Pest Notes, Publication 7467
Revised December 2019

UC IPM

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Cockroaches

Integrated Pest Management In and Around Buildings

Cockroaches, or "roaches" (Figure 1), are among the most important household pests. Indoor cockroaches are known as significant public health pests, and outdoor species that find their way inside are considered serious nuisance pests as well as potential pests of public health. Cockroaches range in size from less than ½ inch long to almost 2 inches long and are mostly nocturnal insects that feed on a wide range of organic matter. Most cockroaches harbor within moist, dark crevices when not foraging for food. They crawl quickly and may climb rough surfaces. A few species can fly short distances or glide as adults during warm nights, but most have no wings, reduced wings, or otherwise do not fly.

Figure 1. Various life stages in a German cockroach colony.

There are five species of cockroaches in California that are commonly regarded as pests: German cockroach, brownbanded cockroach, oriental cockroach, American cockroach, and Turkestan cockroach.

People are repulsed when they find cockroaches in their homes and other buildings. Indoor infestations of cockroaches are also important sources of allergens and have been identified as risk factors for development of asthma in children, especially within multiunit housing environments. The levels of allergens present have been directly correlated to both cockroach density and the conditions that contribute to heavy infestations, such as housing disrepair and poor sanitary conditions.

Of all the cockroach species in California, the German cockroach is the most persistent and troublesome; it lives and breeds in indoor locations associated with food preparation and may pose health concerns due to contamination of food and production of indoor allergens. German cockroaches may become pests in homes, schools, restaurants, hospitals, warehouses, apartments, and in virtually any structure that has food preparation or storage areas. They contaminate food and eating utensils, destroy fabric and paper products, and impart stains and unpleasant odors to surfaces they contact.

German cockroaches are believed to be capable of transmitting numerous disease-causing organisms such as *Staphylococcus* spp., *Streptococcus* spp., hepatitis virus, and coliform bacteria. They have also been implicated in the spread of typhoid and dysentery.

The American cockroach, which may come into contact with human excrement in sewers or with pet droppings outdoors, may transmit bacteria that cause food poisoning (*Salmonella* spp. and *Shigella* spp.).

IDENTIFICATION AND LIFE CYCLE

Cockroaches are medium-sized to large insects in the order Blattodea (superorder Dictyoptera). They are broad, flattened insects with long antennae and a prominent, shield-shaped section behind the head called the pronotum (Figure 1). Termites also belong to the Dictyoptera and are closely related to cockroaches.

Some people confuse cockroaches with beetles, but adult cockroaches have membranous wings and lack the thick, hardened forewings of beetles.

Almost all cockroaches are nocturnal. They have a tendency to scatter when

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disturbed. Young or immature cockroaches, called nymphs (Figure 1), undergo gradual metamorphosis as they develop and grow into adults, which means they resemble adults and have similar feeding habits, but they do not have fully developed wings and are not reproductively active. Immediately after molting, cockroaches are white, but their outer covering darkens as it hardens, usually within hours. Nymphs are typically the most abundant stage of cockroach found in field populations.

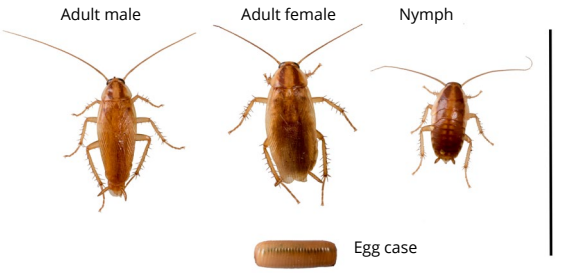
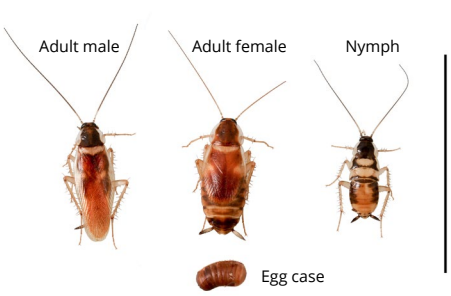
An adult female cockroach produces an egg case, called an ootheca, which it carries around protruding from the tip of the abdomen (Figure 2). The adult female German and field cockroaches carry their egg cases for most of the 30-day incubation period and then drop it about the time the eggs hatch. The other species covered here carry it for only a short time before depositing it in a suitable location where it incubates for weeks or months. In most cases, egg cases are deposited in dark, moist crevices and other protected areas. The time required for a cockroach to complete its life cycle, from egg to reproducing adult, varies by species, from just a few months to more than one year.

