

CHAPTER 5

Cockroaches

Unhygienic scavengers in human settlements

Cockroaches are among the most common pests in many homes and other buildings. At night they search for food in kitchens, food storage places, rubbish bins, drains and sewers. They are pests because of their filthy habits and bad smell. Some people may become allergic to cockroaches after frequent exposure. Cockroaches can sometimes play a role as carriers of intestinal diseases, such as diarrhoea, dysentery, typhoid fever and cholera.

Biology

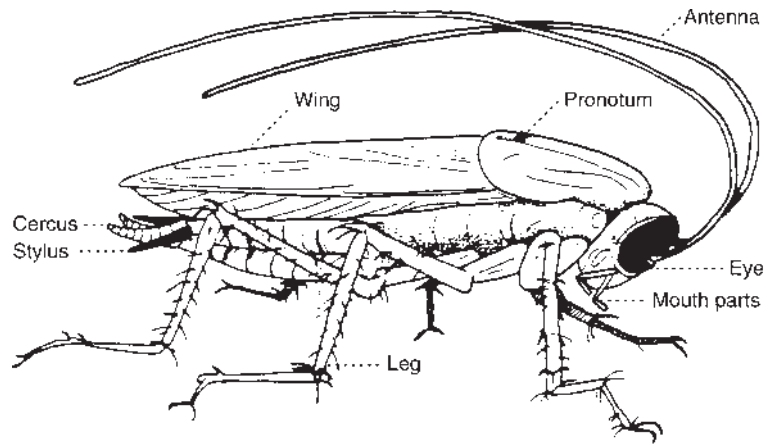
Cockroaches are insects, flattened from top to bottom, usually with two pairs of wings folded flat over the back (Fig. 5.1). Most species rarely fly but they walk very fast. The colour usually varies from light brown to black. The species vary from 2–3 mm to over 80 mm in length.

Of over 3500 identified species only a few are of importance to people because they have adapted to living in buildings. The most common species are:

- *Periplaneta americana*, the American cockroach, which occurs around the world. It is 35–40 mm in length and is a shiny reddish to chocolate brown colour (Fig. 5.2a). The egg case measures 8–10 mm and contains 16 eggs.
- *Periplaneta australasiae*, the Australian cockroach, which occurs mainly in tropical and subtropical areas. It is similar to the American cockroach, but smaller (31–37 mm long) and darker (Fig. 5.2b). It has a pale yellow stripe on each forewing extending for about one-third its length. The egg case contains about 22–24 eggs.
- *Blatta orientalis*, the Oriental cockroach, found mainly in cool temperate regions. It is blackish and 20–27 mm long (Fig. 5.2c). The egg case is 10–12 mm long and contains 16–18 eggs.
- *Supella longipalpa*, the brown-banded cockroach, which occurs around the world. It is 10–14 mm long and has yellow and brown bands (Fig. 5.2d). The egg case is 4–5 mm in length and contains about 16 eggs.
- *Blattella germanica*, the German cockroach, found in most parts of the world. It is light yellowish brown and 10–15 mm in length, making it one of the smallest domestic cockroaches (Fig. 5.2e). The female usually carries the egg case until shortly before the young come out. The egg case is light in colour, about 7–9 mm long and contains about 40 eggs.

