BARK BEETLES

Integrated Pest Management for Home Gardeners and Landscape Professionals

Bark beetles, family Scolytidae, are common pests of conifers (such as pines) and some attack broadleaf trees. Over 600 species occur in the United States and Canada with approximately 200 in California alone. The most common species infesting pines in urban landscapes and at the wildland-urban interface in California are the engraver beetles, the red turpentine beetle, and the western pine beetle (See Table 1 for scientific names). In high elevation landscapes, such as the Tahoe Basin area or the San Bernardino Mountains, the Jeffrey pine beetle and mountain pine beetle are also frequent pests of pines. Two recently invasive species, the Mediterranean pine engraver and the redhaired pine bark beetle, colonize various Mediterranean pines, which are widely planted in and around the Los Angeles Basin and the Central Valley.

Cedar and cypress bark beetles attack arborvitae, cypress, false cypress, junipers, and redwoods. The fir engraver attacks white and red fir at high elevation locations. Oak bark and ambrosia beetles attack oaks and certain other broadleaf trees including California buckeye and tanbark oak. A long-time (naturalized) invasive bark beetle called the shothole borer attacks damaged branches and trunks of many broadleaved tree species, including fruit trees and English laurel. Two other invasive species, the European elm bark beetle and the banded elm bark beetle feed on elms and vector Dutch elm disease fungus (*Ophiostoma novo-ulmi*). In its native habitat in Asia, the banded elm bark beetle reportedly also feeds on certain non-elm tree species.

California now has 20 invasive species of bark beetles, of which 10 species have been discovered since 2002. The biology of these new invaders is poorly understood. For more information on these new species, including illustrations to help you identify them, see the USDA Forest Service pamphlet, *Invasive Bark Beetles*, in References.

Other common wood-boring pests in landscape trees and shrubs include clearwing moths, roundheaded borers, and flatheaded borers. Certain wood borers survive the milling process and may emerge from wood in structures or furniture including some roundheaded and flatheaded borers and woodwasps. Others colonize wood after it has been placed in structures, such as carpenter ants, carpenter bees, powderpost beetles, and termites. For more information on these other borers, see the *Pest Notes* listed in References.

IDENTIFICATION

Bark beetle adults are small, cylindrical, hard-bodied insects about the size of a grain of rice. Most species are dark red, brown, or black. When viewed under magnification, their antennae are visibly elbowed with the outer segments enlarged and clublike (Fig. 1). When viewed from above, the head is partly or completely hidden by the pronotum (the top of the body part behind the head). Bark beetles have strong mandibles (jaws) for chewing. A buckshot pattern of holes is apparent on the bark surface of infested branches or trunks where the new adults have emerged. Larvae of most species are off-white, robust, grublike, and may have a dark brown head.

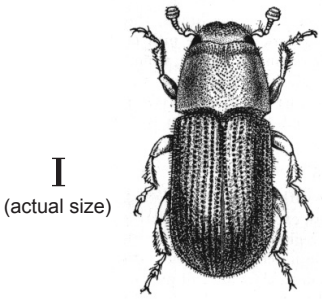

Figure 1. Adult western pine beetle.

Identifying Bark Beetles by their Damage and Signs. The species of tree attacked and the location of damage on the tree help in identifying the bark beetle species present (Table 1). On large pines, for example, engraver beetles usually attack trees near the top, whereas red turpentine beetles attack the lower portion of the trunk. They can even colonize near the root collar and exposed roots and continue to mine under the bark below ground on the large roots. Engraver beetles are dark brown, cylindrical, and have a scoop-like depression at the end of the abdomen that is lined with stout spines. Their presence is indicated by piles of dry boring dust pushed out on the bark surface. Red turpentine beetles are larger than engraver beetles, reddish brown, and have a rounded tip to the abdomen (Fig. 1). Their presence is indicated by large, pinkish brown to white pitch tubes (a mixture of pine sap and beetle boring dust that appears on the lower trunk, Fig. 2).