Cockroaches hide in dark, warm areas, especially narrow spaces where surfaces touch them on both sides. Adult German cockroaches can hide in a crack 1/16 inch wide. Immature cockroaches tend to stay in even smaller cracks where they are well protected. Cockroaches tend to congregate in corners while foraging and generally travel along the edges of walls or other surfaces.

Figure 2. Female German cockroach carrying an egg case, or ootheca.

It is important to correctly identify the species involved in a cockroach infestation so that the most effective control method(s) may be chosen.

Table 1. Identifying Features of Indoor Cockroaches. Vertical bars equal one inch (photos not actual size.

GERMAN COCKROACH Adult: 0.5 inch; light brown, 2 dark stripes on pronotum.	
BROWNBANDED COCKROACH Adult: 0.5 inch; males are golden tan; females are darker brown; both have light-colored bands on abdomen, wings, and sides of pronotum.	

COCKROACHES THAT LIVE INDOORS

German Cockroach

The German cockroach (see Table 1), *Blattella germanica*, is the most common indoor species in California (and perhaps worldwide), especially in multi-unit housing environments. They prefer food preparation areas, kitchens, and bathrooms, favoring warm (70° to 75°F), humid areas that are close to food, water, and dark harborage. Severe infestations may spread to other parts of buildings.

This species has the fastest reproductive cycle of all the common pest cockroaches: a single female and her offspring can produce over 30,000 individuals in a year.

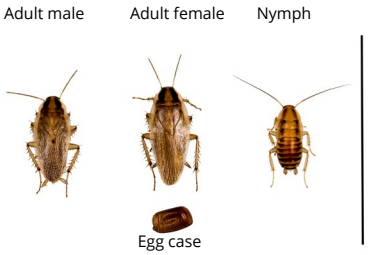
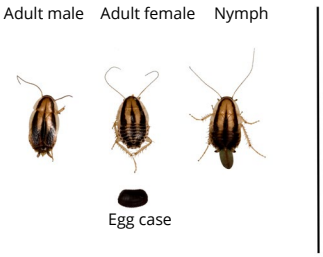
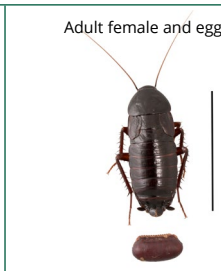
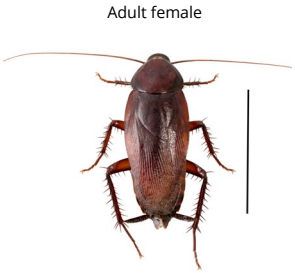
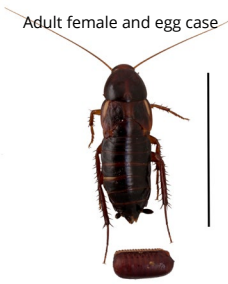
The female carries around a light beige egg case (Figure 2), about ¼ inch long, until 1 to 2 days before it hatches, when she drops it. Sometimes the egg case hatches while it is still being carried by the female. Each egg case contains about 30 young, and a female may produce a new egg case every few weeks.

Brownbanded Cockroach

The brownbanded cockroach (see Table 1), *Supella longipalpa*, is not as common as the German cockroach in California and accounts for only about 1% of all indoor infestations. This species prefers temperatures of about 80°F, about 5° to 10°F warmer than that preferred by German cockroaches. Favored harborage locations include crevices within or near electrical appliances, behind artwork and decorations on walls, within hollow legs of furniture, and within accumulations of clutter. They are not usually associated with food preparation areas but may be found in offices, animal care facilities, kitchens, schools, laboratories, industrial facilities, and hospitals. Brownbanded cockroaches prefer starchy foods, such as the glue on stamps and envelopes.

Adult males sometimes fly when disturbed, especially at higher temperatures (above 85°F), but females cannot fly. Females glue light brown egg cases, which are about ¼ inch long, to ceilings, beneath furniture, or in closets or other dark places where

Table 2. Identifying Features of Outdoor Cockroaches. Bars equal one inch (photos not actual size).