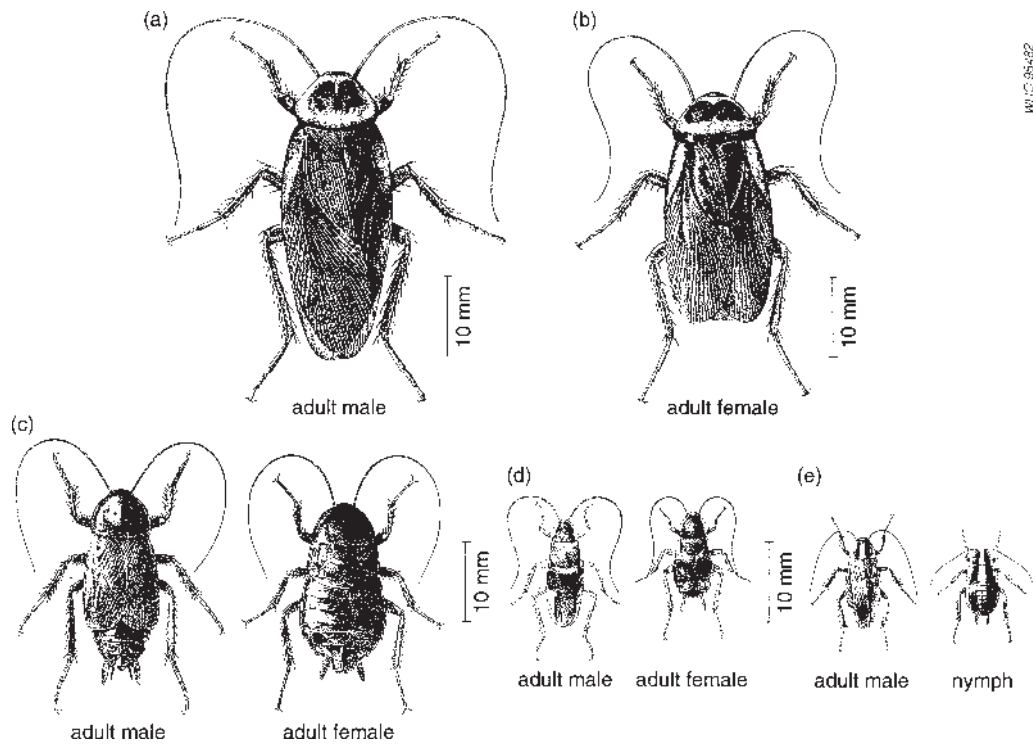
Life cycle

Cockroaches are relatively primitive, having only three stages in their life cycle: egg, nymph and adult (Fig. 5.3). The female deposits its eggs in groups surrounded by a leathery, bean-shaped egg case or capsule called an ootheca. Some



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Fig. 5.1
Side view of a cockroach (*Blattella germanica*) (© WHO).



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Fig. 5.2
The most common cockroach species: (a) American cockroach, *Periplaneta americana*; (b) Australian cockroach, *Periplaneta australasiae*; (c) Oriental cockroach, *Blatta orientalis*; (d) brown-banded cockroach, *Supella longipalpa*; (e) German cockroach, *Blattella germanica* (by courtesy of the Natural History Museum, London).

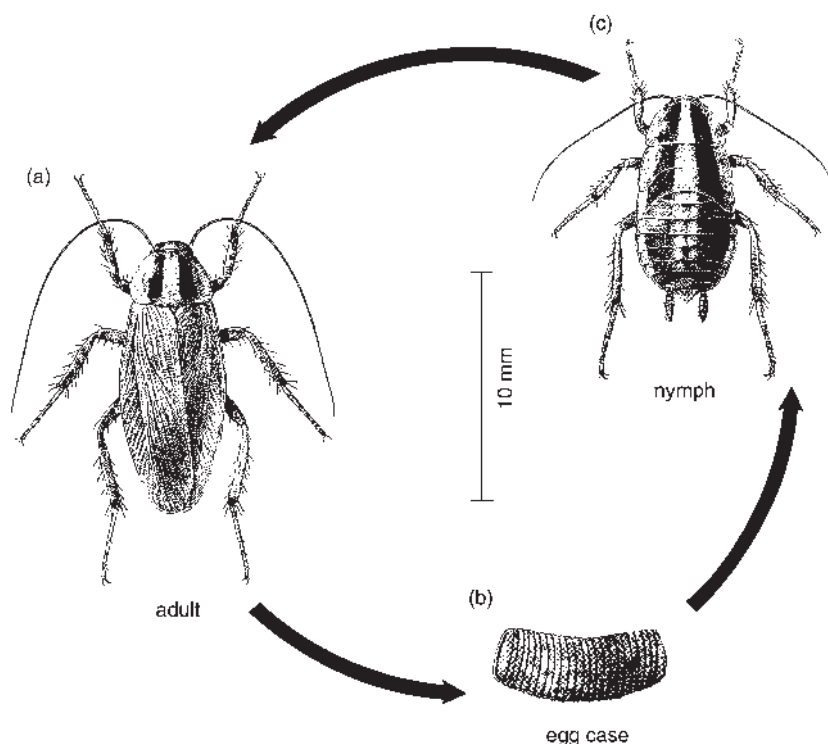


Fig. 5.3
Life cycle of the German cockroach (by courtesy of the Natural History Museum, London).

species, such as the German cockroach, carry the ootheca for several weeks attached to the back end of the body. Most others deposit the ootheca after one or two days. Oothecae are very distinctive and can frequently be used to determine the species present. Depending on the species, temperature and humidity, the eggs hatch after 1–3 months.

