips

When thrips feed, they distort or scar leaves, flowers, or fruit. Healthy woody plants usually tolerate thrips, although damage can become unattractive. Herbaceous ornamentals and developing fruits and vegetables can suffer more serious injuries. Manage thrips by combining good cultural care, pest exclusion, thrips-resistant plants, and less toxic insecticides that are softer on natural enemies.

Thrips are tiny, slender insects with hairs on their wing margins.

- They are less than 1/20 inch long and their color varies depending on the species and life stage.
- Thrips hatch from eggs and develop through two feeding larval (nymphal) stages and two nonfeeding stages (prepupa and pupa) before developing into adults.
- Most pest thrips feed while hidden, often in buds and shoot tips or beneath sepals; you'll often observe the damage before seeing the thrips.
- Greenhouse thrips and western flower thrips are two common pest species in landscapes.
- Certain thrips are beneficial predators of some insects and mites.

Damage often isn't apparent until tissue grows and expands. Look for:

- Scabby, silvery to dark brown discoloration on fruit, leaves, or petals
- Dark specks of excrement on fruit or leaves
- Distorted, curled, galled, or dead shoot tips and leaves

Check for thrips before taking action.

- Be certain that pest thrips are present and causing damage before taking control action. Harsh weather, inadequate plant care, pathogens, and other invertebrates can cause similar-looking damage.
- Shake foliage or flowers over white paper to see if this dislodges any thrips.
- Hang blue or bright yellow sticky traps to detect flying thrips.

Thrips are difficult to control. Combine methods for best results.

- Find out what species you have and research the best approach; see *Pest Notes: Thrips*.
- Conserve parasites and predators by avoiding persistent pesticides.
- Avoid overwatering or applying nitrogen fertilizer, which can increase thrips populations.
- Prune off declining, injured, or infested plant parts.
- Use row covers or cages over small plants to exclude thrips and other flying insects.
- Cover soil with reflective mulch, which repels flying thrips, if foliage of growing plants covers less than about half of the soil surface.

What about pesticides?

- Pesticides won't restore the appearance of injured plant material. Plants remain damaged until injured tissue drops or is pruned off and new growth appears.
- Thrips are difficult to control with pesticides. Often pesticides won't be effective unless you wait until the next season and spray new plant growth.
- Horticultural oils, insecticidal soaps, and pyrethrins can provide temporary control, especially for greenhouse thrips. Spinosad may be more effective.
- Pesticides alone rarely provide good control, so combine spraying with other methods.

Whiteflies

Adult sweetpotato whitefly, *Bemisia tabaci.*

Photo by Jack Kelly Clark.

The parasite *Encarsia pergandiella* has emerged from the round hole in the whitefly nymph at the bottom. The T-shaped slit in the whitefly exuvia above indicates a healthy whitefly adult emerged.

Photo by Jack Kelly Clark.

Applying a sticky barrier on a tree wrap to exclude ants and other flightless insects.

Photo by Cheryl A. Reynolds.

Whiteflies

Whiteflies are tiny, sap-sucking insects that fly around plants when disturbed. Adults are white and may have darker markings on their wings, while nymphs (immature stage) are oval, legless, and don't move. Nymphs cause most of the damage. Several whitefly species occur in California. Natural enemies often keep them under control. Prevent whitefly problems using reflective mulches, reducing dusty conditions, choosing less susceptible plants, and avoiding pesticides that kill whitefly natural enemies. When management is required, consider using sticky traps, spraying insecticidal soaps or oils, or removing infested plants.

Signs of a whitefly infestation can include:

- Tiny nymphs on the underside of leaves.
- Sticky honeydew on leaves, fruit, or beneath plants, or a covering of black sooty mold.
- Yellowing, silvering, or drying leaves that have whitefly nymphs on them.
- Deposits of white wax with certain whiteflies.

Reduce whiteflies using traps or hand removal.

- Inspect new plants for whiteflies before bringing them into your garden.
- Prune out isolated infested leaves when you first detect them.
- Hose adults off plants with a strong stream of water.
- Hang store bought, sticky-coated yellow traps or make your own. Use one trap for every medium-size vegetable plant.
- Promptly destroy infested annuals when the flowering or fruiting ends.

Use reflective mulch to protect young plants.

- Use shiny metallic-coated construction paper or reflective plastic mulch products. These mulches repel whiteflies while plants are small.
- Lay the product on bare soil, bury its edges with soil, and insert seedlings or seeds into holes in the mulch.
- Plastic mulches require drip irrigation underneath them; paper mulches may be sprinkle or furrow irrigated.
- Remove mulches when plants get large and temperatures get hot.