Identifying Bark Beetles by their Galleries. Peeling off a portion of infested bark to reveal the winding pattern of the beetle galleries (tunnels chewed by adults and larvae) is a good way to

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Table 1. Bark Beetles Common in California Landscapes

Species	Trees affected	Generations per year	Comments
Cedar and cypress bark beetles (*Phloeosinus* species)	arborvitae, cypress, false cypress (*Chamaecyparis),* junipers, and redwood	1 to 2	tunnels resemble centipede (Fig. 2) on wood surface and the inner bark; adult feeds on and kills twigs; egg-laying female attracted to trunk of dead or dying trees
Elm bark beetles (*Scolytus multistriatus*, *Scolytus schevyrewi*[1])	elms	2	overwinter as fully grown larvae in bark; shot holes in bark indicate damage; lay eggs in limbs and trunk of injured, weakened, or recently cut elms; spread Dutch elm disease fungi
Engraver beetles (*Ips emarginatus, Ips mexicanus, Ips paraconfusus, Ips pini, Ips plastographus*)	pine	1 to 5	overwinter as adults; often make wishbone-shaped tunnels; attack pines near the top of the stem
Fir engraver (*Scolytus ventralis*)	white and red fir	1 to 2	overwinter as larvae; adults excavate deep and long, two-armed galleries across the grain of the sapwood
Jeffrey pine beetle (*Dendroctonus jeffreyi*)	Jeffrey pine	1 to 2	attack midtrunk of large trees, from 5 to about 30 ft; make long J-shaped galleries, overwinter as larvae in the inner bark
Mediterranean pine engraver (*Orthotomicus* [formerly *Ips*] *erosus*)[1]	pine	3 to 4	infest trunk and large limbs of Mediterranean pines, especially Aleppo pine (*Pinus halepensis*) and Italian stone pine (*Pinus pinea*)
Mountain pine beetle (*Dendroctonus ponderosae*)	pine, frequently on lodgepole and sugar pine	1 to 2	attack midtrunk of large trees, from 5 to about 30 ft; makes long J-shaped galleries, overwinter as larvae in the inner bark
Oak ambrosia beetles (*Monarthrum* species); Oak bark beetles (*Pseudopityophthorus* species)	buckeye, oaks, and tanbark oak	2 or more	overwinter beneath bark; bleeding, frothy, bubbling holes with boring dust indicate damage; attack stressed trees
Redhaired pine bark beetle (*Hylurgus ligniperda*)[1]	pine	2 to 3	believed to prefer roots and lower trunk of declining Aleppo pine and Canary Island pine (*Pinus canariensis*)
Red turpentine beetle (*Dendroctonus valens*)	pines, rarely in larch, spruce, or white fir	0.5 to 2	attack lowest 2 to 8 ft. of trunk and the large roots; pitch tubes appear on bark; overwinter as adults and larvae; rarely kill trees
Shothole borer (*Scolytus rugulosus*)	English laurel, fruit trees, hawthorn, and other woody plants	2 or more	infestation indicated by gumming of woody parts, appearance of boring dust, or twig dieback; remove and destroy infested parts
Twig beetles (*Pityophthorus carmeli*, *Pityophthorus juglandis*, *Pityophthorus nitidulus*, *Pityophthorus setosus*)	pine, walnut	2 or more	attack lateral shoots and twigs, can mine the pith; pine species are associated with pitch canker disease transmission; on walnut *Pityophthorus juglandis* is associated with thousand cankers disease transmission
Western pine beetle (*Dendroctonus brevicomis*)	Coulter and ponderosa pines	2 to 4	attack midtrunk, then spreads up and down; larvae feed on inner bark, complete development in outer bark; attack in conjunction with other pests

[1] Recently introduced species whose biology and potential impact in California is poorly understood.