FIELD COCKROACH Adult: 0.5 inch; gray to olive brown; 2 black stripes on pronotum; 1 black stripe between the eyes.	
THREE-LINED COCKROACH Adult: Wingless with 3 black stripes across the pronotum and abdomen. Small, about ¼ inch.	
ORIENTAL COCKROACH Adult: 1.25 inches; almost black; male, wings are shorter than body; female, wings are not fully formed. Egg case: dark brown to blackish.	 
SMOKYBROWN COCKROACH Adult: 1.5 inches; dark brown to mahogany; almost-black pronotum.	 
AMERICAN COCKROACH Adult: 2 inches; reddish brown; large body, edges of pronotum are light colored.	 
TURKESTAN COCKROACH Adult: female, 1 inch with cream-colored markings along the edges behind the head and around the short, rounded wings; males slightly smaller with yellowish-tan wings and cream-colored stripes along the edges.	 

eggs incubate for several weeks before hatching. Multiple egg cases may be glued together in large deposits. Each female and her offspring are capable of producing over 600 cockroaches in one year.

COCKROACHES THAT LIVE OUTDOORS

Oriental Cockroach

The oriental cockroach (see Table 2), *Blatta orientalis*, is sometimes referred to as a water bug or black beetle. It lives in cool, dark, damp places like garages, basements, water meter boxes, and drains. It is most likely to occur in single-family dwellings that are surrounded by vegetation such as woodpiles, ivy and ground cover. It is also common in outside locations where people feed pets, livestock, or wildlife.

Oriental cockroaches prefer cooler temperatures than the other species do, and populations of this species often build to large numbers in masonry enclosures such as water meter boxes. At night, oriental cockroaches may migrate into buildings in search of food, water, or mates. They usually remain on the ground floor of buildings and move more slowly than the other species.

Oriental cockroaches do not fly and are unable to climb smooth vertical surfaces; consequently they may be found trapped in porcelain sinks or tubs after falling in or climbing up through damaged drain pipes.

Females deposit dark red-brown egg cases, which are about ⅜ inch long, in debris or food located in sheltered places. Each female and her offspring can produce nearly 200 cockroaches in one year. Development from a newly emerged nymph to adult can take from 1 to 2 years or more.

Oriental cockroach females look similar to those of Turkestan cockroaches (Figure 3). Oriental cockroach nymphs look similar to those of Turkestan cockroaches but lack reddish coloration (Figure 4).

Turkestan Cockroach

The Turkestan cockroach, *Blatta lateralis* (see Table 2, Figures 3-5), is a newer invasive species usually found in outdoor locations such as water meter boxes, cracks between blocks of poured concrete, compost piles, leaf litter, potted plants, and sewer systems. This species is often sold online and reared as food for insect-eating pets. Females are often confused with the oriental cockroach but can be distinguished by the cream-colored markings along the edges behind the head and around the short, rounded wings (Figure 3). Males may look similar to the American cockroach but are smaller and have yellowish-beige wings with cream-colored stripes along the edges (see Table 2, Figure 5). The nymphs are dark brown to black with reddish heads, thoraxes, and legs.

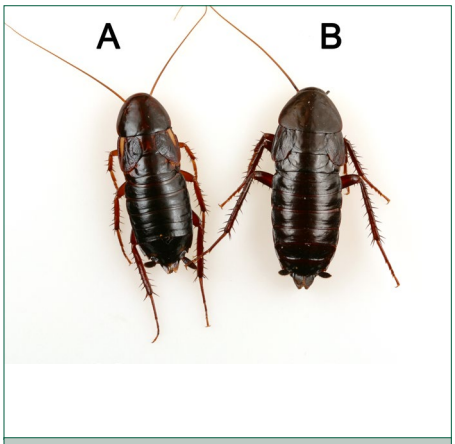


Figure 3. Females of the Turkestan cockroach (A) and the oriental cockroach (B) have greatly reduced wings.

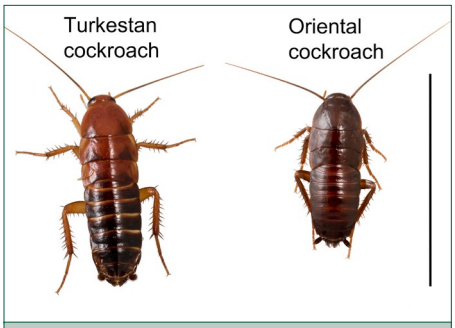


Figure 4. Nymphs of the Turkestan and the oriental cockroach look similar. Note the reddish legs and thorax on the Turkestan cockroach.