Protect other insects that help reduce whitefly numbers.

- Many beneficials or “natural enemies” such as lacewings and lady beetles help control whiteflies.
- Look for signs of parasitization by mini-wasps, such as circular holes in nymphs or a change in color.
- Prevent dusty conditions since dust disrupts beneficials.
- Keep ants, which protect whiteflies from natural enemies, out of plants.
- Avoid using pesticides such as pyrethroids, organophosphates, carbaryl, or neonicotinoids.

What about pesticides?

- Choose products that are least harmful to natural enemies—such as insecticidal soaps and oils—and combine their use with the other practices listed above.
- Good coverage, including the underside of leaves, is essential. Repeat applications might be required.
- Avoid using pesticides if natural enemies are present.
- Even the most toxic insecticides are only partially effective against whiteflies.

Powdery Mildew

White patches of powdery mildew on euonymus leaf.

Photo by Jack Kelly Clark.

Foliage damaged by powdery mildew.

Photo by Jack Kelly Clark.

Powdery mildew, *Sphaerotheca pannosa,* on rose.

Photo by Jack Kelly Clark.

Powdery Mildew

White powdery growth on leaves and shoots can be a sign of powdery mildew. This disease affects many plants, and one of several fungi can cause it. Manage powdery mildew by growing resistant plant varieties and altering the growing environment. In some situations, fungicide treatments might be required for susceptible plant species.

Symptoms can vary by plant species.

- White powdery spots develop on both leaf surfaces and expand as the infection grows.
- Leaves turn yellow or brown and fall off, exposing the plant or fruit to sunburn.
- Leaves or shoots can twist or distort.
- The fruiting parts of vegetables are usually not affected, but apples, grapes, and stone fruits can develop web like russet scars or corky areas.

Powdery mildew is common in warm, dry conditions.

- Unlike many diseases, powdery mildew doesn't require moist conditions to grow.
- Moisture during the spring inhibits growth.
- Moderate temperatures (60° to 80°F) and shade encourage the disease.

Alter the growing environment to make plants less susceptible.

- Grow plants in sunny locations.
- Provide good air circulation by pruning excess foliage.
- Fertilize properly because too much nitrogen causes lush foliage and shade, providing conditions for fungal growth.

Plant resistant varieties.

Some plants have resistant or less susceptible varieties such as:

- Ornamentals: crape myrtle, rose, London plane tree, rhododendron, and zinnia.
- Fruit: apple, raspberry, and peach.
- Vegetables: melon, pumpkin, squash, cucumber, bean, and pea.

Consider nonchemical methods.

- Wash spores off infected plants with overhead sprinkling. To prevent other disease problems, do this midmorning so moisture dries rapidly.
- Prune out small infestations and remove infected buds during the dormant season. Quickly remove infected materials so you don't spread spores.

What about pesticides?

- Some infections may require fungicides.
- Control mild to moderate infections with horticultural oil or with plant-based oils, such as neem oil. Do not use oils if you have applied sulfur or the temperature is above 90°F.
- Prevent infections with sulfur products, especially ready-to-use products with soap like surfactants. These products are not effective after the disease appears. Repeat applications might be necessary as new leaves grow.
- Other fungicides are available. Many must be applied before you see the first sign of disease.

Rusts—Various fungi

Dry, orangish spore masses on the underside, and discolored spots on the upper side, of rose leaves infected by rose rust, *Phragmidium mucronatum.*

Photo by Jack Kelly Clark.

Orange sporophores, or telial cushions (fungal fruiting bodies), of incense cedar rust, *Gymnosporangium libocedri,* on the underside of incense cedar leaflets.

Photo by R. F. Scharpf, USDA Forest Service, Bugwood.org.

Round swellings on pine terminals infected by western gall rust, *Endocronartium (=Peridermium) harknessii.*

Photo by Arthur H. McCain.

Rusts—Various fungi

These fungi are named for the dry to gelatinous, orange, reddish, or yellowish fruiting bodies and spore masses that many species form on infected tissue. Rusts infect many hosts, including birch, cedar, cottonwood, cypress, fuchsia, hawthorn, juniper, pear, pine, poplar, rhododendron, and rose.

Identification

Rust fungi and their damage usually occur on fruit, green stems, and leaves of broadleaf plants or on the bark or needles of conifers. The host species and characteristics of the damage and fungal fruiting bodies and spores are used to identify rusts. Many species of rust have four or five types of fungal spores that differ in appearance and the time of year when they are present.