The young cockroaches, or nymphs, are wingless, and usually only a few millimetres long; they are white on hatching but darken within a few hours. They grow in stages by repeatedly shedding the cuticle or skin. They are fully grown after several months to more than a year, depending on the species. The adults may or may not possess wings, consisting of one outer leathery pair beneath which is folded a membranous pair.

Behaviour

Pest cockroaches live in close association with people (1, 2). They are tropical in origin but in the temperate zones most species live in parts of houses and other buildings where warmth, moisture and food are adequate.

Cockroaches usually live in groups. They are mostly active at night; in the daytime they hide in cracks and crevices in walls, door frames and furniture, and in secure places in bathrooms, cupboards, steam tunnels, animal houses, basements, televisions, radios and other electric devices, drains and sewer systems. If the lights are turned on in an infested kitchen at night the cockroaches will run from dishes, utensils, working surfaces and the floor towards shelter.



Fig. 5.4
Uncovered garbage bins offer an excellent environment for cockroaches to develop (© WHO).

Cockroaches eat a great variety of food, including all food used for human consumption (Fig. 5.4). They prefer starchy and sugary materials. They sip milk and nibble at cheese, meats, pastry, grain products, sugar and sweet chocolate. They also feed on cardboard, book bindings, ceiling boards containing starch, the sized inner lining of shoe soles, their own cast-off skins, dead and crippled cockroaches, fresh and dried blood, excrement, sputum, and the fingernails and toenails of babies and sleeping or sick persons.

Dispersal

Mass migrations have been reported for some species, apparently resulting from overcrowding. The migrants move into new areas by crawling or flying. They commonly enter houses in boxes of bottled drinks and bags of potatoes, onions or other foodstuffs that have become infested in poorly maintained foodstores. Long-distance transportation of the pests can occur on aircraft, ships or other vehicles.

Public health importance

Nuisance

Cockroaches are important pests because they spread filth and ruin food, fabrics and book-bindings. They disgorge portions of their partially digested food at intervals and drop faeces. They also discharge a nauseous secretion both from their mouths and from glands opening on the body which give a long-lasting, offensive cockroach smell to areas or food visited by them.

Diseases

Cockroaches move freely from building to building or from drains, gardens, sewers and latrines to human habitations. Because they feed on human faeces as well as human food they can spread germs that cause disease (Fig. 5.5) (2, 3). Cockroaches are not usually the most important cause of a disease, but like houseflies



Fig. 5.5
Cockroaches can spread disease by contaminating human food with germs they pick up in latrines, garbage dumps, etc.

they may play a supplementary role in the spread of some diseases. They are proven or suspected carriers of the organisms causing:

- diarrhoea
- dysentery
- cholera
- leprosy
- plague
- typhoid fever
- viral diseases such as poliomyelitis.

In addition they carry the eggs of parasitic worms and may cause allergic reactions, including dermatitis, itching, swelling of the eyelids and more serious respiratory conditions (4).

Control measures

Effective control is easier in temperate climates (where cockroach populations cannot survive outdoors in winter) than in humid and warm areas. The key to control is cleanliness, which may be difficult in houses where there are children and domestic animals. In isolated homes, control is easier to achieve than in apartments where cockroaches may have easy access from adjacent quarters. Reinfestation occurs from outdoors in warm areas, or along heating ducts and water pipes in apartments, or from groceries or luggage brought from cockroach-infested areas. Cockroaches may even sometimes be found in very clean houses, but are unlikely to establish colonies.

The presence of several sizes of nymphs and oothecae is an indication of a well-established colony. Infestations can be detected by searching behind skirting-boards, boxes, furniture and other common hiding places. At night, cockroaches are easily detected using light.

Heavy infestations of cockroaches can be dealt with by chemical control measures, followed by environmental management to deprive the insects of food and shelter. Low numbers can be effectively controlled by baits or traps.

Environmental management

Cleanliness and hygiene

Food should be stored in tightly covered containers in screened cabinets or refrigerators (Fig. 5.6). All areas have to be kept clean so that no fragments of food or organic matter remain. Rubbish bins should be securely covered and emptied frequently, preferably daily.

Basements and areas underneath buildings should be kept dry and free of accessible food and water.

Reduction of accessibility

Groceries, laundry, dirty clothing, egg crates and furniture should be checked before being taken into a building.

In some instances, accessibility to buildings can be reduced by closing gaps in floors and door frames. Openings for drain water and sewer pipes, drinking-water and electricity cables should also be closed (Fig. 5.7).

