

CHAPTER 3

Triatomine bugs

Vectors of Chagas disease

Triatomine bugs are large bloodsucking insects that occur mainly in Latin America and the southern USA. A number of species have adapted to living in and around houses and are important in the transmission to humans of *Trypanosoma cruzi*, the parasite that causes Chagas disease (also known as American trypanosomiasis). Chagas disease, which occurs in most South and Central American countries, is incurable and in its chronic phase may cause damage to the heart and intestines. Some patients eventually die from heart failure. Transmission can be successfully interrupted by controlling the triatomine bugs in and around the houses where they have their resting places.

Biology

Although different *Triatoma* species occur in various countries they are all similar in appearance and life cycle, and are easy to distinguish from other insects (Fig. 3.1). In Latin American countries the bugs are known under a variety of local names, including barbeiros, vinchucas, pitos and chinches.

Life cycle

The total duration of the life cycle of the triatomine bug, from egg to adult, varies from 4 to 24 months, depending on the species and environmental conditions (Fig. 3.2). The most important vector species usually have one or two cycles per year. The adults differ from the immature stages (nymphs) by the presence of fully developed wings and genitalia. The adults and immature stages occupy similar habitats and have similar feeding habits.

Behaviour

The bugs occur in both forested and dry areas in the Americas. The adult and immature stages live in the burrows and nests of wild animals, including birds, bats, squirrels, opossums and armadillos, on which they feed during the night by sucking blood when the animals are asleep. A number of species have adapted to living in and near houses, where they feed on humans and domestic animals, including chickens, cattle, goats, cats and dogs. Feeding may take 10–25 minutes.

Resting places

The triatomine bug species that transmit Chagas disease rest during the day in dark crevices close to their source of blood.

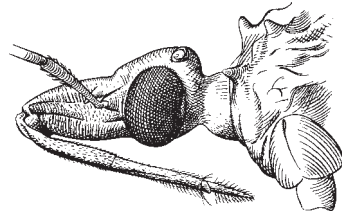


Fig. 3.1
Close-up of the head of a triatomine bug, showing the proboscis (by courtesy of the Natural History Museum, London).

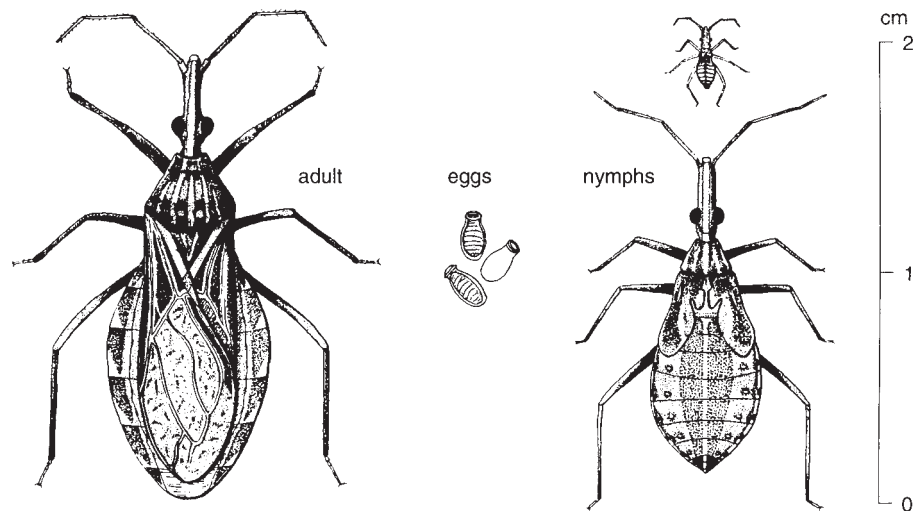


Fig. 3.2
Life cycle of the triatomine bug (by courtesy of the Natural History Museum, London).

Domestic resting places

During daytime the triatomine bugs prefer to hide in dark crevices, which are abundant in unplastered cracked walls of mud or mud-brick. Other hiding places are behind pictures, among furniture, boxes, and clothes hanging from pegs in walls, and in beds (Figs. 3.3 and 3.4). An important vector species, *Rhodnius prolixus*, which is found in Colombia, Venezuela and Central America, often hides in palm-thatched roofs. *Triatoma infestans*, which is the most important vector species in South America, often hides in roofs of wood and soil (Fig. 3.5). A vector species in Central America, *Triatoma dimidiata*, also hides in cracks in floors.