The biology of the Turkestan cockroach is similar to that of the oriental cockroach, though Turkestan cockroach females reach maturity faster and produce more eggs (Figure 6) during their lifetimes than oriental cockroach females. In recent years, the oriental cockroach is being displaced by the Turkestan cockroach, especially in southern California, the Central Valley, and other warm, dry parts of the state.

American Cockroach

The American cockroach (see Table 2), *Periplaneta americana*, prefers warm and humid environments, usually with temperatures above 82°F. Under the right conditions, they readily live outdoors. Occasionally, they forage from sewers and other areas into the ground floor of buildings, especially if pipes are damaged, screens are missing, or water traps in drains are faulty. They are common in sewers, water meter boxes, storm drains, steam tunnels, animal-rearing facilities, and zoos.

Because American cockroaches may come into contact with human excrement in sewers or with pet droppings outdoors, they are capable of transmitting bacteria that cause food poisoning (*Salmonella* spp. and *Shigella* spp.).

Adult females carry the egg cases around for about 6 days and then cement them to a protected surface where they incubate for about 2 months or longer. The egg cases, which are about ⅜ inch long, are brown when laid but turn black in 1 to 2 days. Each egg case contains about 12 young; a female and her offspring can produce over 800 cockroaches in one year.

Figure 5. Male (left) and female (right) Turkestan cockroach mating on a concrete wall outdoors.

Field Cockroach

The field cockroach (see Table 2), *Blattella vaga*, prefers outdoor locations in leaf litter and plant debris but may invade indoor areas when it is hot or dry outdoors. They are most commonly found in southern California and desert areas.

Field cockroaches are often mistaken for German cockroaches (Figure 7).

Adult females carry the egg cases until they are ready to hatch. Each egg case usually contains between 30 and 40 young. Development from a newly emerged nymph to adult can be completed in about 3 months.

Three-lined Cockroach

The three-lined cockroach (see Table 2), *Luridiblatta trivittata*, is native to Mediterranean countries such as Algeria, Morocco, Spain, and Libya. Little is known about the biology of this species. In its native range, it is found in leaf litter in semi-arid forests. Within California, it has been observed harboring in irrigated landscapes in leaf litter and plant debris. They are currently found in the San Francisco Bay Area as well as other parts of northern and central coastal California.

Three-lined cockroaches can sometimes invade structures in late summer and autumn in California, in search

Figure 6. Turkestan cockroach oothecas, deposited in moist soil under a barrel of kitchen grease stored outside.

of water during the driest parts of the year. Attempts to rear three-lined cockroaches in the laboratory have so far been unsuccessful.

Smokybrown Cockroach

The invasive smokybrown cockroach (see Table 2), *Periplaneta fuliginosa*, has been considered a nuisance pest in some parts of southern California, but it is now rarely encountered. This species is usually found outside in decorative plantings and planter boxes, woodpiles, garages, and water meter boxes; it may occasionally inhabit municipal sewers. Smokybrown cockroaches prefer the upper parts of buildings; they also may live under shingles or siding and sometimes get into trees, shrubs, and other vegetation during summer months. They sometimes invade homes, taking refuge in areas such as the attic. Adults can fly, especially on warm humid evenings.

Females carry the dark brown to black egg case, which measures about ⅜ inch long, for about 1 day before dropping it. Eggs can quickly hatch in 24 days or take 70 days after being laid, depending on temperature. About 40 to 45 nymphs hatch from a single egg case. Nymphs are dark brown and have white segments at the end of their antennae and across their backs.

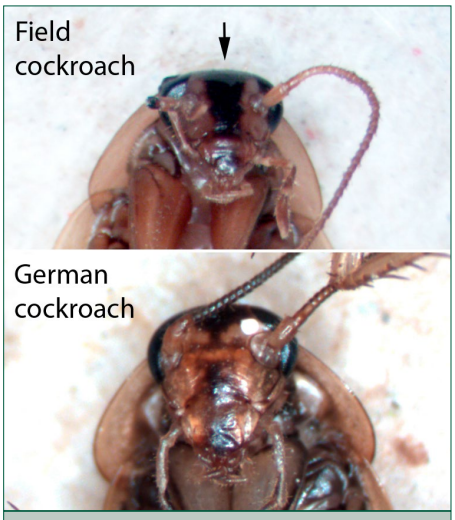


Figure 7. Field cockroaches can sometimes be distinguished from their indoor relatives, German cockroaches, by an olive coloration and a black stripe between the eyes on the front of the head (arrow).