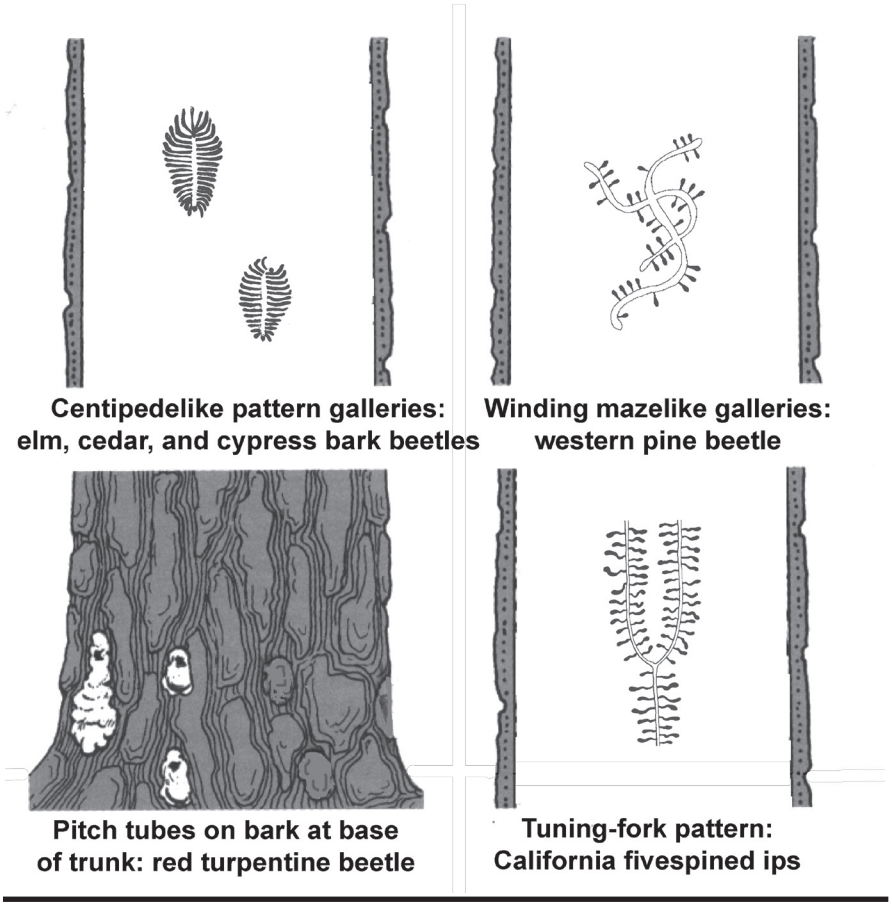

Figure 2. Signs of bark beetle activity include pitch tubes on the bark surface (lower left), egg galleries (tunnels), and larval mines beneath the bark. Galleries filled with boring dust (frass) are shown in black, whereas open portions of galleries are white.

identify individual beetle species. Red turpentine beetle and western pine beetle adults usually pack about 60% of their egg-laying galleries with a sawdustlike boring dust called "frass," whereas engraver beetles maintain clean, open adult galleries. Red turpentine beetle adults mine out wide cavelike galleries that progress down along the stem. Their larvae feed as a group in generally the same direction as the gallery. Western pine beetle adults tunnel back and forth across the stem in a gallery pattern that looks like a piece of spaghetti (Fig. 2). Their larvae feed individually in mines that lead away from the adult gallery. Engraver beetle adults make shorter, compact gallery patterns that are made up of 3 to 4 egg galleries emerging from an open cell in the center (Fig. 2). The larvae feed individually in mines much like the western pine beetle. Galleries chewed by larvae of all species are packed with frass (Fig. 2).

LIFE CYCLE

Bark beetle females lay small, oval, whitish eggs just beneath the outer bark (Fig. 3). After the eggs hatch, the tiny larvae mine galleries that branch out from the egg-laying gallery. At first the larval mines are very narrow, but they gradually increase in diameter as the larvae grow. Pupation occurs within or beneath the bark in enlarged chambers at the ends of the larval tunnels. Pupae are usually plump and whitish. Adults can emerge at any time of year, if they are fully developed and the temperatures are high, but emergence is most common in late spring and again in late summer to early fall. After emergence, adults may re-infest the same tree or, in most cases, disperse to attack susceptible trees elsewhere (Fig. 3). Most bark beetle species have two or more generations a year in California, depending on temperature. At warmer locations (such as lower elevations away from the coast), the season of attack is usually longer and beetles have more generations per year in comparison with cooler coastal or high-elevation locations.

DAMAGE AND SIGNS

Bark beetles mine the inner bark (the phloem-cambial region) on twigs, branches, or trunks of trees and shrubs. This activity often starts a flow of tree sap in conifers, but sometimes even in hardwoods like elm and walnut. The sap flow (pitch tube) is accompanied by the sawdustlike frass created by the beetles. Frass accumulates in bark crevices or may drop and be visible on the ground or in spider webs. Small emergence holes in the bark are a good indication that bark beetles were present. Removal of the bark with the emergence holes often reveals dead and degraded inner bark and sometimes new adult beetles that have not yet emerged. Bark beetles frequently attack trees weakened by drought, disease, injuries, or other factors that may stress the tree. Bark beetles can contribute to the decline and eventual death of trees, however only a few aggressive species are known to be the sole cause of tree mortality.