Peridomestic resting places

Some of the triatomine bug species find suitable resting places in areas surrounding houses, from which they may re-enter houses to feed. Resting occurs in all sorts of stored objects, such as firewood, lumber, tiles, stones and bags of food. Resting bugs are also found in animal quarters, such as chicken houses and goat corrals.

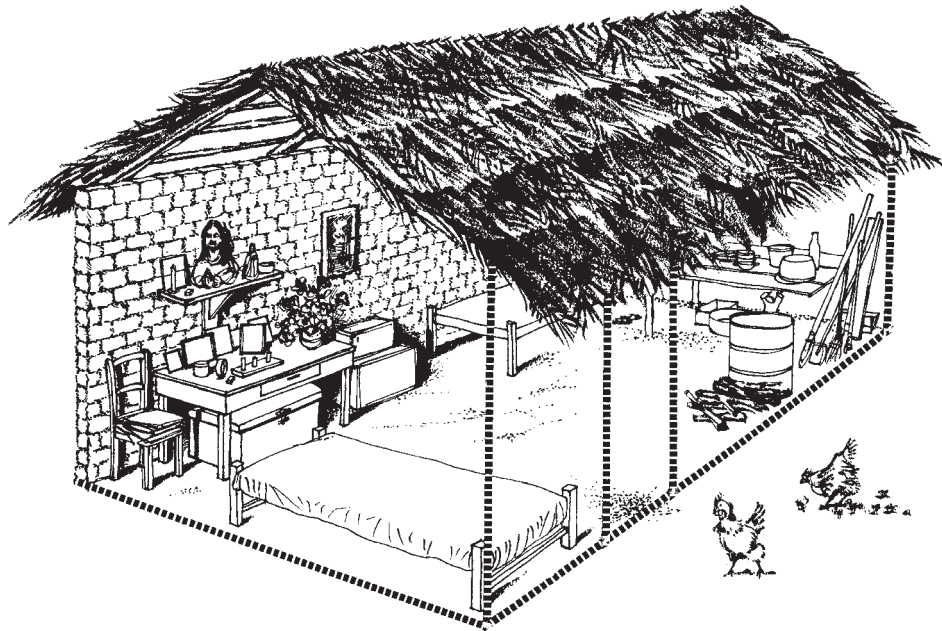


Fig. 3.3

The bugs find suitable hiding places in crevices in mud-brick walls and dark places among boxes, firewood and other objects, behind pictures, in beds and in palm-thatched roofs.

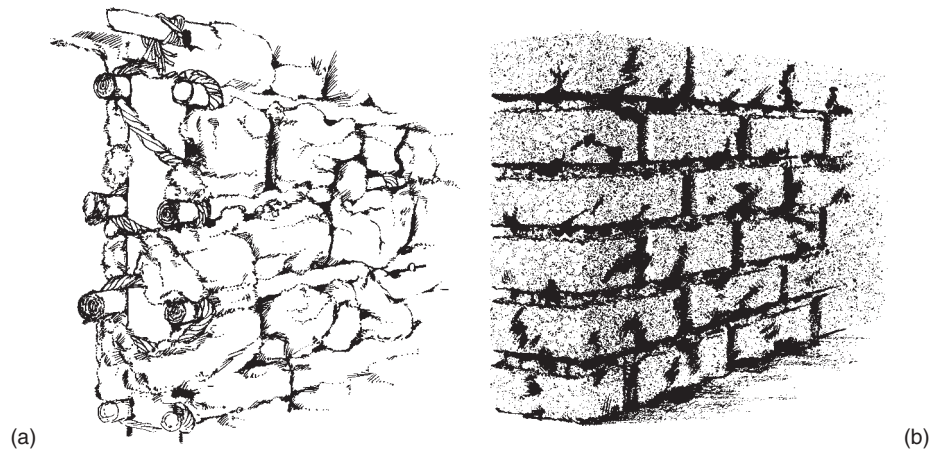


Fig. 3.4

The most important resting places are (a) the deep cracks in walls of mud and wattle or (b) mud-bricks (adobe).