Chemical control

Cockroaches are difficult to control with insecticides for several reasons, one of which is that they may become resistant to commonly used compounds. Moreover, many insecticides are repellent to them and are therefore avoided (5). Chemical control gives only temporary relief and, wherever possible, it should be accompanied by environmental sanitation and house improvement (6).

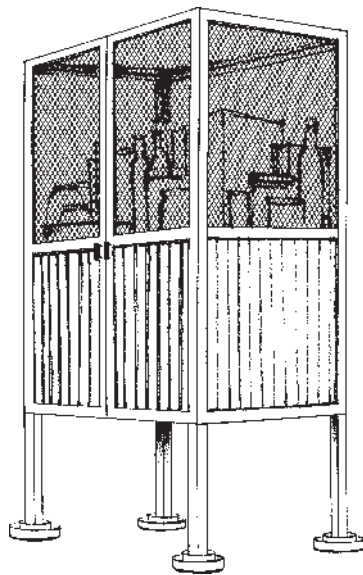


Fig. 5.6
Food can be protected in a cockroach-, fly- and ant-proof cabinet.

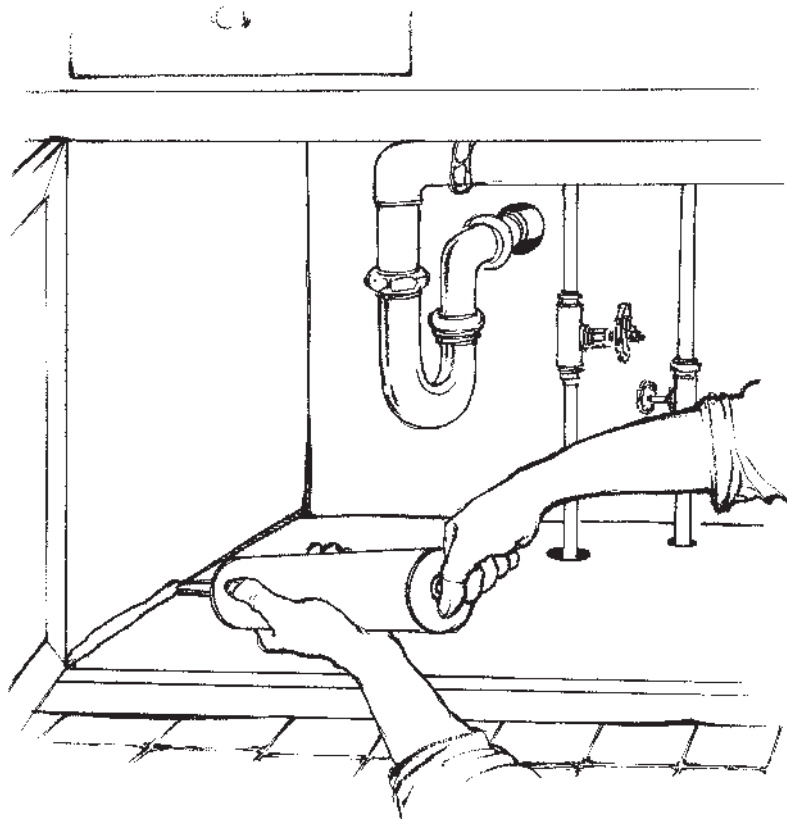


Fig. 5.7
Reduce accessibility to cockroaches by sealing openings, cracks and crevices.

Insecticides are applied to the resting and hiding places as residual sprays and insecticidal dusts. Such applications are effective for periods ranging from several days to months, depending on the insecticide and the substrate on which it is deposited. Insecticides can also be combined with attractants as toxic baits.

Resistance

The German cockroach is resistant to several organochlorine, organophosphorus, carbamate and pyrethroid insecticides (7). The Oriental cockroach, the American cockroach and the large brown cockroach (*Periplaneta brunnae*) have developed little resistance, mainly to DDT and chlordane. Recently, the American cockroach has been found to be resistant to trichlorfon in China and the large brown cockroach to diazinon in the USA.

Application

Areas to be treated

Areas to be treated include kitchens, galleys, behind and along skirting-boards, in and around sinks, in or under cupboards, under chairs and tables, in utility cabinets, near refrigerators and ice boxes, under loose floor coverings, food prepa-

ration areas, ducts, pipes, sewers and manholes. Food storage areas in restaurants, warehouses and other commercial establishments should be treated.

Frequency of treatment

How long the deposits of insecticide remain effective depends on a number of factors, such as the thoroughness of application, the speed of re-infestation, the chemical used, the dosage and formulation applied, the type of surface to which it is applied, the temperature and humidity, and the amount of wearing or rubbing off that occurs. Insecticides generally last longer on painted than on unpainted surfaces and longer on wood than on brick or block surfaces.