Chrysanthemum rusts and rose rust cause discolored spots on leaves, which may drop prematurely. Gymnosporangium rusts on cedar, cypress, and juniper cause bunchy shoot growth (witches' brooms) and colorful raised growths or spots on foliage. On their alternate hosts in the rose family, Gymnosporangium rusts primarily cause leaf spots, but on pear sporadically damage fruit.

Pine rusts may discolor only the leaves or needles, cause symptoms mostly on bark, or affect both bark and foliage depending on the species of host plant and rust fungus. Western gall rust and white pine blister rust cause cankers, galls, ooze, and roughening on bark. Foliage outward or upward from infected bark can become yellowish, then brown or reddish and drop prematurely.

Life cycle

Rusts infect hosts when plant surfaces are wet and temperatures are mild, mostly during the fall to spring or almost any time of the year in coastal locations. Rust fungi are spread primarily by windblown spores and when infected plants (e.g., from a nursery) are moved. Each species of rust is specific to certain hosts.

Most species of rust fungi have several different-looking life stages and complex life cycles, alternating generations between two hosts in different plant families. Others, such as rose rust, *Phragmidium mucronatum,* and western gall rust are restricted to one host genus and spread, respectively, from rose to rose or pine to pine.

Damage

Infected foliage on broadleaf hosts may become spotted, turn yellow or brown overall, and drop prematurely. Infected conifers may develop bushy growth (e.g., witches' brooms), cankered, galled, and oozing bark and limbs, and spotted needles.

Many rusts have minimal affect on plant health, but certain rusts can kill their hosts. The importance of rust damage varies greatly, such as depending on local environmental conditions and the abundance and nearness of other hosts that are sources of infectious spores.

Solutions

Avoid overhead watering. Collect fallen, infected leaves and needles and dispose of them away from host plants. Cut off and dispose of diseased shoots and branches as soon as they appear, except do not prune woody parts so extensively that plants are seriously damaged. Removing nearby alternate hosts of the fungus may help to reduce new infections in certain situations.

Plant rust-resistant cultivars if available, such as roses in coastal locations where rose rust is a chronic problem. Fungicides applied in the spring can prevent or reduce some rust diseases. The frequent applications required to provide good control of rust may not be warranted in many landscape situations.

GOOD GUYS THE NATURAL ENEMIES

Lady beetles, or "ladybugs

Lady beetles, or "ladybugs," are round- or half-dome-shaped insects with hard wing covers. About 200 species occur in California and most are predators both as adults and larvae. Some species specialize on aphids or other groups; others have a broader diet.

Convergent Lady Beetle, *Hippodamia convergens*

Eggs of convergent lady beetle, *Hippodamia convergens.*

Larva of convergent lady beetle.
Photo by Jack Kelly Clark.

Pupa of convergent lady beetle, *Hippodamia convergens.*
Photo by Jack Kelly Clark.

Adult convergent lady beetle, *Hippodamia convergens.*
Photo by Jack Kelly Clark.

Other Lady beetles

Three color forms of adult multicolored Asian lady beetles, *Harmonia axyridis.*
Photo by Jack Kelly Clark.

Adult ashy gray lady beetle, *Olla v-nigrum.*
Photo by Jack Kelly Clark.

Vedalia beetles in foreground, cottony cushion scale in background.
Photo by Jack Kelly Clark.