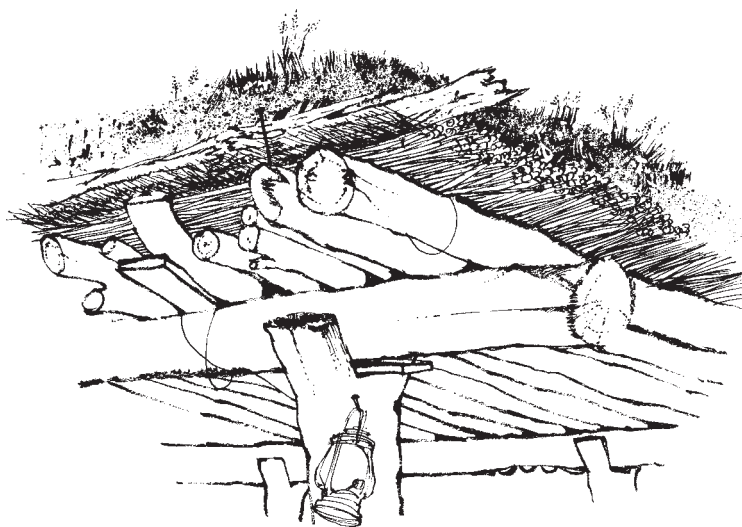


Fig. 3.5
Roofs of wood and soil are important resting places for *Triatoma infestans* in Argentina and Bolivia.

Public health importance

Nuisance

Biting is usually relatively painless and most people are not woken up when it occurs. In some cases severe itching and other skin problems occur afterwards. Large populations of triatomine bugs can cause chronic anaemia through loss of blood (1, 2).

Chagas disease

American trypanosomiasis, or Chagas disease, is caused by a protozoan parasite, *Trypanosoma cruzi*, which is transmitted to humans by triatomine bugs. The disease is associated with poverty in rural areas in Central and South America. In 1996 it was estimated that between 16 and 18 million people were infected, of whom over 6 million would develop clinically overt disease and 45 000 would die per year (Fig. 3.6) (3).

Transmission

The bugs ingest the parasites when they feed on an infected animal or person. Infected bugs then deposit the parasites with their faeces on the skin of another person during or shortly after feeding. Scratching or rubbing helps the parasites to enter the body through the bite wound or broken skin. Carried by the fingers, they can also penetrate through the mucosae of the eyes, nose or mouth, eventually reaching the bloodstream. The parasites cannot penetrate undamaged skin (Fig. 3.7).

Transmission of the parasite can take place between wild animal reservoirs and bugs without the involvement of human beings. Humans may become infected when they enter the natural environment where infected wild animals and vectors occur. Where these areas become dominated by humans—the reservoir animals



Fig. 3.6
Geographical distribution of Chagas disease in the Americas, 1996 (© WHO).

being killed or forced out—the bugs may increasingly transmit the parasite to domestic animals and people. The construction of houses and animal shelters provides alternative resting and hiding places for the bugs.

Transmission is also possible from mother to unborn child during pregnancy and by transfusion of infected blood. This is an increasingly important problem in some urban areas.

Clinical symptoms

A small sore often develops at the point where the parasite enters the body. If this site is around the eye a marked swelling of the eyelid may develop, known as Romaña's sign (Fig. 3.8); this happens in an estimated 50% of infected people. Some days later fever may occur and the lymph nodes may swell. This stage may be fatal in children, but in most cases the patient survives.