In addition to attacking larger limbs, some species such as cedar and cypress bark beetles feed by mining twigs up to 6 inches back from the end of the branch, resulting in dead tips. These discolored shoots hanging on the tree are often referred to as "flagging" or "flags." Adult elm bark beetles feed on the inner bark of twigs before laying eggs. If an adult has emerged from cut logs or a portion of a tree that is infected by Dutch elm disease, the beetle's body will be contaminated with fungal spores. When the adult beetle feeds on twigs, the beetle infects healthy elms with the fungi that cause Dutch elm disease.

Elms showing yellowing or wilting branches in spring may be infected with Dutch elm disease and should be reported to the county agricultural commissioner.

MANAGEMENT

Except for general cultural practices that improve tree vigor, little can be done to control most bark beetles once trees have been attacked. Because the beetles live in the protected habitat beneath the bark, it is difficult to control them with insecticides. If trees or shrubs are infested, prune and dispose of bark beetle-infested limbs. If the main trunk is extensively attacked by bark beetles, the entire tree or shrub should be removed. Unless infested trees are cut and infested materials are quickly removed, burned, or chipped on site, large numbers of beetles can emerge and kill nearby host trees, especially if live, unattacked trees nearby are weakened or stressed by other factors. Never pile infested material adjacent to a live tree or shrub.

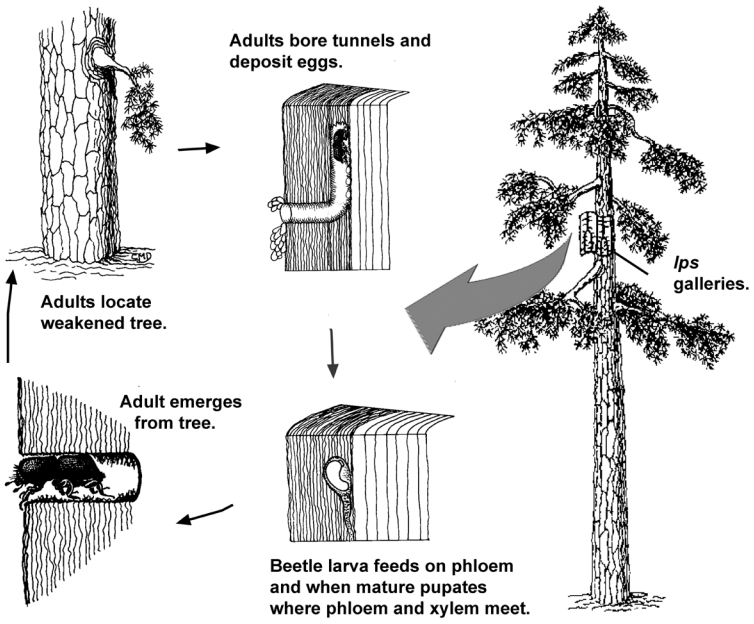

Figure 3. Life cycle of the California fivespined ips, an engraver beetle.

Cultural Control

Tree Selection. Plant only species properly adapted to the area. Learn the cultural requirements of trees, and provide proper care to keep them growing vigorously. Healthy trees are less likely to be attacked and are better able to survive attacks from a few bark beetles. Where bark beetles have been a problem, plant nonhost trees. For instance, engraver beetles and red turpentine beetles do not attack redwoods or atlas cedars. A mixture of tree and shrub species in planted landscapes will reduce mortality resulting from bark beetles and wood borers.

Reduce Tree Stress. Pay particular attention to old, slow-growing trees, crowded groups of trees, and newly planted trees in the landscape. Large nursery stock or transplanted trees, notably oaks and pines, can become highly susceptible to bark beetles or wood borers after replanting. Transplanting success depends on the tree species and its condition, appropriate tree and site selection, characteristics of the planting site, the season of the year, the transplanting method, and follow-up care. Stresses placed on a tree caused by poor planting or planting at the wrong time of year, lack of proper care afterwards, or the planting of an inappropriate species for the site will increase a tree's susceptibility to bark beetles or wood borers.

