CHAPTER 6
Houseflies

Carriers of diarrhoeal diseases and skin and eye infections

The common housefly, *Musca domestica*, lives in close association with people all over the world (Fig. 6.1). The insects feed on human foodstuffs and wastes where they can pick up and transport various disease agents. In addition to the housefly, a number of other fly species have adapted to life in human settlements, where they present similar problems. In warmer climates, the filth fly, *M. sorbens* is of particular interest in this regard. It is closely related to the housefly and considered important in the spread of eye infections. Blowflies (Calliphoridae) and other flies have been associated with the transmission of enteric infections.

Biology

Life cycle

There are four distinct stages in the life of a fly: egg, larva or maggot, pupa and adult (Fig. 6.2). Depending on the temperature, it takes from 6 to 42 days for the egg to develop into the adult fly. The length of life is usually 2–3 weeks but in cooler conditions it may be as long as three months.

Eggs are usually laid in masses on organic material such as manure and garbage. Hatching occurs within a few hours. The young larvae burrow into the breeding material; they must obtain oxygen from the atmosphere and can, therefore, survive only where sufficient fresh air is available. When the breeding medium is very wet they can live on its surface only, whereas in drier materials they may penetrate to a depth of several centimetres.

The larvae of most species are slender, white, legless maggots that develop rapidly, passing through three instars. The time required for development varies from a minimum of three days to several weeks, depending on the species as well as the temperature and type and quantity of food available. After the feeding stage is completed the larvae migrate to a drier place and burrow into the soil or hide under objects offering protection. They form a capsule-like case, the puparium, within which the transformation from larva to adult takes place. This usually takes 2–10 days, at the end of which the fly pushes open the top of the case and works its way out and up to the surface. Soon after emergence the fly spreads its wings and the body dries and hardens. The adult fly is grey, 6–9 mm long and has four dark stripes running lengthwise on the back. A few days elapse before the adult is capable of reproduction. Under natural conditions an adult female rarely lays eggs more than five times, and seldom lays more than 120–130 eggs on each occasion.

Food

Both male and female flies feed on all kinds of human food, garbage and excreta, including sweat, and on animal dung. Under natural conditions flies seek a wide

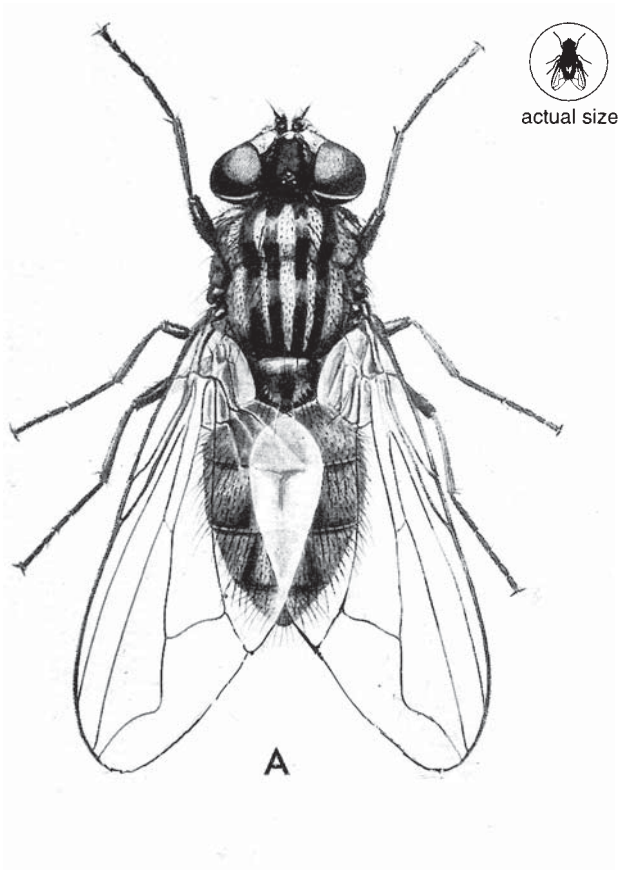

Fig. 6.1
The housefly (*Musca domestica*) (by courtesy of the Natural History Museum, London).

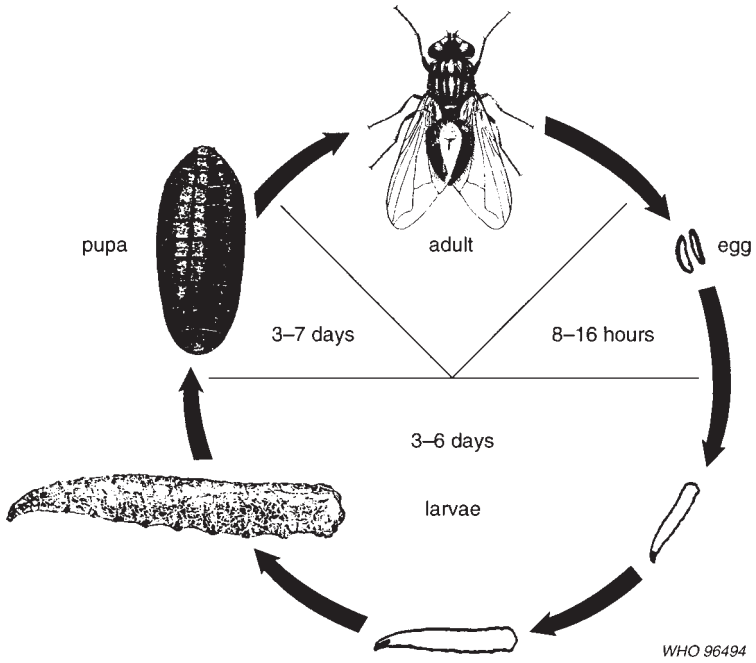

Fig. 6.2
The life cycle of the fly (© WHO).

variety of food substances. Because of the structure of their mouthparts, food must be either in the liquid state or readily soluble in the salivary gland secretions or in the crop. Liquid food is sucked up and solid food is wetted with saliva, to be dissolved before ingestion. Water is an essential part of a fly's diet and flies do not ordinarily live more than 48 hours without access to it. Other common sources of food are milk, sugar, syrup, blood, meat broth and many other materials found in human settlements. The flies evidently need to feed at least two or three times a day.