The next phase is without symptoms and may last months or years. However, the parasites invade and slowly affect most organs in the body, and this eventually results in chronic symptoms, such as irreversible damage to the heart and intestines. It is estimated that 27% of those infected develop heart problems which may

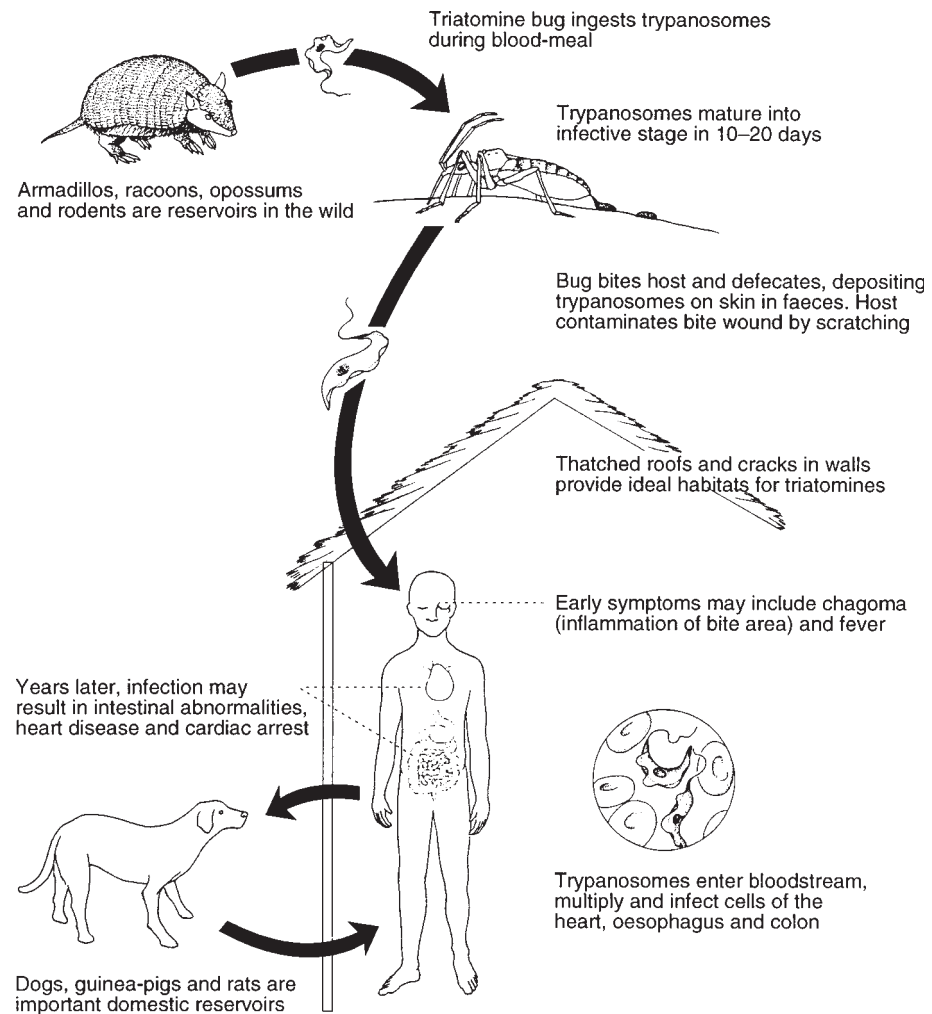


Fig. 3.7

Life cycle of *Trypanosoma cruzi* (by Taina Litwak for the United States Agency for International Development's VBC Project).

cause sudden death, 6% develop abnormalities of the digestive system, and 3% show damage to the central and peripheral nervous systems.

Prevention and control

No satisfactory drugs for the treatment of chronic Chagas disease are available. For early infection, which is difficult to diagnose, nifurtimox and benznidazole can be used, although they may cause side-effects. To improve early diagnosis, a network of laboratories has been established in the endemic countries, facilitating field collection of blood samples and ensuring standard criteria for diagnosis.

The avoidance of infection through control of the triatomine bugs is particularly important. The most important methods are:

- spraying of the walls and roofs of houses with insecticides; this is the preferred method in most areas with endemic Chagas disease;



Fig. 3.8
A typical early symptom of Chagas disease is swelling of the eyelid, known as Romaña's sign.

- improvement of houses to reduce or eliminate hiding places; this is the most suitable method for individual self-protection, and is of particular importance in preventing reinfestation where insecticidal spraying has eliminated the bugs.

The transmission of Chagas disease through blood transfusion is being prevented by the development and implementation of special tests to screen blood in blood banks.