Australian Cockroach

The Australian cockroach, *Periplaneta australasiae*, is a tropical species and prefers warm and humid habitats. It is occasionally encountered in greenhouses and animal rearing facilities, and zoos. The adults resemble American cockroaches but are recognizable by the cream-colored band along the fore wing. The life cycle is similar to that of American cockroaches.

MANAGEMENT

Managing cockroaches is not easy. For serious indoor infestations and other large or complex cockroach problems, professional pest control services are often required. In some cases, however, you may be able to manage cockroaches on your own. To be successful, you must first determine which species is present and where they are located. The more hiding places you locate and manage, the more successful your control program will be. Remember that most cockroaches are tropical and like warm, dark hiding places with access to water. Some of these locations may be difficult to access.

To prevent cockroach infestations, it is essential to reduce food and water sources as well as known and potential hiding places. If cockroaches have access to food, baits (which are primary control tools) may take longer to provide satisfactory control. Insecticide sprays alone will not eliminate cockroaches. An integrated pest management (IPM) approach that uses several control methods is usually required.

Monitoring for Cockroaches

Traps. Sticky traps or glue boards (Figure 8) offer the best way to detect and monitor cockroach populations. By placing traps in several locations and inspecting them regularly, you can identify the most severely infested areas and know where to concentrate control efforts. Traps can also be very helpful in evaluating the effectiveness of control programs. Most cockroach sticky traps available at home and garden stores work well for monitoring. These traps are open at both ends and are lined inside with a sticky material.

Figure 8. Sticky traps or glue boards are excellent monitoring tools for cockroaches.

Figure 9. Areas where cockroaches harbor and breed will be associated with accumulations of fecal specks, cast skins, oothecas, and dead cockroaches.

To be effective, traps must be placed where cockroaches are likely to encounter them when foraging. The best places are at the junctions of floors and walls and close to sites where cockroaches are suspected. Good potential monitoring sites can be determined by accumulations of fecal matter (e.g., dark spots or smears), cast skins, egg cases, and live or dead cockroaches (Figure 9).

Place traps in all corners of the room to give you an idea where cockroaches are entering. In the kitchen, put traps against walls behind large appliances (Figure 10) and in cabinets. Number the traps so you can keep records for each trap separately.

Check the traps daily for several days until it is apparent where the greatest number of cockroaches are being caught. Many times, cockroaches will be caught within the first 24 hours of placing a trap. Discard sticky traps by placing them in a sealed plastic bag in the trash.

To evaluate success, keep records of cockroaches trapped in different locations before and after you start your management efforts.

You can also detect a cockroach infestation by using a flashlight (Figure 11) to inspect cracks, underneath counters, around water heaters, and in other dark locations. A small mirror on a long handle can be useful in hard-to-see areas.

Other Methods

Sanitation. Cockroaches thrive where food and water are available to them. Even tiny amounts of crumbs or liquids caught between cracks provide a food source. Important sanitation measures include the following:

- Store food in insect-proof containers such as glass jars or re-sealable plastic containers.
- Keep garbage and trash in containers with tight-fitting lids and use plastic liners when possible. Keep trash cans away from doorways. Special trash cans may be mounted on pedestals in public spaces like schools to keep them off the ground where cockroaches forage (Figure 12). Remove trash, newspapers, magazines, piles of paper bags, rags, boxes, and other items that provide hiding places and harborage.
- Eliminate plumbing leaks and other sources of moisture. Increase ventilation where condensation is a problem.
- Vacuum cracks and crevices to remove food and debris. Be sure surfaces where food or beverages have been spilled are cleaned up immediately. Vacuuming also removes cockroaches, shed skins, and egg cases, reducing overall cockroach numbers. Because aerosolized bits of cockroaches' shed skins and droppings may cause allergies when inhaled, it is recommended that the vacuum cleaner have a high efficiency particulate absorber (HEPA) filter or triple filters.

Exclusion and Removal of Hiding Places. During the day, cockroaches hide around water heaters, in cupboard cracks, stoves, crawl spaces, outdoor vegetation, and many other dark locations. They invade kitchens and other areas at night.

Limiting hiding areas or avenues of access to living areas is an essential part of an effective management strategy. False-bottom cupboards, hollow walls, and similar areas are common cockroach refuges that should be properly sealed.