Breeding sites

Female flies deposit their eggs on decayed, fermenting or rotting organic material of either animal or vegetable origin. Unlike blowflies and fleshflies, houseflies rarely breed in meat or carrion.

Dung

Heaps of accumulated animal faeces are among the most important breeding sites for houseflies. The suitability of dung for breeding depends on its moisture (not too wet), texture (not too solid) and freshness (normally within a week after deposition).

Garbage and waste from food processing

Garbage provides the main medium for breeding (Fig. 6.3). It includes waste associated with the preparation, cooking and serving of food at home and in public places, and with the handling, storage and sale of food, including fruits and vegetables, in markets.

Organic manure

Fields that are heavily manured with organic matter such as dung, excrement, garbage and fish-meal may provide suitable breeding places for flies.

Fig. 6.3
Garbage is the main medium for fly breeding in urban areas.

Sewage

Houseflies also breed in sewage sludge and solid organic waste in open drains, cesspools (underground pools for household sewage) and cesspits.

Accumulated plant materials

Piles of decaying grass clippings, compost heaps and other accumulations of rotting vegetable matter serve as good breeding places for flies.

Ecology of adult flies

An understanding of the ecology of flies helps to explain their role as carriers of disease and allows the planning of control measures. Adult flies are mainly active during the day, when they feed and mate. At night they normally rest, although they adapt to some extent to artificial light.

Resting places

During the daytime, when not actively feeding, flies may be found resting on floors, walls, ceilings and other interior surfaces as well as outdoors on the ground, fences, walls, steps, simple pit latrines, garbage cans, clothes lines, grasses and weeds.

At night, flies are normally inactive. Their favourite resting places at this time are ceilings and other overhead structures. When temperatures remain high during the night, houseflies frequently rest out of doors on fences, clothes lines, electric wires, cords, weeds, grasses, hedges, bushes and trees. These resting places are generally near favoured daytime feeding and breeding areas and sheltered from the wind. They are usually above ground level, but rarely more than five metres high.

Fluctuations in fly numbers

Fly numbers in a given locality vary with the availability of breeding places, sunshine hours, temperature and humidity. Fly densities are highest at mean temperatures of 20–25 °C; they decrease at temperatures above and below this range and become undetectable at temperatures above 45 °C and below 10 °C. At very low temperatures, the species can stay alive in a dormant state in the adult or pupal stage.

Behaviour and distribution

During the day, flies are mainly gathered on or around feeding and breeding places, where mating and resting also take place (Fig. 6.4). Their distribution is greatly influenced by their reactions to light, temperature, humidity, and surface colour and texture. The preferred temperature for resting is between 35 °C and 40 °C. Oviposition, mating, feeding and flying all stop at temperatures below 15 °C.

Flies are most active at low air humidities. At high temperatures (above 20 °C), most houseflies spend the time outdoors or in covered areas near the open air.

Fig. 6.4
Food market. During the day adult flies can be found in large numbers on food tables, garbage and the ground.

When not eating, flies rest on horizontal surfaces and on hanging wires and vertically suspended articles and ceilings indoors, especially at night. A detailed study of local resting places is essential for successful control.

Public health importance

Nuisance

In large numbers flies can be an important nuisance by disturbing people during work and at leisure. Flies soil the inside and outside of houses with their faeces. They can also have a negative psychological impact because their presence is considered a sign of unhygienic conditions.

Diseases

Flies can spread diseases because they feed freely on human food and filthy matter alike. The fly picks up disease-causing organisms while crawling and feeding. Those that stick to the outside surfaces of the fly may survive for only a few hours, but those that are ingested with the food may survive in the fly's crop or gut for several days. Transmission takes place when the fly makes contact with people or their food (Fig. 6.5). Most of the diseases can also be contracted more directly through contaminated food, water, air, hands and person-to-person contact. This reduces the relative importance of flies as carriers of disease.

Fig. 6.5
Humans can be infected by eating food contaminated by flies.

Fig. 6.6
People who keep cattle are sometimes surrounded by large numbers of filth flies (*Musca sorbens*), important vectors of certain eye infections.

The diseases that flies can transmit include enteric infections (such as dysentery, diarrhoea, typhoid, cholera and certain helminth infections), eye infections (such as trachoma and epidemic conjunctivitis) (Fig. 6.6), poliomyelitis and certain skin infections (such as yaws, cutaneous diphtheria, some mycoses and leprosy).

Control measures

Flies can be killed directly by insecticides or physical means such as traps, sticky tapes, fly swats and electrocuting grids. However, they should preferably be controlled by improving environmental sanitation and hygiene. This approach provides longer-lasting results, is more cost-effective and usually has other benefits.

Improvement of environmental sanitation and hygiene

Four strategies can be employed:

— reduction or elimination of fly breeding sites;
— reduction of sources that attract flies from other areas;
— prevention of contact between flies and disease-causing germs;
— protection of food, eating utensils and people from contact with flies.