Prevention is the most effective method of managing bark beetles and related wood-boring insects; in most instances it is the only available control. Avoid injuries to roots and trunks, damage and soil compaction during construction activities, and protect trees from sunburn (sunscald) and other abiotic disorders. Irrigation may be important during dry summer months in drought years, especially with tree species that are native to regions where summer rain is common. Also, dense stands of susceptible trees should be thinned (complete removal of some of the trees) to increase the remaining trees' vigor and ability to withstand an attack.

Irrigate when appropriate around the outer canopy, not near the trunk. Avoid the frequent, shallow type of watering that is often used for lawns. A general recommendation is to irrigate trees infrequently, such as twice a month during drought periods. However, a sufficient amount of water must be used so that the water penetrates deeply into the soil (about 1 foot below the surface). The specific amount and frequency of water needed varies greatly depending on the site, size of the tree, and whether the tree species is adapted to summer drought or regular rainfall.

Properly prune infested limbs, and remove and dispose of dying trees so that bark- and wood-boring insects do not emerge and attack other nearby trees. Timing of pruning is important; avoid creating fresh pruning wounds during the adult beetles' flight season. Do not prune elm trees from March to September or pines during February to mid-October. Do not pile unseasoned, freshly cut wood near woody landscape plants. Freshly cut wood and trees that are dying or have recently died provide an abundant breeding source for some wood-boring

beetles. Tightly seal firewood beneath thick (10 mil), clear plastic sheets in a sunny location for several months to exclude attacking beetles, and kill any beetles already infesting the wood. To be effective, solar/plastic treatment requires vigilance and careful execution. It is important to keep wood piles small, use high-quality clear plastic resistant to UV (ultraviolet light) degradation, and thoroughly seal edges and promptly patch holes to prevent beetles from escaping. For more information on cultural controls, see the publications by Donaldson and Seybold 1998 and Sanborn 1996 in References.

Biological Control

When bark beetles attack trees, natural enemies are attracted to feeding and mating bark beetles (Fig. 4). The two main groups of natural enemies are predators and parasites. Predators are more important in regulating bark beetle populations than parasites. Natural enemies are unlikely to save an infested tree, but they can reduce bark beetle population size, thereby reducing the number of nearby trees that are attacked and killed by bark beetles. The release of predators and/or parasites into sites infested with bark beetles has not been an effective tactic to suppress bark beetle populations.

The following natural enemies attack the western pine beetle, but rarely control it: woodpeckers, several predaceous beetles such as the blackbellied clerid (*Enoclerus lecontei*) and a trogossitid beetle (*Temnochila chlorodia*), a predaceous fly (*Medetera aldrichii*), snakeflies, and parasitic wasps.

Behavioral Control

Bark beetles locate mates and attract or repel other individuals of the same species by emitting species-specific airborne chemicals called pheromones. Pheromones are naturally occurring chemicals that are widely used as baits to monitor bark beetles by attracting them to traps. These baits are especially important for detecting invasive species. Professional foresters have sometimes controlled or suppressed small local populations of bark beetles by using attractant pheromones in traps, and repellent pheromones and other behavioral chemicals to deter beetles from valuable trees. Some behavioral chemicals are being used experimentally on an area-wide basis to protect stands of forest trees. The interactions among host trees and beetles and their pheromones are complex and often poorly understood. Researchers are refining the reliability of pheromone-based management techniques. Behavioral chemicals are currently recommended for use only by specially trained professionals familiar with bark beetle management. Landscape professionals and home gardeners should consult with local California Cooperative Extension specialists if they are interested in this management option.