Frequent washing of a treated surface or coatings of dust or grease can render an insecticide useless. A single treatment rarely results in eradication. For most species, additional treatments may be necessary at monthly intervals to kill newly hatched nymphs or to prevent reinfestation.

Safety and precautions

Care should be taken to avoid food contamination. Avoid treating areas where children may come into contact with the residue. In special situations, such as the treatment of zoos or pet shops, residual sprays or dusts cannot be used. In such cases it may be possible to apply a limited quantity of chemical with a brush. Alternatively, a chemical with low toxicity to mammals and birds, such as boric acid powder or silica aerogel, may be used.

Some formulations may stain fabrics, wallpaper, floor tiles or other household materials. Information should be obtained on this subject before treatment is carried out.

Residual sprays

Residual sprays are usually applied with household plunger-type sprayers or hand-compression air sprayers. The sprayers are equipped with pinstream nozzles to spray the insecticide into cracks and areas that are hard to reach. A broader fan spray is useful for areas that are more accessible. The spray should moisten the surface thoroughly but not to the point of water running off or dripping.

A volume of four litres of diluted insecticide per 100m² sprayed in swaths 30–50 cm wide is often appropriate. The insecticide can be applied with a paint brush when other equipment is not available. Thorough treatment of runways and harbourage areas is essential for effective control. Usually, a heavy initial treatment is followed by periodic follow-up treatments. Sewer shafts sprayed once with chlorpyrifos or diazinon may remain cockroach-free for nine months or more (8).

Insecticides

Because of the development of resistance, and for environmental reasons, the chlorinated hydrocarbons have been replaced by the biodegradable organophosphorus and carbamate insecticides, the synthetic pyrethroids and, most recently, by insect growth regulators. Insect growth regulators are compounds that are highly toxic to insect larvae or pupae, interfering with their development into

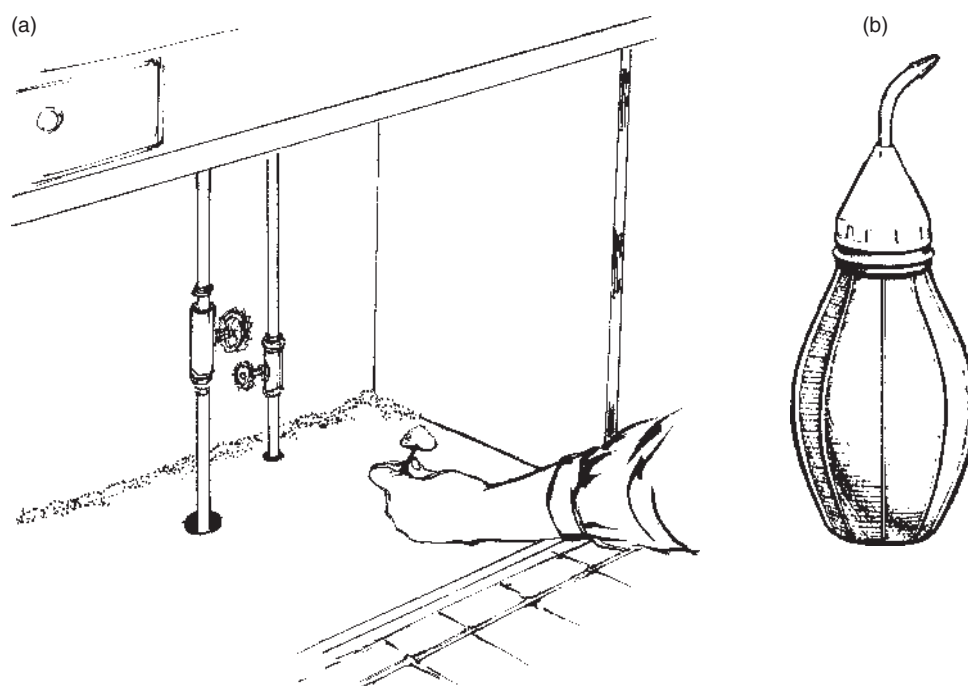


Fig. 5.8 Insecticidal dusts can be applied with (a) a spoon (© L. Robertson) or (b) a puff-duster (© WHO).

adults (see also Chapter 1, p. 134). They have a very low toxicity to non-target organisms. Their use is limited by their high cost and limited availability, but they may be of considerable value where cockroaches have developed resistance to other commonly used insecticides. Table 5.1 lists a number of these insecticides and the recommended dosages. For more information on spraying and the safe use of insecticides, see Chapters 9 and 10.