Reduction or elimination of fly breeding sites

Animal sheds, stables, pens and feed lots

Solid concrete floors with drains should be constructed; dung should be cleaned out and floors should be flushed daily.

Poultry houses

Where birds are kept in cages and dung accumulates below them, fans should be used to dry it; leaking water pipes should be repaired, dung should be removed and the floors should be flushed at frequent intervals.

Dung heaps

Dung should be stacked to reduce the surface area and the zone in which the temperature is suitable for fly breeding. It should be covered with plastic sheets or

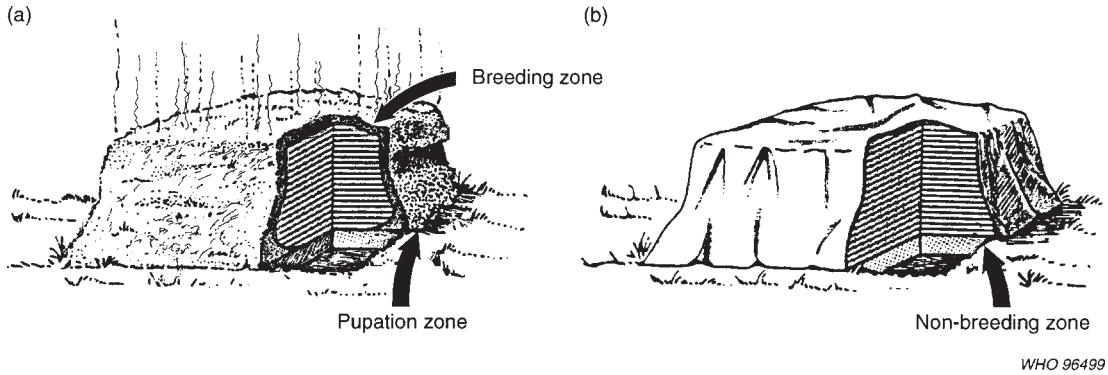

Fig. 6.7
Fly breeding in dung heaps can be prevented by placing a light cover, e.g. a plastic sheet, over the dung; the sheet reduces heat loss and the surface layers become too hot for breeding (© WHO).

other fly-proof material. This prevents egg-laying and kills larvae and pupae as the heat produced in the composting process can no longer escape (Fig. 6.7). It is preferable to stack the dung on a concrete base, surrounded by gutters to prevent the migration of larvae to pupate in soil around the heap. In hot climates, dung may be spread on the ground and dried before the flies have time to develop.

Human excreta

Breeding in open pit latrines can be prevented by the installation of slabs with a water seal and a fly screen over the vent pipe. If a water seal is not feasible, a tightly fitting lid may be placed over the drop hole. Installing a ventilated pit latrine can also reduce fly breeding (see Chapter 1 for more information).

Defecation in the field, other than in latrines and toilets, may provide breeding places for filth flies (*Musca sorbens*). This is a common problem where large groups of people, e.g. refugees, stay together in temporary camps. Installation of proper latrines should be given priority. In the absence of proper facilities, people could be asked to defecate in a special field at least 500 m downwind of the nearest habitation or food store and at least 30 m from a water supply. This reduces the numbers of flies in the camp and makes it easier to remove exposed faeces. Covering the faeces with a thin layer of soil may increase breeding since the faeces are then likely to dry out more slowly.

Garbage and other organic refuse

This breeding medium can be eliminated by proper collection, storage, transportation and disposal (Fig. 6.8). In the absence of a system for collection and transportation, garbage can be burnt or disposed of in a specially dug pit. At least once a week the garbage in the pit has to be covered with a fresh layer of soil to stop breeding by flies.

Flies are likely to breed in garbage containers even if they are tightly closed. In warm climates the larvae may leave the containers for pupation after only 3–4 days. In such places, garbage has to be collected at least twice a week. In temperate climates once a week is sufficient. When emptying a container it is important to remove any residue left in the bottom.

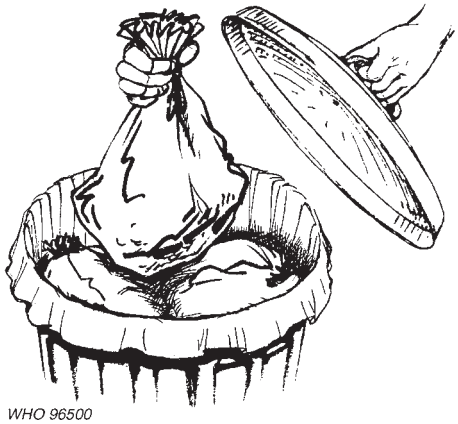

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Fig. 6.8
Good garbage containers with tightly fitting lids may help to reduce fly breeding in towns.

In most countries, garbage is transported to refuse dumps, where, to reduce breeding, it is necessary to compact the refuse and cover it daily with a solid layer of soil (15–30 cm). Such dumps should be at least several kilometres away from residential areas.

As discussed in Chapter 1, refuse can be used for filling mosquito breeding places in borrow-pits, marshy areas and other low-lying sites. If properly covered with soil, the sites are called sanitary landfills (Fig. 6.9).

In some cities, large quantities of refuse are burned in incinerators. In dry areas, simple small incinerators can be installed.

Soil impregnated with organic matter

Accumulations of sludge and solid organic waste in open sewage drains, cesspools and seepage pits have to be removed (Fig. 6.10). Drains can be flushed out afterwards. Fly breeding can be reduced by covering the drains but, as discussed in Chapter 1, this may cause problems when drains are not maintained properly. Outlets of wastewater on soil should be eliminated.