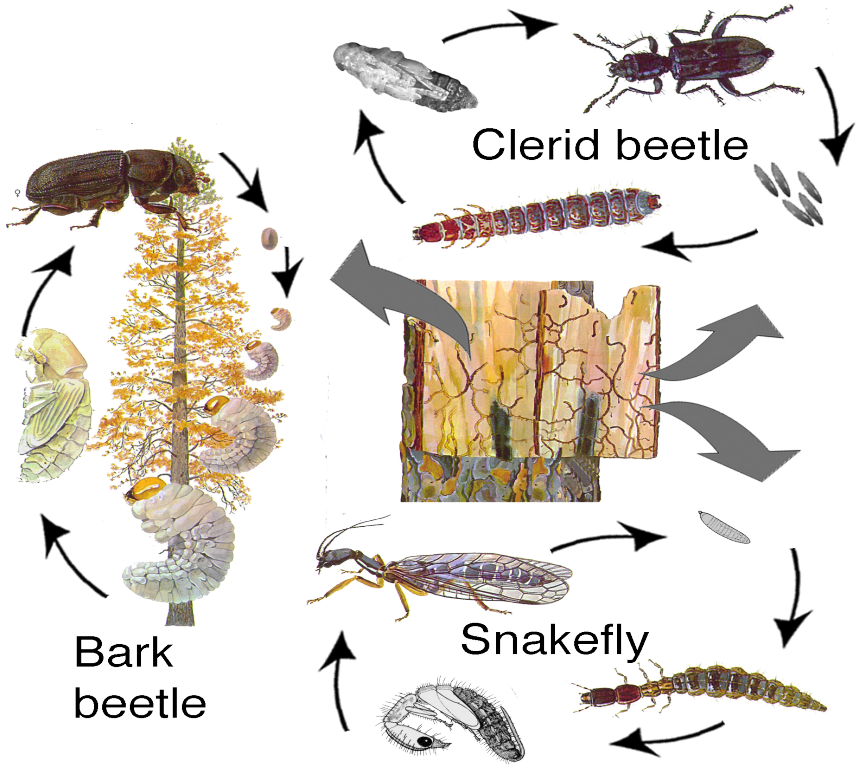

Figure 4. Bark beetles and declining trees produce airborne chemicals that attract adult predators and parasites. Peeling back bark on an infested tree often reveals the immature stages (eggs, larvae, and pupae) of both bark beetles (shown above left) and their natural enemies. Predators include various beetles, such as the often abundant *Enoclerus* species (family Cleridae, immature stages and adult top right) that feed mostly on bark beetles and less common groups, such as snakeflies (family Raphidiidae, bottom right) that prey on a variety of insects. Natural enemies are unlikely to save an infested tree, but they can reduce bark beetle populations.

Chemical Control

Unless trees are monitored regularly so that bark beetle attack can be detected early, any chemical spray application made once the beetles have aggregated and penetrated the bark is likely to be too late and ineffective. Treatment must target the adults by spraying the bark so that beetles are killed when they land on trees and attempt to bore into the bark to lay eggs. Chemically treating trees that have been previously attacked will provide no benefit and could kill beneficial insects. Seriously infested trees, or trees that are dead or dying due to previous beetle attacks, cannot be saved with

insecticide treatments and should be removed. Systemic insecticides, meaning those that are implanted or injected through the bark or applied to soil beneath trees, have not been shown to prevent attack or control populations of bark beetles. Although new systemic products are being investigated, they are not currently recommended for bark beetle control.

Circumstances for Effective Use of Insecticides. Highly valued, uninfested host trees may be protected by spraying their bark with a persistent, registered insecticide labeled as a preventive spray for bark beetles. Look for signs of recent infestation to help decide whether preventive spraying of nearby, lightly attacked or unattacked trees may be justified. Spraying a persistent insecticide on valuable, uninfested host trees near infested trees may be warranted to protect uninfested host trees from bark beetles. However, do not substitute preventive sprays for proper cultural care. The infestation status of a tree can be determined by inspecting the trunk or limbs for fresh pitch tubes or frass; peeling a small portion of the outer bark from the trunk or limbs and looking for signs of adult beetles or larvae; and inspecting the foliage for yellow or yellow-green needles or leaves. Frequently the infestation is diagnosed after the beetles have vacated the tree. For example, when reddish brown foliage is observed the tree is dead and the new generation of bark beetles has already emerged from the tree. Fading foliage throughout the tree crown indicates a dead tree and no insecticide treatment will be effective. Because each bark beetle species attacks only certain tree species, spray only healthy trees that are susceptible to the beetle species attacking nearby trees (for example, pine bark beetles do not attack oaks and oak bark beetles do not attack pines) (Table 1). Insecticide sprays are not recommended against shothole borer and cedar or cypress bark beetles.