Control measures

Recommended control activities differ according to the level of infestation of houses with triatomine bugs and the occurrence of transmission of Chagas disease. Seven countries in which the disease is endemic, namely Argentina, Bolivia, Brazil, Chile, Paraguay, Uruguay and Venezuela, have established national programmes for vector control. These programmes are mostly based on the spraying of walls in houses and the peridomestic resting places with residual, long-lasting insecticides. Specially trained government teams normally carry out the spraying activities, which are divided into preparatory, attack and vigilance phases. During the attack phase, all houses are sprayed in communities where infested dwellings have been detected.

In Brazil, for example, if no more than 5% of the houses in a locality are found to be infested after spraying, it is placed in the vigilance phase. Spraying is interrupted but householders themselves report the presence of bugs (see p. 232). Reinfested houses are then re-treated, together with all surrounding houses.

Good results have been obtained with this approach, but it is expensive. More emphasis is now being given to cheaper methods, the decentralization of control activities, and increased community involvement. Efforts in Bolivia, Brazil and Venezuela have demonstrated that house improvement is also an effective control method (3).

In northern Argentina a community-based programme of large-scale distribution of fumigant canisters in combination with the monitoring of surveillance boxes (see p. 234) successfully interrupted the transmission of Chagas disease. However, it is not clear whether this approach could be applied in other areas (4).

In the vigilance phase, government action almost ceases and community action is needed to improve housing and the peridomestic environment, carry out surveillance activities, treat reinfested houses, and implement simple methods of self-protection such as the application of insecticidal paint and the use of impregnated sheeting, impregnated mosquito nets and fumigant canisters.

A recent development may significantly change the way in which Chagas disease is controlled: in 1991 the health ministers of Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay adopted a resolution calling for action to eliminate Chagas disease through a combination of vector control measures and blood screening. The intention is to spray every home in areas known to be infested with *Triatoma infestans*. An intergovernmental commission has been appointed to raise and administer funds and to coordinate the plan (5).

Application of insecticides to house walls

Triatomine bugs usually make extensive contact with walls and roofs of houses by walking over them at night and hiding on or in them during the day. The application to walls and roofs of an insecticide with a long residual life may kill most of the bugs (Fig. 3.9). Apart from spraying houses, and especially bedrooms, it is recommended that bug habitats in the peridomestic environment be sprayed. If applied correctly, the recommended insecticides have low toxicity for humans.

Insecticide spraying is a specialized skill and operatives need training. Communities may consider having some of their members trained for this purpose. Health

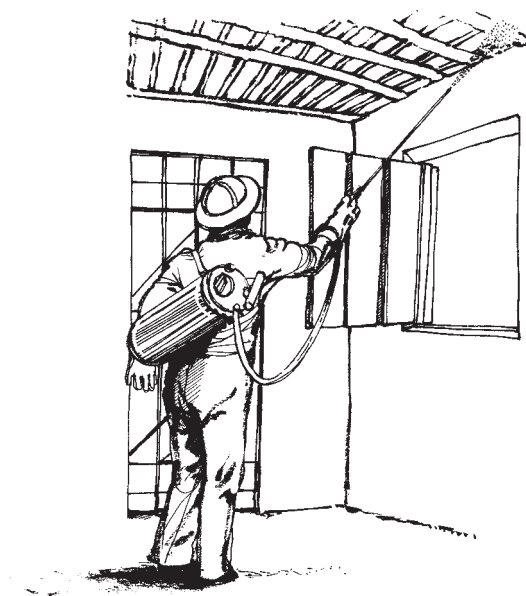


Fig. 3.9
Insecticides are generally applied to walls and roofs by spraying.

workers in medical organizations may also consider this as one of their responsibilities. Untrained people should not try to apply insecticides in their houses since this is likely to result in uneven coverage, wastage, and overexposure of inhabitants to insecticides. Even the safest insecticides should not be applied by hand or without proper precautions. Information on spraying equipment and techniques and on the safe use of insecticides is given in Chapters 9 and 10.