Special precautions should be taken in abattoirs and places where fish is handled and sold. If possible, concrete floors should be installed with drains to facilitate cleaning.

In places where manure is used to fertilize fields, heavy applications in lumps should be avoided.

Reduction of sources that attract flies from other areas

Flies are attracted by the odour emanating from breeding sites. In addition they are attracted by products such as fish-meal and bone-meal, molasses and malt from breweries, milk, and sweet-smelling fruit, especially mangoes.

Attraction to waste can be prevented by cleanliness, the removal of waste, and its storage under cover. Industries using attractive products can install special exhausts for odours.

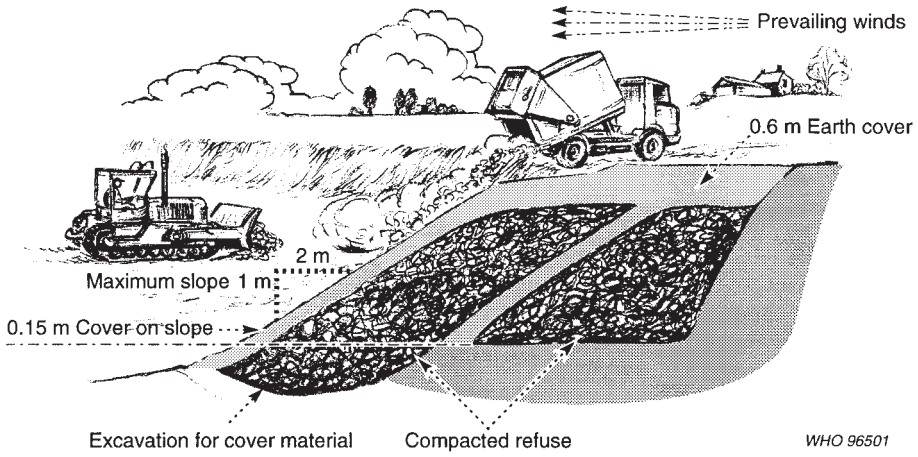

Fig. 6.9
Sanitary landfill (*1*).

Fig. 6.10
Regular cleaning of drains is needed to avoid fly breeding in accumulations of garbage.

Prevention of contact between flies and disease-causing germs

The sources of germs include human and animal excrement, garbage, sewage, infected eyes, and open sores and wounds. Measures to eliminate fly breeding also reduce contact between flies and germs. The most important are:

— the installation and use of proper latrines and toilets where flies cannot make contact with faeces;
— the prevention of contact between flies and sick people, their excreta, soiled baby nappies, open sores, and infected eyes;
— the prevention of access of flies to slaughter offal and dead animals.

Protection of food, eating utensils and people from contact with flies

Food and utensils can be placed in fly-proof containers, cupboards, wrapping materials, etc. Nets and screens can be used on windows and other openings. Doors can be made self-closing. Doorways can be provided with anti-fly curtains, consisting of strings of beads or plastic strips which touch each other and prevent flies from passing through (Fig. 6.11). Nets can be placed over babies to protect them from flies, mosquitos and other insects, and can also be used to cover food or utensils (Fig. 6.12). Electric fans can create an air barrier across entrances or corridors that have to be kept open.

The screening of buildings is the most important method but it may cause inconvenience because of reduced ventilation and light. Mesh with openings of 2–3 mm is sufficient unless it is desired to exclude mosquitos also, in which case the openings should be 1.5 mm or less (see Chapter 1). Plastic-coated material is preferable to metal because the latter may corrode.

Flies that enter screened rooms can be killed with traps, sticky tapes or space sprays delivered from an aerosol spray can.

Fig. 6.11
Door screens made of strings of beads can serve as a barrier against flies and other insects.

Fig. 6.12
Self-supporting fly nets can be used to protect babies from flies.

Methods of killing flies directly

The methods that can be used to kill flies directly can be classified as physical or chemical. They are presented below roughly in order of increasing complexity to the user.

Physical methods

Physical control methods are easy to use and avoid the problem of insecticide resistance, but they are not very effective when fly densities are high. They are

particularly suitable for small-scale use in hospitals, offices, hotels, supermarkets and other shops selling meat, vegetables and fruits.

Fly traps

Large numbers of flies can be caught with fly traps. An attractive breeding and feeding place is provided in a darkened container. When they try to leave, the flies are caught in a sunlit gauze trap covering the opening of the container. This method is suitable only for use out of doors.

One model consists of a plastic container or tin for the bait, a wooden or plastic cover with a small opening, and a gauze cage resting on the cover. A space of 0.5 cm between the cage and the cover allows flies to crawl to the opening (Fig. 6.13).