How to Apply Insecticides. Insecticide products available to home users are not effective for bark beetle control. Most home gardeners also lack the high-pressure spray equipment and experience to effectively treat large trees. Protective spraying for bark beetles must be done by a licensed pesticide applicator. When hiring a professional applicator, discuss the specific pesticide to be used and effective timing of the application. Also see *Pest Notes: Hiring a Pest Control Company* in References. The applicator must use a product with bark beetles listed on the label, and mix and apply the formulation following label directions. Proper application involves thoroughly drenching the main trunk, exposed root collar near the base of the tree, and larger branches (for engraver beetles) with a pyrethroid, such as Astro or Dragnet, or any of the flowable (EC) formulations of the chemical carbaryl to prevent new bark beetle infestations. (Note: These products are not available to home users.) The material must be applied before the new adults penetrate the bark surface of the tree. Regardless of the insecticide used, the applicator should mix only what is needed and dispose of any excess insecticide by properly following label directions.

When to Apply Insecticides. Preventive treatments must be applied to the tree trunk or branches to kill adults before they penetrate the bark and lay eggs. Treatment following successful attacks and egg laying will not be effective. In most cases, the time to apply is in late winter to early spring in warm areas of the state and late spring in cooler and higher elevation areas. For most insecticide treatments associated with bark beetles listed on the insecticide label, generally only one application per year is necessary to provide season-long control. However, depending on local conditions, the life cycle of the beetle, and the insecticide used, in a few situations a second application may be needed several months later to protect individual trees. For example, in California a single spray applied for red turpentine beetle and engraver beetles around mid-February, before adults arrive on new trees, should provide enough control for the home gardener or arborist to implement cultural practices to improve the vigor and defense of pines. However, if strong spring rains or regular irrigation sprinkling of the stem remove the insecticidal barrier, a second application may be necessary.

Red Turpentine Beetle. This beetle is very common on Monterey pines planted in urban landscapes and highway corridors within about 100 miles of the California coast. It is also prevalent on most pines that grow in the Sierra Nevada, particularly on pines damaged by wildfire. Otherwise healthy pines often survive attacks by a few individuals of the red turpentine beetle. Prominent pitch tubes on the lower trunk of standing trees or stumps of recently cut trees nearly always indicate the beetle's presence. A red turpentine beetle attack likely indicates that pines are stressed from an unfavorable growing environment, injuries, inappropriate cultural care, or that pines are declining from old age. Ensure that planted trees receive proper care and a good growing environment to enhance tree survival.

Western Pine Beetle. This native species attacks the trunk of ponderosa and Coulter pines and creates long winding galleries in the phloem. The trunk quickly becomes covered with small pitch tubes as the beetles can be attracted in large numbers (aggregate) in only a few days. Drought-stressed trees are highly susceptible to attacks by these bark beetles. Heavily attacked trees invariably die and should be removed as soon as attacks are observed. Unattacked trees that are particularly vulnerable, such as during drought or those adjacent to attacked trees, can be protected by watering, if possible, and by applying an insecticide to the outer bark surface ***before*** beetles have attacked the tree.

Elm Bark Beetles. Elm bark beetles are pests because they feed in the phloem of elms and spread the fungus that causes Dutch elm disease. The fungus kills the vascular system of elms, causing foliage to turn yellow and brown and then die. Be sure to distinguish diseased trees from those damaged by leaf-chewing caused by elm leaf bee-

tles (*Xanthogaleruca luteola*). Chewed leaves turn brown, which, when viewed from a distance, resemble discolored leaves caused by Dutch elm disease. If planting elms, choose from among the many new elm cultivars that are resistant to both disease and leaf beetles, as discussed in *Pest Notes: Elm Leaf Beetle* in References.

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For more information contact the University of California Cooperative Extension in your county. See your telephone directory for addresses and phone numbers.

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To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned.

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WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Pesticides applied in your home and landscape can move and contaminate creeks, rivers, and oceans. Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

Do not place containers containing pesticide in the trash or pour pesticides down sink or toilet. Either use the pesticide according to the label or take unwanted pesticides to a Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Household Hazardous Waste Collection site nearest you. Dispose of empty containers by following label directions. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.