Unfortunately, not all wall materials are equally suitable for the application of insecticides. Walls made of non-porous materials such as tropical hardwood, painted wood, and compressed or fire-baked bricks, and walls covered with plaster, are the most suitable since the insecticide will remain on the surface. Porous materials such as mud absorb much of the insecticide applied. Moreover, minerals in mud and whitewash on plaster may rapidly degrade conventional insecticide formulations. The activity of an insecticide may last a year or more on timber walls but less than 2–3 months on adobe.

Insecticides

DDT is not sufficiently effective against triatomine bugs. More expensive insecticides, such as dieldrin, benzene hexachloride (BHC) and propoxur have been used. Their residual activity on mud walls does not generally last for more than three months. Nowadays the insecticides of choice are mainly synthetic pyrethroids, such as cypermethrin, cyfluthrin, deltamethrin, permethrin, lambdacyhalothrin and fenprothrin. Although often more expensive than previously used insecticides they tend to have much longer residual activity, are applied in lower dosages, and are thus more cost-effective (6).

Wettable powders and suspension concentrates are suitable formulations for spraying on porous wall surfaces. Their residual efficacy is longer than that of emulsifiable concentrates because the insecticide particles are larger and do not penetrate into wall surfaces but remain available for contact with insects.

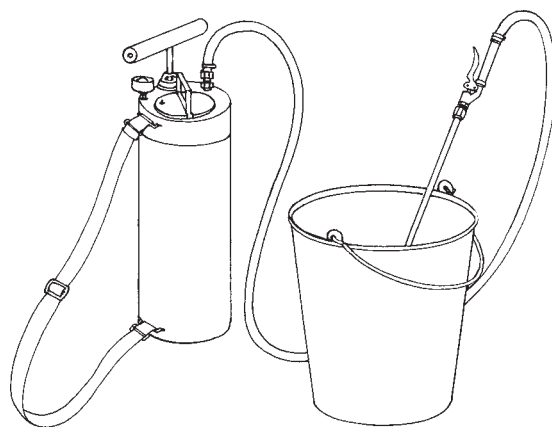
Slow-release formulations (insecticidal paints)

These formulations seem to cope with the problem of quick degradation of insecticide on mud surfaces as well as with absorption. They are based on latex or polyvinyl acetate and can be applied to walls by spraying or brushing (Figs. 3.10 and 3.11).

Application of the paint by brushing has the advantage of being simpler and cheaper than conventional insecticide application, taking into account the long persistence of the products. However, mud walls are not very suitable for brushing, which erodes the surface; spraying covers the surface with a thin film and is preferred by vector control agencies because it is less time-consuming and more efficient.

Recently an insecticidal paint effective against triatomine bugs has been specially developed for spraying on mud surfaces (7, 8). It is also suitable for brush-on application. After drying it becomes transparent and produces a thin plastic film.

This product has to be mixed with water before application.

**Fig. 3.10**

Insecticidal paint can be sprayed on to surfaces. The filter in the handle grip has to be removed to avoid polymerization of the latex. Between applications the nozzle should be kept under water and at the end of a spraying operation the equipment should be carefully cleaned with water.

**Fig. 3.11**

Slow-release insecticidal paints are suitable for brush-on application.

Composition of insecticidal paint

Only insecticides with a high vapour pressure can be used, because the particles have to move to the surface of the paint layer. Malathion, propoxur, pirimiphos methyl and fenitrothion are suitable. Thus 8.3% malathion emulsifiable concentrate or wettable powder added to an emulsifiable suspension consisting mainly of polyvinyl acetate, after drying, leaves a thin film containing around 13% of active ingredient that continuously migrates to the surface.

Advantages and disadvantages of insecticidal paints

Advantages

- The insecticidal paints have greater persistence and therefore better cost-effectiveness than conventional insecticides. One application may last up to two years, whereas standard formulations of insecticides such as the synthetic pyrethroids and BHC do not last longer than a year. In a study in Brazil the cost of keeping a house free of triatomine bugs for one year was estimated at US\$29 for paint, \$73 for BHC, and between \$31 and \$66 for most common pyrethroids.
- The paints are appreciated by house owners because they make mud walls more resistant to abrasion.

Disadvantages

- A larger quantity of formulation has to be transported per house and precautions have to be taken to prevent blockage of spray nozzles by the polymerizing latex.