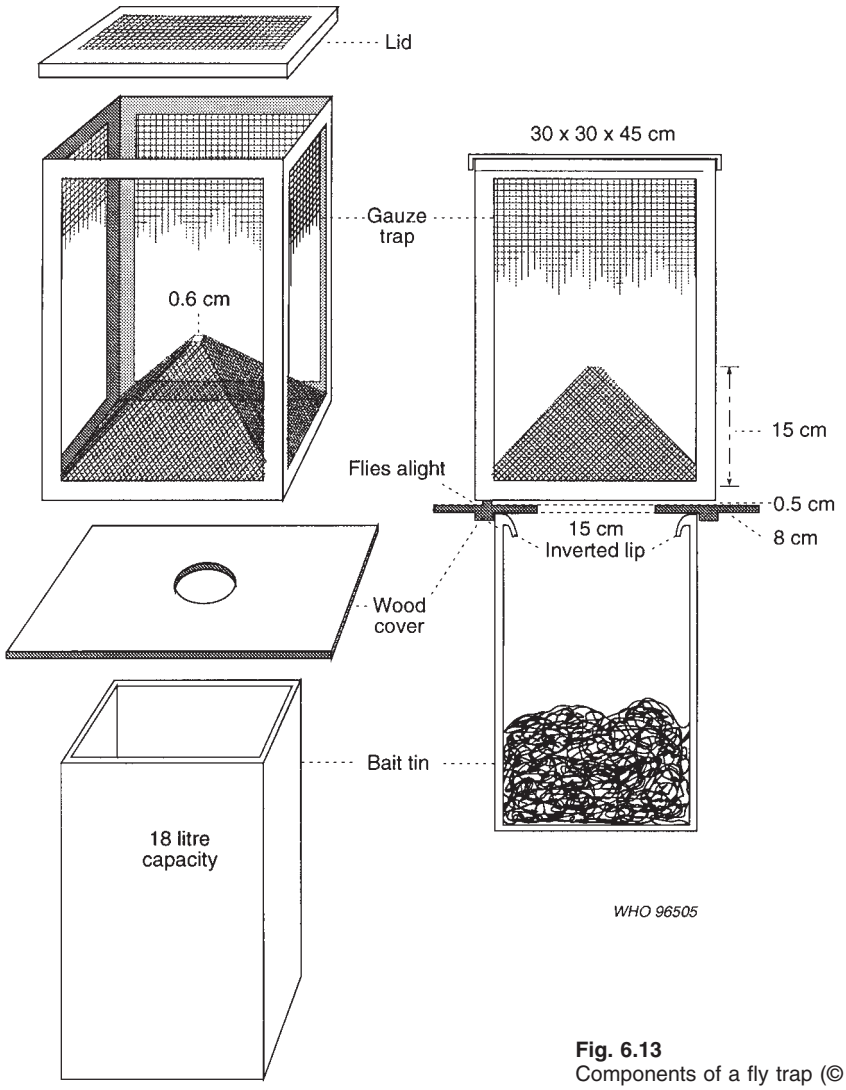

Fig. 6.13
Components of a fly trap (© WHO).

The container should be half-filled with bait, which should be loose in texture and moist. There should be no water lying at the bottom. Decomposing moist waste from kitchens is suitable, such as green vegetables and cereals and overripe fruits. Chunks of decomposing meat or fish can be added. Where evaporation is rapid the bait has to be moistened on alternate days. Other suitable baits are described on p. 316.

After seven days the bait will contain a large number of maggots and needs to be destroyed and replaced. Flies entering the cage soon die and gradually fill it until the apex is reached and the cage has to be emptied. The trap should be placed in the open air in bright sunlight, away from shadows of trees.

Sticky tapes

Commercially available sticky tapes, suspended from ceilings, attract flies because of their sugar content. Flies landing on the tapes are trapped in a glue. The tapes last for several weeks if not fully covered by dust or trapped flies.

Light trap with electrocutor

Flies attracted to the light are killed on contact with an electrocuting grid that covers it (Fig. 6.14). Blue and ultraviolet light attracts blowflies but is not very effective against houseflies. The method should be tested under local conditions before an investment is made. It is sometimes used in hospital kitchens and restaurants.

Chemical methods

Control with insecticides should be undertaken only for a short period when absolutely necessary because flies develop resistance very rapidly. The application of effective insecticides can temporarily lead to very quick control, which is essential during outbreaks of cholera, dysentery or trachoma.

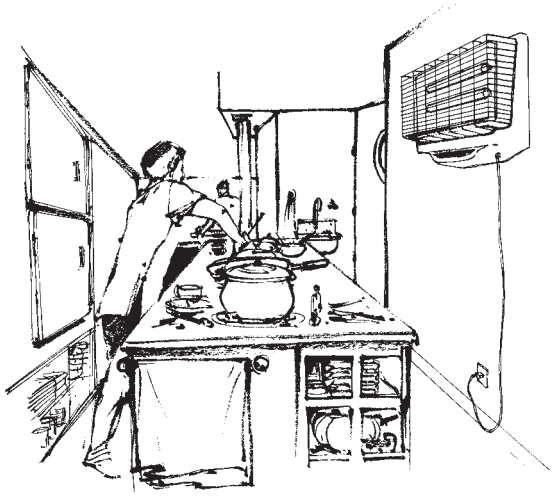

Fig. 6.14
Light trap with electrocutor.

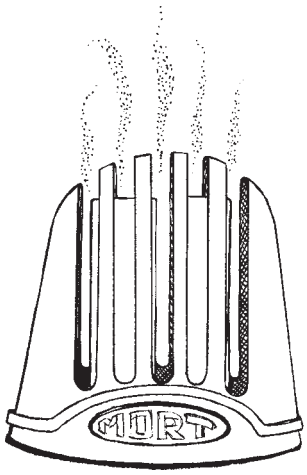

Fig. 6.15
A dichlorvos vapour dispenser.

Dichlorvos vaporizer

Insecticide vaporizers such as strips of absorbent material impregnated with dichlorvos are commercially available (Fig. 6.15). They release dichlorvos slowly over a period of up to three months provided that ventilation is limited. Most strips are made to treat rooms of 15–30 m^3.

This method is effective only in places with little ventilation. There is a possible danger of some toxic effects in humans and the method should not be used in rooms where infants or old people are sleeping. For more information, see Chapter 1, p. 68.