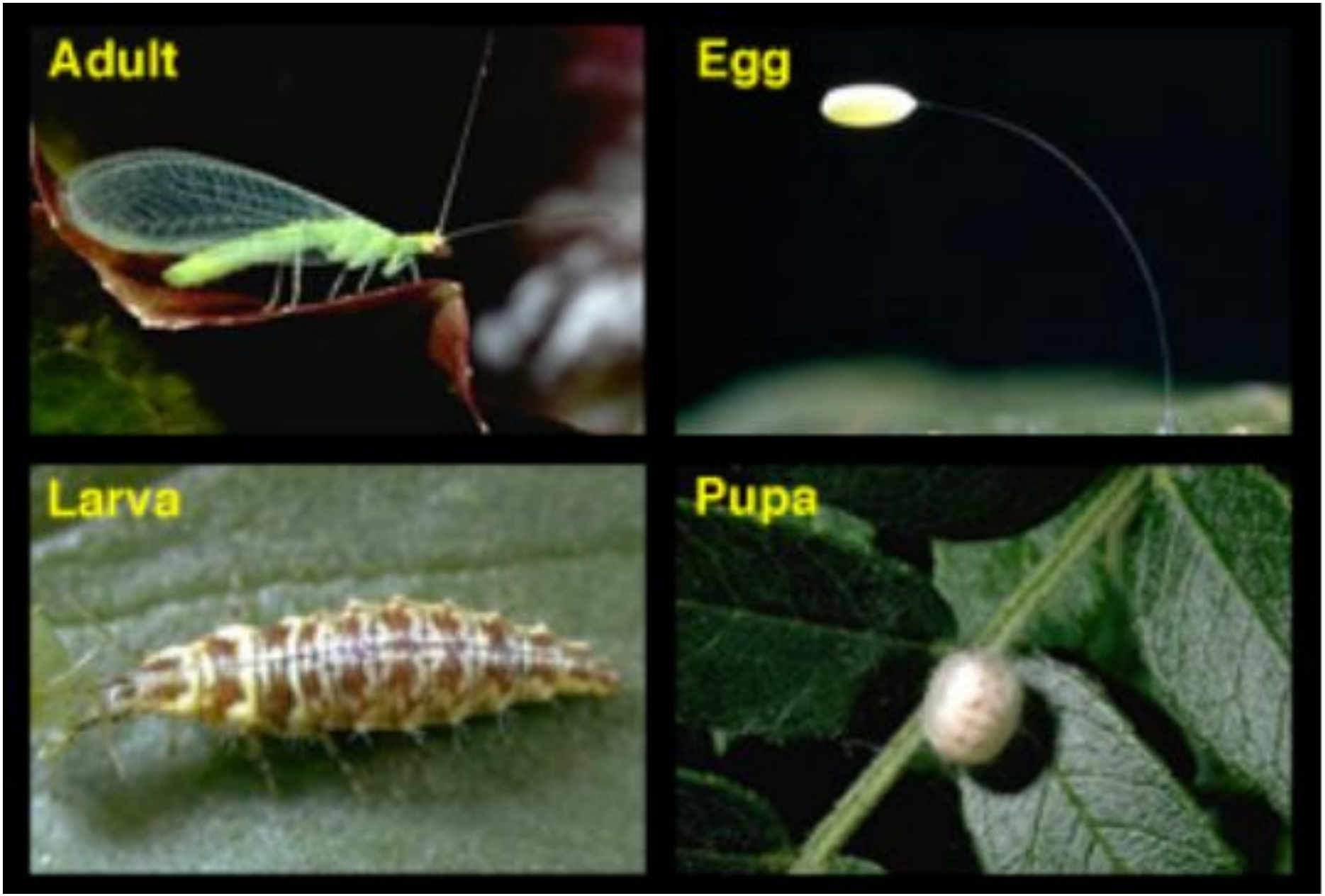
Adult California lady beetle.
Photo by Jack Kelly Clark.

Adult (bottom left) and larva (center) of the black lady beetle, *Rhyzobius forestieri,* and the adult (bottom center) and larva (bottom right) of *Chilocorus bipustulatus* with European fruit lecanium, *Parthenolecanium corni,* scales on which they feed.
Photo by Jack Kelly Clark.

Adult and pupa of a lady beetle, *Axion plagiatum*.
Photo by Jack Kelly Clark.

Adult twospotted lady beetle.
Photo by Jack Kelly Clark.

Green Lacewings



Predaceous ground beetle

Adult predaceous ground beetle, *Tanystoma (=Agonum) maculicolle.*Photo by Jack Kelly Clark

Adult predaceous ground beetle, *Calosoma* sp.Photo by Jack Kelly Clark.

Predatory ground beetle larva.Photo by Jack Kelly Clark

Larva of a predatory ground beetle (Carabidae, lower right) and larvae of a masked chafer, *Cyclocephala* sp.Photo by Jack Kelly Clark.

Assassin Bugs

Adult spined assassin bug, *Sinea diadema.*Photo by Jack Kelly Clark.

Eggs of the leafhopper assassin bug, *Zelus renardii.*Photo by Jack Kelly Clark.

Assassin bug, *Zelus* sp., nymph.Photo by Jack Kelly Clark.

Pirate Bugs

Adult minute pirate bug, *Orius tristicolor*, feeding on an aphid. Credit: Jack Kelly Clark,

Eggs of pirate bugs, *Anthocoris* sp., are inserted into leaf tissue. Only their white caps protrude. The yellow egg in this photo is a psyllid egg.Photo by Jack Kelly Clark.

Nymph of minute pirate bug, *Orius tristicolor.*Photo by Jack Kelly Clark.