Coating house frames with insecticide-impregnated paint^a

In constructing a mud-and-wattle house, before the wooden frame is filled with mud, it can be painted with a slow-release insecticidal paint (Fig. 3.12). Any cracks that appear at a later stage will offer toxic resting places to the bugs.

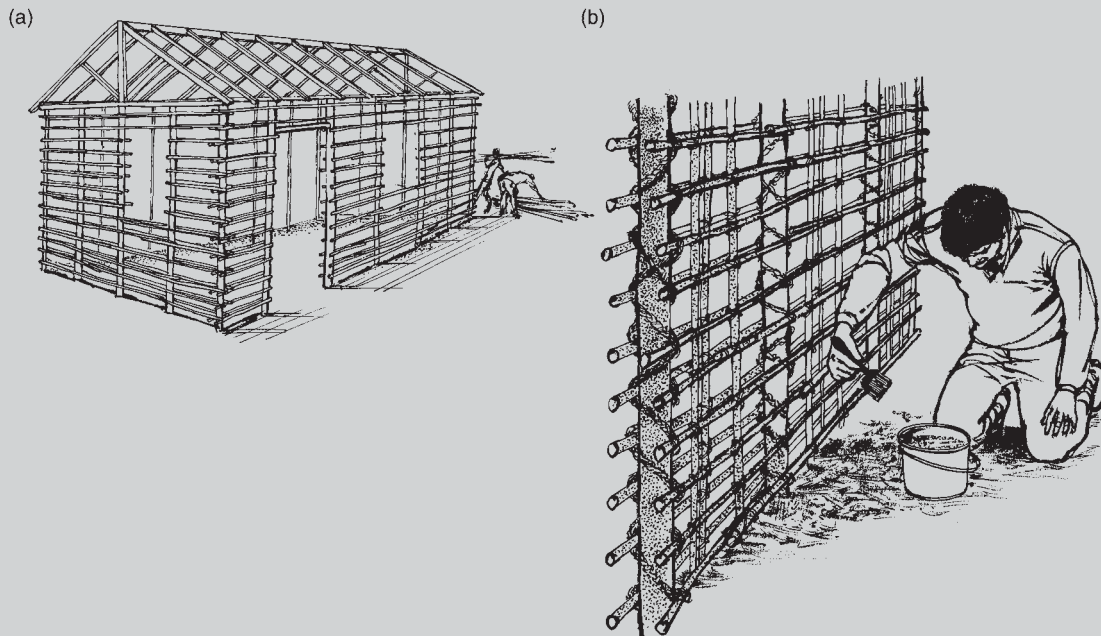


Fig. 3.12

Insecticidal paint can be applied to the wooden frame of a mud-and-wattle house.

The most important requirement for a paint to be applied on the wood is a long residual effectiveness because reapplication is impossible. A paint made of oxidized bitumen and an organophosphorus compound such as malathion or chlorpyrifos seems to be most suitable. In laboratory and field experiments (7, 8) it remained toxic for at least five years. When used for this purpose the unattractive black appearance is of no importance.

^a For more information, contact Nucleo de Pesquisas de Produtos Naturais, Federal University of Rio de Janeiro, CEP 21941, Rio de Janeiro, Brazil.

Determination of residual activity

A simple test can detect loss of residual activity of an insecticide over time. For one test about ten adult bugs or nymphs should be collected (preferably recently-fed fifth-instar nymphs) and exposed for a fixed time to the surface area under investigation. They should be confined beneath a standard WHO bioassay cone or an inverted glass Petri dish (or any other flat transparent container) attached to the treated surface with elastic bands, tape, nails or other suitable means (Fig. 3.13). The container should preferably be placed on a flat surface without cracks to prevent the bugs from escaping. If this is impossible the cracks should be filled and the container sealed to the wall surface. Large fifth-instar bugs or adults are preferred because they are the least susceptible to insecticides and can less easily escape through small openings. For purposes of comparison the same kind of surface should be used in each test.