Introduction of toxic materials to resting sites

The idea of providing toxic resting sites for flies is based on the observation that houseflies prefer to rest at night on edges, strings, wires, ceilings and so on. Materials that can be impregnated with insecticide include bednets, curtains, cotton cords, cloth or gauze bands and strong paper strips. The strips can be effective for many weeks in both tropical and temperate areas. This method is cheap, has a long residual effect and is less likely to provoke insecticide resistance than are residual sprays. However, it does not work in rooms with an air draught under the ceiling, which is the case in many ventilated rooms and stables. Fly numbers are initially reduced rather slowly and other chemical methods may be more effective in giving immediate results.

Application

The materials are dipped in a diluted emulsion of insecticide, possibly with some sugar, glycerol or other attractant and glue or oil for making a durable film. After dipping, the liquid is allowed to drip off and the strips to dry. An old method makes use of bunches of twigs soaked in a toxic solution.

In the 1950s, a cheap but very toxic insecticide, parathion, was used commercially to treat bands or cords. Safer for humans and therefore preferred today are organophosphorus compounds such as diazinon, fenchlorphos, malathion, fenthion, dimethoate and trichlorfon; carbamates such as propoxur and

Fig. 6.16
Strips or cords of cotton, cloth or gauze impregnated with a long-lasting insecticide can easily be suspended from ceilings.

dimetilan; and pyrethroids such as cypermethrin, deltamethrin, permethrin and cyfluthrin.

When preparing the materials it should be borne in mind that high concentrations of insecticide may be repellent or irritant to flies. Lower concentrations may therefore be more effective. The attractance or repellency of several dosages can be tested under field conditions. A solution strength of 1–10% usually gives good results with organophosphorus and carbamate insecticides.

The impregnated materials are suspended under the ceiling or other fly-infected place at the rate of about 1 metre per square metre of floor area. Vertical parts or loops are more attractive to flies than horizontal ones, and red or dark colours are better than light ones. The materials can be attached by stapling and pinning or can be suspended from a horizontal line stretched along the ceiling (Fig. 6.16).

The cords or bands can also be stretched on frames which can then be moved as required. The strips may be used in animal sheds, poultry farms, markets, shops, restaurants and any other fly-infested area.

Attraction of flies with toxic baits (Table 6.1)

Traditional toxic baits made use of sugar and water or other fly-attracting liquids containing strong poisons such as sodium arsenite. Milk or sweet liquids with 1–2% formaldehyde can still be recommended for killing flies. Improvements became possible with the development of organophosphorus and carbamate compounds that are highly toxic to flies but relatively safe to humans and other mammals.

Table 6.1
Insecticides used in toxic baits for fly control

Insecticide	Dry scatter	Liquid sprinkle	Liquid dispenser	Viscous paint-on
Organophosphorus compounds				
dichlorvos[a]	+[b]	+ +[b]	+ +	
dimethoate[a]		+	+ +	
trichlorfon[a]	+ +	+ +	+ +	+ +
azamethiphos	+			+ +
diazinon	+ +	+		+
fenchlorvos	+	+		+
malathion	+	+		+
naled	+	+		+
propetamphos				+ +
Carbamates				
bendiocarb	+ +	+		
dimetilan[a]		+	+ +	+
methomyl[c]				+ +
propoxur	+ +	+		
formaldehyde[a]			+	

[a] Aqueous suspension.
[b] + or + + indicates insecticides that are most suitable or have been most widely used for the particular type of application.
[c] Can also be used in the form of granules stuck on strips or boards.

The power of a bait depends on (a) the natural attractants to which the flies are adapted and (b) the degree of competition from other attractants (food). As a rule, baits do not attract flies at a distance. However, special attractants, other than sugar, may greatly increase the effect of baits to a radius of a few metres. These attractants include fermented yeast or animal protein (e.g. whole egg), ammonium carbonate, syrups and malt. A commercially available synthetic fly attractant, SFA, has proved to be very effective in poultry farms in certain areas. It consists of 88% commercial fish-meal, 5% ammonium sulfate, 5% trimethylamine hydrochloride, 1% linoleic acid and 1% indole. The attractants are slowly released when the bait is moistened. Another commercially available attractant is the fly pheromone muscalure which may attract flies up to three weeks after application.

Advantages

The various types of bait are cheap and easy to use. The control of flies is effective in places with moderate availability of fly breeding sites. The scattering or sprinkling of certain types of bait can cause marked reductions in fly densities within a few hours. Such applications have to be repeated up to six times a week for good control. Liquid bait dispensers and stations (trays) for dry baits may continue to be effective for a week or two. The paint-on bait is the most convenient: it can be applied easily on both horizontal and vertical fly-resting surfaces and can have a long residual effect. Flies are less likely to develop resistance to toxic baits than to residual sprays. Even flies that have developed resistance to an insecticide applied on a surface may still be killed by it in a bait formulation.

Disadvantages

Baits that are sprinkled or scattered require frequent application. Liquid baits must be placed out of reach of children and animals.

Types of bait

Dry scatter baits

These contain 0.1–2% of insecticide in a carrier, which may be plain granular sugar or sugar plus sand, ground corncobs, oyster shells, etc. Another attractant may be added. The bait should be scattered in thin layers of 60–250 g per 100 m^2 on resting places such as floors. It can also be placed in special bait stations: trays or containers made of metal, wood, cardboard, etc. It is most effective if there are suitable surfaces where it can be applied.

Liquid sprinkle baits

These contain insecticide (0.1–0.2%) and sugar or other sweetening agents (e.g. 10%) in water. The liquid is applied by a sprinkling can or a sprayer to floors in places where there are no children or animals, as well as to other suitable horizontal or vertical surfaces, out of reach of animals and children.