Predaceous adult of a soldier beetle (Cantharidae). Credit: Jack Kelly Clark

Soil-dwelling larva of a leatherwing, or soldier beetle (Cantharidae).Photo by Jack Kelly Clark.

Soldier Beetles

Spiders

spiders are mostly beneficial because they feed on pest insects. However, many people think that all spiders are dangerous and aggressive. In California, the main spider capable of causing serious injury is the black widow, which generally remains outdoors and out of sight. Spiders seen out in the open during the day are unlikely to bite people. Focus pest management efforts on removing webs and hiding places. Pesticides are not generally recommended.

What to know about spiders:

- The jaws of most spiders are too small to bite humans.
- Adult female black widows are the main spiders capable of seriously injuring people in California. They are shiny black with a red hourglass marking on the underside and are commonly found outdoors, in sheltered, dry, undisturbed areas such as wood piles and garages.
- Anyone bitten by a black widow spider should remain calm and seek medical advice.
- The brown recluse spider and the hobo spider do not live in California.
- Some other spiders bite when trapped in clothing or bedding, but the effect is usually no more severe than itching or the reaction to a bee sting.

To prevent spiders from entering your house, take these steps:

- Seal home foundation cracks and other access holes.
- Inspect window and door screens for good seals to keep out spiders and the insects they prey on.
- Keep areas around home foundations free of clutter.

Manage spiders using these tips:

- Indoors, regular housecleaning provides adequate spider control.
- Vacuum up the spider and its web.
- Alternatively, squash spiders or capture them in a jar and release them outside.
- Prevent clutter buildup that can provide spider hiding places both indoors and out.
- Remove spider webs from the exterior of the house with a broom or high pressure hose.

Spiders and biological control:

When removing spiders, don’t overlook the fact that spiders eat a large number and variety of nuisance and pest insects. Spiders also have natural enemies—wasps, other spiders, birds, reptiles, and others—that sometimes keep them from becoming too numerous.

Syrphid Flies

Adult syrphid fly.Photo by Jack Kelly Clark.

Egg of syrphid fly (hover fly).Photo by Jack Kelly Clark.

Predaceous syrphid fly larva preying on aphids.Photo by Jack Kelly Clark.

Flower fly or syrphid (Syrphidae) larva preying on a spirea aphid, *Aphis spiraecola*.Photo by Jack Kelly Clark.

Pupa of syrphid fly (hover fly).Photo by Jack Kelly Clark.

Sixspotted Thrips

Adult sixspotted thrips, *Scolothrips sexmaculatus*, feeding on a spider mite. Credit: Jack Kelly Clark

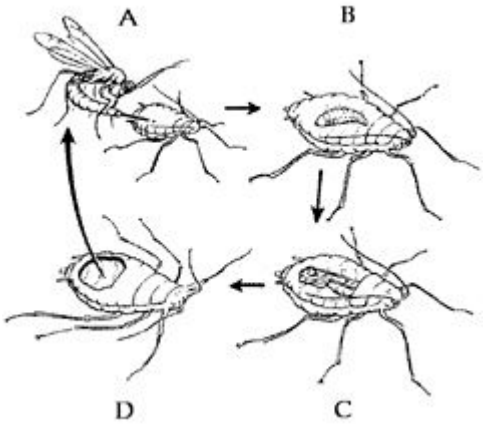
Adult sixspotted thrips, *Scolothrips sexmaculatus,* and egg and larva of mites on which it feeds.Photo by Jack Kelly Clark.

Nymph of sixspotted thrips, *Scolothrips sexmaculatus,* feeding on a spider mite.Photo by Jack Kelly Clark.

Adult sixspotted thrips, *Scolothrips sexmaculatus,* (left) and fourth instar nymph ("pupa").Photo by Jack Kelly Clark.

Predatory (parasitic) wasps

A parasitic wasp, *Trioxys pallidus*, parasitizing a walnut aphid



A. An adult parasite lays an egg inside a live aphid. **B**. The egg hatches into a parasite larva that grows as it feeds on the aphid's insides. **C.** After killing the aphid, the parasite pupates. **D.** An adult wasp emerges from the dead aphid, then flies off to find and parasitize other aphids.

Photo by Jack Kelly Clark.

Mummified aphids are the result of being parasitized by a parasitic wasp. The holes in the mummies show where the fully-grown wasp emerged. Mummies may be bronze or black depending on parasite species.

Portions of this presentation have been created using information from three existing slide presentations used in the Advanced UC Master Gardener Training session held in Santa Rosa, Ca. July 2019.

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