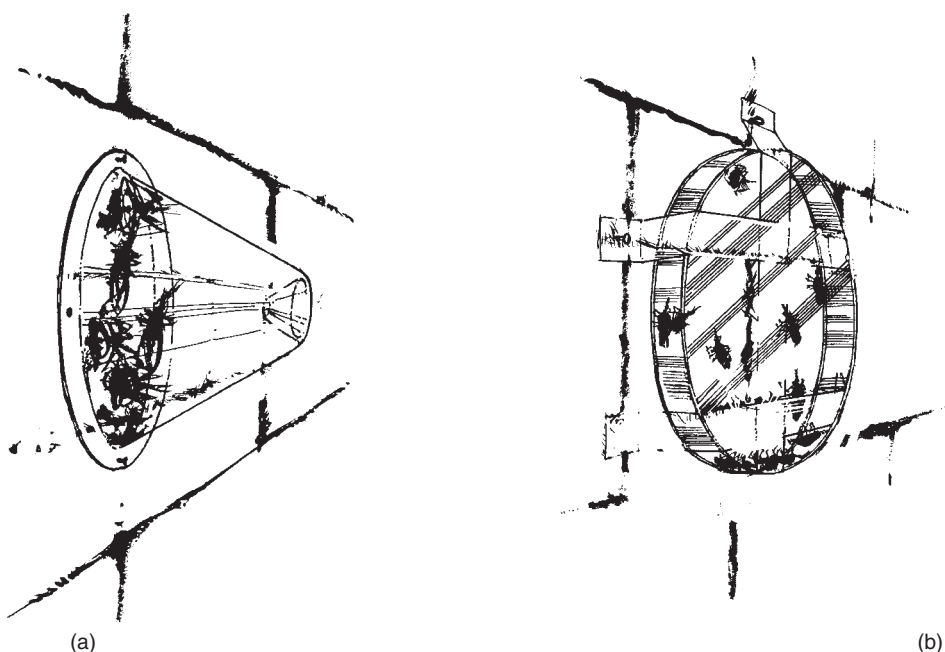


Fig. 3.13

A loss in residual activity of insecticide on a wall can be detected by exposing triatomine bugs to the treated wall surface under a standard WHO bioassay cone (a) or, for example, an inverted Petri dish (b).

Bugs for testing can be obtained from vector control agencies and research institutes or by collection in the field. Be very careful to avoid contact with the faeces of wild bugs because they may be infected with the parasites that cause Chagas disease.

The period of exposure can last from several hours to several days. The duration should be chosen in a test conducted shortly after the insecticide has been applied, such that a mortality of between 90% and 100% among the exposed bugs is achieved. After the exposure period, the bugs should be held for 1–3 days in a cup (Fig. 3.14). The cup should be kept in a cool place and should contain a piece of paper to absorb excrement. At the end of this period, the final mortality is recorded. When a test shows a significantly lower mortality than a previous identical test—say 60% compared with 100%—the insecticide is no longer sufficiently effective.

House improvement

Long-term protection from bugs can be achieved by modifying houses and their immediate surroundings in such a way that resting places are no longer available to the bugs (9–11). Inexpensive methods are available to improve walls, roofs and floors (12). However, bugs coming from surrounding infested houses or the peridomestic environment may continue to find suitable resting places in boxes, behind pictures and so on. House improvement is therefore more effective if carried out simultaneously by most people in a given area (Fig. 3.15).

Existing houses

Walls

Walls can be improved by filling cracks with plaster prepared from locally available materials (Fig. 3.16). Special attention should be given to filling the cracks at the tops of walls, just below roof level.

How to prepare plaster

1. Mix sand (6 parts), sieved earth (1 part), cow dung (1 part) and lime or cement (0.5–1 part). The lime can be prepared by heating locally collected limestone rocks in an open wood-fired kiln for 24 hours, then pulverizing

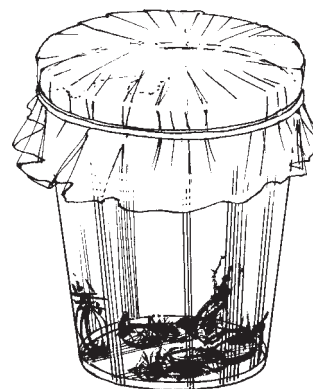


Fig. 3.14
After exposure the bugs are placed in a holding cup for 1–3 days to assess mortality.