Liquid bait dispensers

These hold formulations similar to the liquid sprinkle baits and consist of a container, inverted jar or bottle feeding trough, and a sponge or wick with the liquid (Fig. 6.17). Alternatively, mats or balls of absorbent material may be impregnated with insecticide and moistened for use.

Viscous paint-on baits

These are composed of an insecticide (2–6%), a binder and sugar (or just insecticide in syrup or molasses) to form a paint that can be applied with a brush to partitions, walls, posts, window areas and ceilings or to strips, plates, etc., which are suspended or otherwise fastened where there are concentrations of flies (Fig. 6.18). The bait sticks to the surface and may be active for weeks or months. Trichlorfon is a commonly used insecticide for this type of application. Flies that are not killed on contact with the treated surface may be killed through feeding on the bait.

Treatment of resting sites with residual insecticides

Surfaces on which flies rest can be sprayed with a long-lasting insecticide (see

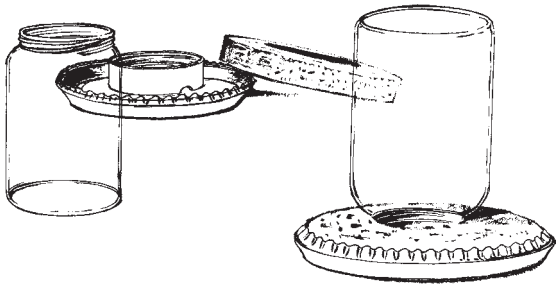

Fig. 6.17
A liquid bait device in which a sponge is kept wet by an inverted, partially filled jar.

Fig. 6.18
Painting of toxic bait on places where flies often rest.

Chapter 9). This method has both an immediate and a long-term effect. Depending on the insecticide, the wall surface material, temperature, humidity, exposure to sunlight and the level of resistance in the flies, residual effectiveness can last from several days to a period of weeks. It is important to know where the flies spend most of their time at night. Only surfaces that have been observed to be used as resting sites should be sprayed. Residual spraying is mainly carried out in animal units on farms.

Disadvantages

The selection of an insecticide is difficult because the results given by a particular compound are likely to be good in one area and disappointing in another. The risk of resistance developing in flies is greater with residual sprays than with other chemical treatments used against adult flies.

Insecticides

Table 6.2 indicates a number of insecticides and recommended application rates for residual spraying. Prior to selection it is best to consult an expert in pest control.

Applications are made with hand-operated sprayers (Chapter 9) or power-operated sprayers at low pressure to avoid the insecticide particles drifting away.

Space-spraying

Flies can be quickly knocked down and killed by mists or aerosols of insecticide solutions or emulsions. The treatment is carried out by spraying with pressurized aerosol spray cans, hand-operated sprayers or small portable power-operated sprayers. The principle is to fill a space with a mist of small droplets that are picked up by the insects when they fly.

Table 6.2
Organophosphorus and pyrethroid insecticides used for residual treatment in fly control

Insecticide	Dosage (g/m^2) of active ingredient	Remarks
Organophosphorus compounds[a]		
azamethiphos	1.0–2.0	Mainly sold as a sugar bait.
bromophos	1.0–2.0	Low level of resistance in most places.
diazinon	0.4–1.0	
dimethoate	0.25–1.0	
chlorfenvinphos	0.4	Resistance problems in most areas.
fenchlorvos	1.0–2.0	
fenitrothion	1.0–2.0	
jodfenphos	1.0–2.0	
malathion	1.0–2.0	
pirimiphos methyl	1.0–2.0	Low level of resistance in most places. Mainly used as sugar bait formulation.
propetamphos	0.25–1.0	
trichlorfon	1.0–2.0	
Pyrethroids		
alphacypermethrin	0.02	In Canada and some parts of Europe resistance develops quickly.
cyfluthrin	0.03	
cypermethrin	0.025–0.1	
deltamethrin	0.01–0.15	
fenvalerate	1.0	
permethrin	0.025–0.1	

[a] For most of the organophosphorus compounds there are restrictions in some countries on their use in dairies, food-processing plants or other places where food is exposed, and several of these compounds are also restricted as regards exposure to chickens, dairy cows and other animals present during spraying.

Compared with residual spraying of resting surfaces, space-spraying has an immediate effect but it is short-lasting. The risk of the development of insecticide resistance is less. The method can be used indoors, outdoors and for direct spraying of aggregations of flies.

Indoor space treatments

In animal sheds, space sprays are mainly used as a supplement to residual treatments or toxic baits, but on farms where the latter treatments fail (e.g. because of resistance), frequent space-spraying may be used as a primary means of chemical control. The insecticide chosen should be safe for use with domestic animals. The treatments should be done when as many flies as possible are indoors, e.g. in the evenings.

Advantages: indoor space sprays are useful for achieving quick reductions in fly densities in houses, kitchens, restaurants, shops, animal sheds, etc. (Fig. 6.19).

Disadvantages: space sprays should not be used in kitchens or restaurants when meals are being prepared or served; the effect is limited and such sprays are mainly suitable when used as an additional method.

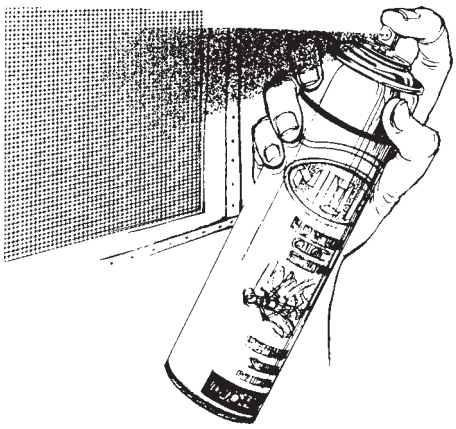

Fig. 6.19
Aerosol spray cans are widely available and are effective in killing houseflies in confined spaces.