Dusts

Dry powder formulations are made by mixing insecticide powder with talcum or another inert carrier powder. They are most useful for the treatment of hollow walls, false ceilings and other cockroach hiding places that cannot easily be reached. The powders can be blown into spaces with a hand-operated puff-duster or a plunger-type duster, or even applied with a spoon (Fig. 5.8). Long, slender extension tubes can be attached to some types of duster to put the dust deep into hiding places. The dust disperses well and may penetrate deep into cracks and crevices. Heavy dust deposits may repel or drive away cockroaches and cause them to move to untreated areas or less accessible places. Dusts should not be applied to wet surfaces as this reduces their effectiveness. When used together with residual sprays, dusts should be applied only once the sprayed surfaces are dry.

Aerosols

Insecticidal aerosols are fine sprays of very small (0.1–50 µm) droplets of insecticide. Aerosols are not suitable for residual treatment but they can be used for space

Table 5.1
Insecticides commonly employed in the control of cockroaches

Insecticide	Chemical type ^a	Formulation	Concentration		Safety classification by WHO ^b
			g/l or g/kg	%	
Alphacypermethrin	PY	spray	0.15	0.015	MH
Bendiocarb	C	spray	2.4–4.8	0.24–0.48	MH
		dust	10	1.0	
		aerosol	7.5	0.75	
Betacyfluthrin	PY	spray	—	12.5	MH
Chlorpyrifos	OP	spray	5	0.5	MH
Cyfluthrin	PY	spray	—	5–10	MH
Cyphenothrin	PY	spray	1.25–2.5	0.125–0.25	SH
		aerosol	1–3	0.1–0.3	
Deltamethrin	PY	spray	0.025	0.0025	MH
		dust	0.5	0.05	
		aerosol	0.2	0.02	
Diazinon	OP	spray	5	0.5	MH
		dust	20	2.0	
Dichlorvos	OP	spray	5	0.5	HH
		bait	19	1.9	
Dioxacarb	C	spray	5–10	0.5–1.0	MH
Fenitrothion	OP	bait	250	25	MH
		spray	5–10	0.5–1.0	
		aerosol	7.5	0.75	
Flufenoxuron	IGR	bait	0.01	0.001	SH
Hydramethylnon	ETI	bait	—	1–2	SH
Jodfenphos	OP	spray	10	1.0	UH
Malathion	OP	spray	30	3.0	SH
		dust	50	5.0	
Permethrin	PY	spray	1.25–2.5	0.125–0.25	MH
		dust	5	0.5	
Pirimiphos methyl	OP	spray	25	2.5	SH
		dust	20	2.0	
Propetamphos ^c	OP	spray	5–10	0.5–1.0	HH
		dust	20	2.0	
		aerosol	20	2.0	
Propoxur	C	spray	10	1.0	MH
		bait	20	2.0	

^a C = carbamate; OP = organophosphorus compound; PY = synthetic pyrethroid; IGR = insect growth regulator; ETI = electron transport inhibitor.

^b Classes: HH = highly hazardous; MH = moderately hazardous; SH = slightly hazardous; UH = unlikely to present acute hazard in normal use.

^c If applied by non-commercial operators, it should be supplied, for safety reasons, in a diluted form not exceeding 50 g of active ingredient per litre.