If it is not practical to remedy these problem areas, consider insecticides formulated for cockroach control (Table 3 and Table 4). See the Chemical Control section for specific options.

Limit Access. Prevent access to the inside of buildings through cracks, conduits, under doors, or through other structural flaws. Take the following measures if observation or trapping shows cockroaches are migrating into a building from outdoors or other areas of the building:

- Seal cracks and other openings to the outside.
- Use door sweeps (Figure 13) and weather stripping on doors and windows.
- Look for other methods of entry, such as from items being brought into the building, especially appliances, furniture, boxes, and items that were recently in storage.
- Inspect food deliveries before putting them in kitchens.
- Look for egg cases glued to undersides of furniture, in refrigerator and other appliance motors, boxes, and other items. Remove any that you find.
- Locate and seal cracks where cockroaches can hide.
- Trim shrubbery around buildings to increase light and air circulation, especially near vents, and eliminate ivy or other dense ground covers near the house, as these may harbor cockroaches.
- Remove trash and stored items such as stacks of lumber or firewood from around the outside of buildings that provide hiding places for cockroaches.

Figure 10. Sticky trap placed behind a large appliances against walls ito monitor for cockroaches.

Figure 11. Use a flashlight to inspect crevices where cockroaches may be hiding during the day.

Figure 12. Garbage can mounted on a pedestal to prevent access by cockroaches.

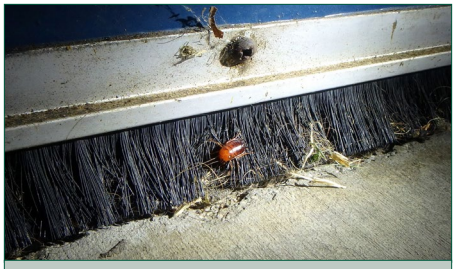


Figure 13. Install door sweeps on exterior doors to prevent outdoor cockroaches from entering structures.

- Consider keeping a layer of gravel about 6 to 12 inches wide around the perimeter of buildings. This reduces moisture, making this area less hospitable to outdoor cockroaches.

Chemical Control

Insecticides are most effective in controlling cockroaches when combined with sanitation and exclusion practices that limit the cockroach's ability to establish or reinvade. **Pesticides alone will not solve a cockroach problem.**

If insecticides are used, they must always be used with extreme care. Indoor chemical control is warranted only if the cockroach population is established, but not for an incidental intruder or two.

Baits. Bait products are the primary pesticides used to treat cockroach infestations. They can be packaged as pastes, gels, and granules (Table 3).

Most insecticides used in baits are slow acting. Baits do not control all cockroaches equally. For instance, brown-banded cockroaches are especially difficult to control using baits. Female cockroaches with egg cases do very little feeding and avoid open spaces, so they are less likely to be immediately affected by a bait. An effective bait program does not give immediate results but instead may take 7 days or longer. Baits can be quite effective for long-term control of cockroaches. Removing other food sources will greatly enhance the effects of baits.

As with sticky traps, insecticidal baits do not attract cockroaches over long distances, so place them near hiding spaces or where roaches are likely to encounter them while foraging.

Outdoors, place baits and bait stations around building perimeters, in valve or water meter boxes, wood piles, and around planters.

Indoors, place baits under appliances, along walls, and in cabinets. Baits can also be placed next to fecal specks and droppings of cockroaches. These deposits contain a natural attractant or aggregation pheromone. Look for these fecal specks and droppings under kitchen counters, behind kitchen drawers, and in the back of cabinets.

Bait Stations. The most popular bait application method for home use is within prefilled bait stations (Figure 14), small plastic units that contain an attractive food base along with an insecticide. Refillable bait stations (Figure 15) are available in stores and can be refilled with bait granules or gel.

The advantage of bait stations is that insecticides are confined to small areas within tamper-resistant containers rather than being dispersed widely, potentially reducing exposure to people and pets. Baits in stations remain effective for many months.

Gel Bait. For crack and crevice treatments, gel baits can be very effective. Apply gel using a bait gun or syringe in small dabs in cracks and crevices where cockroaches will find it.

Gel baits are very effective when placed in or near locations where cockroaches harbor or forage. In some cases, gels may need to be reapplied since deposits harden over time. Gels are very effective when applied to manage German cockroaches and other species living inside structures. Recent research suggests that gel baits, applied within bait stations and in-ground utility ports, can also be used to effectively manage outdoor cockroaches.