Outdoor space treatments

Such treatments are used for quick temporary control of flies, e.g. on refuse dumps where adequate cover by soil is not possible, in recreational areas, markets and food industries, or for area control in cities and towns, especially in emergencies.

As a rule the method has only a temporary effect and it kills only flies that are exposed outdoors. Flies indoors or resting in sheltered locations may survive; those emerging from breeding sites are not controlled. Space treatments should be applied when fly densities are at a peak, for example in the morning. Daily treatments over a period of, say, two weeks may reduce the density to a level where further control can be obtained by treatments at longer intervals, e.g. 1–2 weeks.

Advantage: fly densities are reduced quickly.

Disadvantages: costs can be high because applications may have to be repeated; the method is not very successful where fly breeding sources are abundant; effectiveness depends on air currents during spraying.

Application involves mist spraying, fogging or ultra-low-volume spraying. This is done by power-operated equipment from the ground or the air. Mistblowers are most practical because they are less dependent on air currents to distribute the insecticide. Insecticides and effective dosages for outdoor space-spraying are indicated in Table 6.3.

Direct spraying of fly aggregations

Concentrations of flies on garbage can be sprayed directly with a hand- or power-operated sprayer, delivering a relatively wet spray that kills flies hit directly and leaves a toxic residue that kills those crawling over treated surfaces later in the day. These treatments may also kill larvae.

A range of organophosphorus compounds can be used in kerosene solution or aqueous emulsion at concentrations of 1–2%.

Treatment of breeding sites with larvicides

Chemical substances that kill larvae are mainly used on dung on farms. An important advantage is that control at this stage tackles the problem at its base. However, there are several drawbacks: because the dung is continuously accumulating and changing, larvicides have to be applied frequently to ensure good

Table 6.3
Dosages effective in outdoor space treatments for fly control[a]

Insecticide	Dosage (g/ha) of active ingredient	Insecticide	Dosage (g/ha) of active ingredient
Organophosphorus compounds		**Pyrethroids**	
azamethiphos	50–200	bioresmethrin[b]	5–10
diazinon	340	cyfluthrin	2
dichlorvos	340	deltamethrin	0.5–1.0
dimethoate	220	phenothrin[b]	5–10
fenchlorvos	450	permethrin[b]	5–10
jodfenphos	350	pyrethrins[b]	20
malathion	670	resmethrin[b]	20
naled	220		
pirimiphos methyl	250		

[a] In areas where flies are not resistant to the insecticide.
[b] May be combined with other pyrethroids giving quick knockdown or with a synergist such as piperonyl butoxide (5–10 g/ha).

penetration and distribution. Another problem is that larvicides often kill the natural enemies of the flies, such as beetles, mites and earwigs. The use of larvicides may favour the development of resistance; the choice of compound should therefore be made carefully.

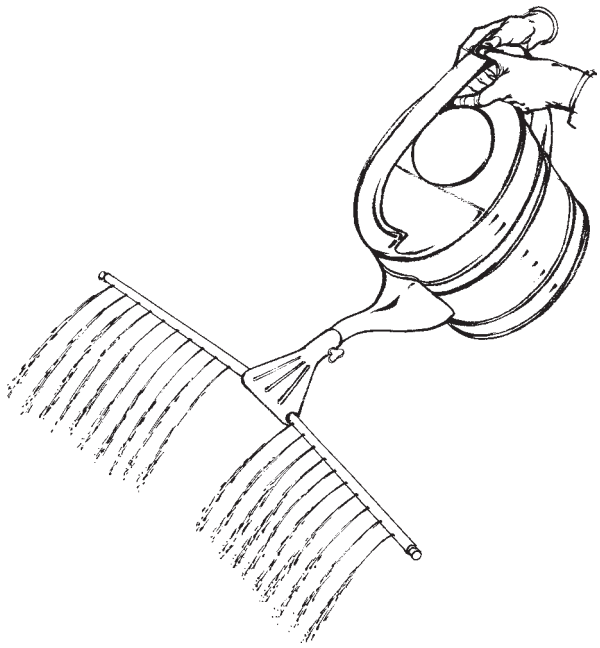

Fig. 6.20
Application of larvicide with a watering can.

Provided there is no resistance, effective compounds and their recommended rates are as follows:

— the organophosphorus compounds dichlorvos and diazinon at 0.3–1.0 g/m^2, and trichlorfon, dimethoate, fenchlorvos, tetrachlorvinphos, bromophos, fenitrothion and fenthion at 1–2 g/m^2;
— the insect growth regulators diflubenzuron, cyromazine and triflumuron at 0.5–1.0 g/m^2 and pyriproxyfen at 0.1 g/m^2; this group prevents larval development for 2–3 weeks.

Larvicides are applied with a sprayer or a watering can as emulsions, suspensions or solutions (Fig. 6.20). The dosage has to be sufficient to wet the upper 10–15 cm of the substrate, i.e. 0.5–5 litres/m^2.

Reference

1. Keiding J. *The housefly—biology and control. Training and information guide (advanced level)*. Geneva, World Health Organization, 1986 (unpublished document WHO/VBC/86.937; available on request from Division of Control of Tropical Diseases, World Health Organization, 1211 Geneva 27, Switzerland).

Selected further reading

The housefly. Training and information guide (intermediate level). Geneva, World Health Organization, 1991 (unpublished document WHO/VBC/90.987; available on request from Division of Control of Tropical Diseases, World Health Organization, 1211 Geneva 27, Switzerland).