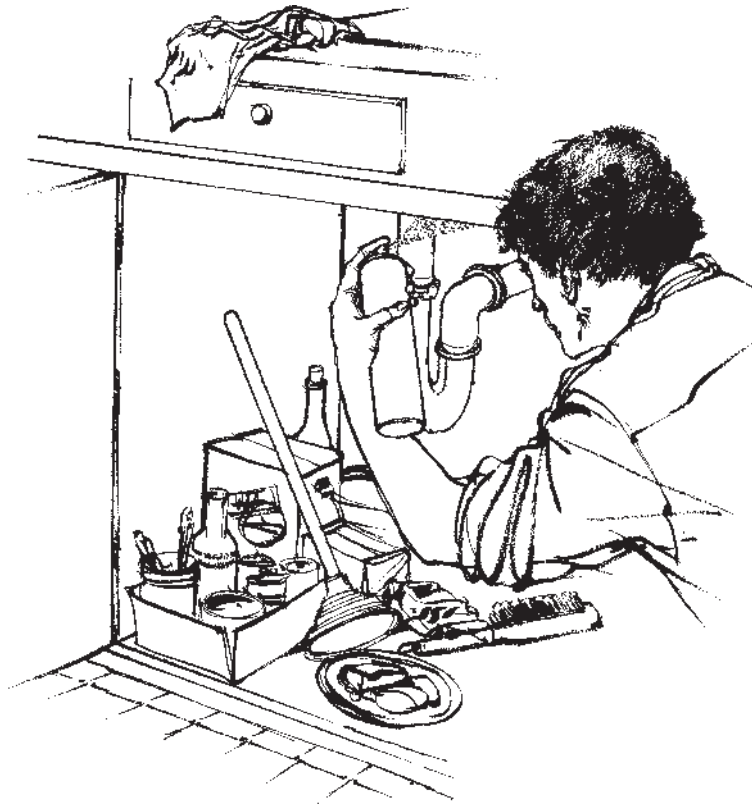


Fig. 5.9

An aerosol spray being used to apply residual insecticide to cockroach hiding places under a kitchen sink.

spraying because the droplets remain in the air for some time, killing insects by contact. Aerosol spray cans containing a residual insecticide with a knock-down insecticide (e.g. propoxur and a pyrethroid) are suitable for cockroach control and are widely available. Aerosols can penetrate into small crevices and other enclosed, inaccessible cockroach hiding places (Fig. 5.9). They usually contain pyrethrins, pyrethroids or another irritant to drive cockroaches out of their hiding places so as to shorten the time of kill. Aerosol application can cause a quick reduction in cockroach numbers but, to obtain longer-lasting control, follow-up treatment with a residual spray may be necessary (see p. 295).

Cities sometimes control cockroaches on a large scale with fogs produced by thermo-fogging machines.

Smokes

Smokes are clouds of insecticide particles produced by heat. The particle size (0.001–0.1 μm) is smaller than in aerosols. Smokes penetrate deep into hiding places and are particularly useful in basements of buildings and sewer and drainage systems.

Baits and traps

Baits have been used for many years in cockroach control and are still employed in certain situations, such as offices and laboratories, particularly if there is resistance to some of the insecticides in use.

Many commercially available products work on the principle of attracting cockroaches to a specific point and then trapping or killing them there. Some substances used as attractants are various food items, pheromones and other attractive chemicals. The trapping element may be a mechanical trap or a sticky material. A simple jar trap can be constructed from an empty jar, petroleum jelly and some food: the cockroaches are attracted to the jar by bread, raisins or other food placed at the bottom, and a thin layer of petroleum jelly on the inside rim prevents the insects from escaping (Fig. 5.10).

Toxic baits are used without a trapping device. They consist of a mixture of attractive food material and an insecticide. Several types of bait are commercially available as pellets or pastes. Pellets are usually dispensed in small containers or scattered in concealed areas. Pastes can also be dispensed in small containers. Some of the newer formulations are self-drying and can be applied directly to