Available commercial baits (Table 4) may contain abamectin, boric acid, fipronil, hydramethylnon, indoxacarb, clothianidin, or imidacloprid mixed with a food base. Some of these products are only available to licensed professionals.

Dusts and powders. Insecticidal dusts (Table 4) can be important parts of an IPM program when applied in enclosed, out-of-the-way locations where cockroaches may hide. The most common active ingredient (a.i.) used against cockroaches is boric acid. Boric acid powder is a contact and oral insecticide and can be used preventively or when treating existing infestations.

Boric acid is not repellent, and if it remains dry and undisturbed, it provides control for a very long time. Because it has a positive electrostatic charge, the dust clings to the body of a cockroach as it walks through a treated area and the cockroach ingests small amounts when it grooms itself.

Boric acid powder has fairly slow activity, and it may be 7 days or more before it has a significant effect on a cockroach population. Boric acid is not recommended for outdoor use since it is toxic to plants.

Figure 14. Prefilled bait stations contain a slow acting insecticide within an edible bait.

Figure 15. Some bait stations can be refilled with gel or granular bait as needed.

Table 3. Cockroach baits available in California in 2019.

Active Ingredient	Brand Name	Form	Availability	
			General Public	Licensed Professionals
Abamectin	Avert Dry Flowable Cockroach Bait, Invict AB Insect Paste	Gel	✓	✓
	Maggie's Farm Supply Effective Ant and Roach Killer, Vendetta Cockroach Gel Bait	Gel	✓	
Boric Acid	Echol's Roach Tablets, Harris Famous Roach Tablets, Intice Perimeter Bait	Granule/flake	✓	
	Magnetic Roach Bait	Gel/paste	✓	✓
	Niban	Granule/flake	✓	✓
Fipronil	Combat Max 12 Month Roach Killing Bait, Combat Max Roach Killing Bait	Bait station	✓	
	Combat Source Kill Max, MaxForce FC Magnum Roach Killer Bait Gel	Gel	✓	
	Combat Roach Killing Bait Strips	Strips	✓	
	MaxForce FC Professional Insect Control Roach Killer Bait, MaxForce FC Select Pro-fessional Insect Control Roach Killer Bait Gel	Gel	✓	✓
	MaxForce FC Roach Killer Bait Stations	Bait station	✓	✓
Hydramethylnon	Combat Roach Killing Gel	Gel	✓	
	Maxforce Complete Brand Granular Insect Bait	Granule/flake		✓
	Combat Roach Killing Bait	Bait station	✓	
	Maxforce Professional Insect Control Roach Killer Bait Gel	Gel	✓	✓
	Maxforce Professional Insect Control Roach Killer Bait	Bait station	✓	✓
Indoxacarb	Advion Cockroach Bait Arena	Bait station	✓	✓
	Advion Cockroach Gel bait	Gel	✓	✓
	Raid Roach Gel	Gel	✓	
Imidacloprid	Invict Gold Cockroach Gel	Gel	✓	

Table 4. Dust products available in California in 2019.

Active Ingredient	Brand Name	Availability	
		General Public	Licensed Professionals
Boric Acid	Bonide Boric Acid Roach Powder, Eaton's Answer Boric Acid Insecticidal Dust, Boric Acid Roach Killer II, Enforcer Roach Ridd, Hot Shot Maxattrax Roach Powder	✓	
	Boractin Insecticide Powder	✓	✓
Silica aerogel	Dri-Out Insecticide		✓
	CimeXa Insecticide Dust, Drione, Tri-die Silica & Pyrethrum Dust	✓	✓

Figure 16. Insecticidal dusts and powders can be applied inside void spaces using a bulb duster or electric dust applicator.

Blow dusts and powders (Figure 16) into cracks and crevices or lightly spread it in areas where visible residues are not a problem and where people will not come into contact with it. Remove kick panels on refrigerators and stoves and apply a light film of dust throughout the entire void underneath these appliances. Thin films of dust are more effective than thick layers, which may cake and clump together.

Holes the size of the tip of a puff-type applicator can be drilled into the top of kick panels beneath cabinets, and dusts and powders may be applied through the holes to these areas as well as under the sink, in the void space between the sink and wall, and around utility pipe penetrations. Also treat along the back edges and in corners of shelves in cabinets, cupboards, pantries, and closets.