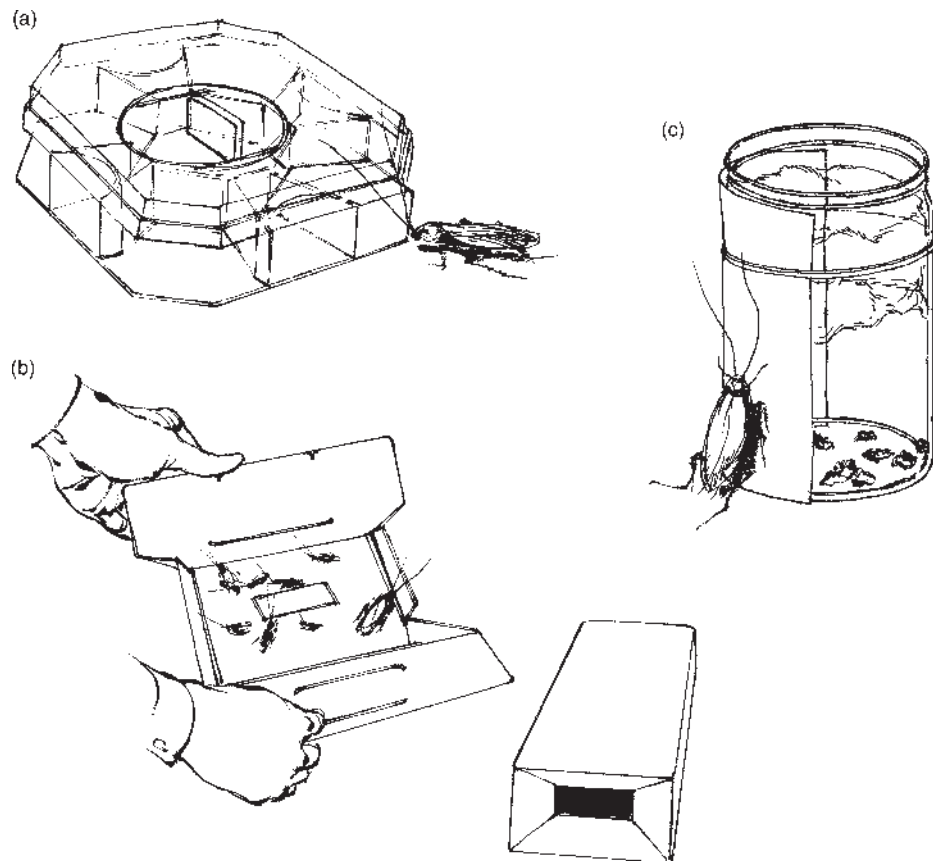


Fig. 5.10

Some types of trap. (a) A sophisticated mechanical trap, containing attractant food. (b) Sticky paper with trapped cockroaches: the trap contains a chemical attractant. (c) A simple jar trap baited with raisins: a sheet of paper enables cockroaches to enter, and a thin coating of jelly prevents escape.

surfaces. In some countries, dry baits are available in sealed traps which are safe to use where children or pets are present. Some food materials which may be used in baits are peanut meal, dog food and maltose.

Application

Baits and traps are easy to use and should be placed at sites frequented by cockroaches. They are most effective in situations where there is little or no food to compete with the bait, as is the case in offices. The maintenance of environmental hygiene is especially important when baits are used alone. In heavily infested areas, baits need to be replaced frequently.

Repellents

There is growing interest in the use of repellents in the control of cockroaches. They may be of special interest for application to hiding places in shipping containers, and in cases and boxes containing drinks, food and other materials. Keeping cockroaches away from such places prevents the distribution or movement of the insects from one locality to another. Repellents can also be used in kitchen cupboards, food and beverage vending machines, and so on.

Several essential oils, such as mint oil, spearmint oil and eucalyptus oil are known to repel cockroaches, but the best results are obtained with synthetic products that are easier to standardize. For example, packing materials or interior surfaces of storerooms can be treated with appropriate dilutions of deet (*N,N*-diethyl-3-toluamide) or DMP (dimethyl phthalate). A deposit of 0.5 mg of deet per cm² repels more than 90% of *Blattella germanica* and more than 80% of *Periplaneta americana* from cardboard boxes for about a week, depending on temperature and humidity. More promising synthetic compounds, such as DEPA (*N,N*-diethylphenylacetamide) and DECA (diethylcyclohexylacetamide), currently being studied in India (9), may be commercially available in the near future.

References

1. Roth LM, Willis ER. The biotic associations of cockroaches. *Smithsonian miscellaneous collection*, 1960, 141: 1-470.
2. Cornwell PB. *The cockroach*. Vol. 1. London, Hutchinson, 1968.
3. Roth LM, Willis ER. The medical and veterinary importance of cockroaches. *Smithsonian miscellaneous collection*, 1957, 134: 1-147.
4. Stankus RP, Horner E, Lehrer SB. Identification and characterization of important cockroach allergens. *Journal of allergy and clinical immunology*, 1990, 86: 781-787.
5. Wooster MT, Ross MH. Sublethal responses of the German cockroach to vapors of commercial pesticide formulations. *Entomologia experimentalis et applicata*, 1989, 52: 49-55.
6. Schal C. Relation among efficacy of insecticides, resistance levels, and sanitation in the control of the German cockroach (Dictyoptera: Blattellidae). *Journal of economic entomology*, 1988, 81: 536-544.

7. Cochran DG. Monitoring for insecticide resistance in field-collected strains of the German cockroach (Dictyoptera: Blattellidae). *Journal of economic entomology*, 1989, 82: 336–341.
8. Rust MK, Reiersen DA, Hansgen KH. Control of American cockroaches (Dictyoptera: Blattidae) in sewers. *Journal of medical entomology*, 1991, 28: 210–213.
9. Prakash S et al. *N,N*-diethylphenylacetamide—a new repellent for *Periplaneta americana* (Dictyoptera: Blattidae), *Blattella germanica*, and *Supella longipalpa* (Dictyoptera: Blattellidae). *Journal of medical entomology*, 1990, 27: 962–967.