Formulated as insecticides, boric acid dusts usually contain about 1% of an additive that prevents caking and improves application properties. If a deposit gets wet and then dries and cakes, it loses its electrostatic charge and will not be picked up readily by cockroaches. If this occurs, clean up old deposits and reapply to these areas.

Desiccant dusts such as diatomaceous earth and silica aerogel are repellent and effective when applied to voids and other out-of-the-way places. Silica aerogel readily absorbs waxes from the surface of insects resulting in their desiccation and death. Silica aerogels may be applied during construction or to prevent cockroaches from becoming established.

Foggers, Sprays and Aerosols. Applications of aerosol insecticides and total-release foggers ('bug bombs') are often ineffective since they don't reach the crevices where cockroaches harbor and breed and can be hazardous due to flammability and exposure concerns.

Although sprays may provide a quick, temporary knockdown of cockroaches, they do not give long-term control. They may also repel and disperse cockroaches to other areas of the building from which they may return later.

Cockroaches have also become resistant to many insecticides in common sprays and aerosols that formerly controlled them. Sprays should not be necessary if an IPM program is followed that uses sanitation, exclusion, and appropriate baits and dusts.

Insecticide treatment of harborage sites for oriental, Turkestan, and American cockroaches may be required when populations of these species are high and cockroaches are moving into buildings.

Follow-up

After a cockroach IPM program has been started, evaluate the effectiveness of the methods that are being used with regular monitoring. Use traps or visual inspections to help determine if further treatment is necessary.

If populations persist, reevaluate the situation. Look for other sources of infestations, make sure that all possible entryways are blocked, be certain that food and water sources are eliminated as much as possible, and continue sealing and eliminating hiding places. It may be necessary to move bait stations to other locations, use more stations, apply more bait, or consider a different bait product.

When cockroach populations are under control, continue monitoring with traps on a regular basis to make sure reinfestation is not taking place. Maintain sanitation and exclusion techniques to avoid encouraging a new infestation. If severe reinfestations continue to recur, consider having the infested areas modified or remodeled to reduce the amount of suitable habitat for cockroaches.

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WARNING ON THE USE OF PESTICIDES

Pesticides are poisonous. Some pesticides are more toxic than others and present higher risks to people, nontarget organisms, and the environment. A pesticide is any material (natural, organic, or synthetic) used to control, prevent, kill, suppress, or repel pests. "Pesticide" is a broad term that includes insecticides, herbicides (weed or plant killers), fungicides, rodenticides, miticides (mite control), molluscicides (for snails and slugs), and other materials like growth regulators or antimicrobial products such as bleach and sanitary wipes that kill bacteria.

Always read and carefully follow all precautions and directions provided on the container label. The label is the law and failure to follow label instructions is an illegal use of the pesticide. 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, and animals. Never place pesticides in food or drink containers. Consult the pesticide label to determine active ingredients, correct locations for use, signal words, and personal protective equipment you should wear to protect yourself from exposure when applying the material.

Pesticides applied in your garden and landscape can move through water or with soil away from where they were applied, resulting in contamination of creeks, lakes, rivers, and the ocean. Confine pesticides to the property being treated and never allow them to get into drains or creeks. Avoid getting pesticide onto neighboring properties (called drift), especially onto gardens containing fruits or vegetables ready to be picked.

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

Produced by the **Statewide Integrated Pest Management Program**, University of California, 2801 Second Street, Davis, CA 95618-7774.

Technical Editor: K Windbiel-Rojas

ANR Associate Editor: BJ Aegerter

Editor and Designer: B Messenger-Sikes

ILLUSTRATIONS: Tables 1 and 2: Photographs by D-H Choe. Figure 1: Jack Kelly Clark; Figures 2, 3, 4, 7, 8, and 13: D-H Choe; Figures 5, 6, 10, and 12: AM Sutherland; Figures 9, 11, 14-16: CA Reynolds.

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University of California scientists and other qualified professionals have anonymously peer reviewed this publication for technical accuracy. The ANR Associate Editor for Urban Pest Management managed this process.

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This material is partially based upon work supported by the Extension Service, U.S. Department of Agriculture, under special project Section 3(d), Integrated Pest Management.

Suggested citation: Sutherland AM, Choe D-H, Rust MK. 2019. *UC IPM Pest Notes: Cockroaches*. UC ANR Publication 7467. Oakland, CA.