Reviewed and Validated – October 2011

Armed Forces Pest Management Board

TECHNICAL GUIDE NO. 30

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Filth Flies

Significance, Surveillance and Control in Contingency Operations

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Published and Distributed by
Armed Forces Pest Management Board
Information Services Division
Forest Glen Section/Walter Reed Army Medical Center
Washington, DC 20307-5001

Office of the Deputy Under Secretary of Defense
(Installations and Environment)

Filth Flies

Significance, Surveillance and Control in Contingency Operations

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FILTH FLIES

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Acknowledgments

Preparation of this Technical Guide (TG) was facilitated by Dr. Herbert T. Bolton, CAPT USN (retired), who generously lent his expertise to its development. Dr. Stephen B. Berté, COL USA (retired), CAPT Mark Beavers, USN, and COL Gene Cannon, USA (retired), also provided professional guidance. Col Brian Spears, USAF (retired), consulted on aspects of aerial pesticide application. Figure 1 was provided by the Centers for Disease Control and Prevention (CDC). Keys and figures in Appendix A were taken from the Medical Entomology Handbook published by the Naval Medical School (1967); the originals were from the CDC or the Notes on Medical Entomology, published by the Naval Medical School (1942). Figures in Appendix B were taken from the U.S. Navy Manual of Preventive Medicine and U.S. Army Field Manual 21-10-1, Unit Field Sanitation Team. Thomas Burroughs, USAPHC, provided the resistance testing information in Appendix D.

AFPMB TECHNICAL GUIDES

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SECTION 1. INTRODUCTION

Filth flies have been, and will continue to be, a major preventive medicine issue during military exercises and operations conducted in warm weather. Filth flies have been implicated as vectors of disease agents, especially in refugee and prisoner of war camps. They can also be a tremendous nuisance when they interfere with and degrade mission performance. Fly problems may develop around field messing facilities that have inadequate screening, which can result in unsanitary conditions that make it difficult to protect food from fly-borne contamination. Likewise, field latrines constructed without adequate fly exclusion can be virtually unusable. In mass casualty situations, such as battlefields and natural disasters, flies will breed in corpses and wounds if they are not controlled or excluded. For these reasons, fly control is often a major responsibility of utmost importance for preventive medicine personnel.

This TG provides basic information about the biology of several fly species known collectively as filth flies. Their medical importance and nuisance impacts are presented within the context of military operations and exercises. In accordance with Department of Defense policy on pesticide use, this TG also provides guidance on preventing fly problems, and implementing control strategies using pesticides and traps.

SECTION 2.
SIGNIFICANCE OF FILTH FLIES TO MILITARY OPERATIONS

2-1. Historical Examples of the Medical Impact of Filth Flies

Filth flies historically have had and continue to have an impact on combat, peacetime contingency operations, disaster relief operations, and refugee health support operations.

Filth flies may interfere with military operations through transmission of disease-causing organisms, contamination of food, myiasis (larval infestation of human and animal tissue), and annoyance or distraction from the job at hand. An increasingly persuasive body of evidence, described in detail below, suggests that flies play a major role in the spread of enteric disease agents. These pathogens have impacted military operations throughout history, underscoring the need for fly control.

Reports of concurrent increases in fly populations and incidence of diarrhea in North African and Middle Eastern military campaigns during World Wars I and II are numerous (Levine and Levine 1991). Colonel J.C.G. Ledingham (1920), Royal Army Medical Corps, Mesopotamian Expeditionary Force in WW I, found a strong correlation between fly density and the incidence of dysentery. In the World War II battle of El Alamein in North Africa, Axis forces suffered severe losses to combat troops due to dysentery presumably from flies.. On Pacific Islands during World War II, flies developed in corpses on battlefields and excrement in latrines to levels beyond modern comprehension. On Saipan in the summer of 1944, DDT applied from C-47 type aircraft at 7-day intervals was required to bring blow flies under control (Hall 1948). In 1958, a United States Marine Corps (USMC) force sent to Lebanon was incapacitated by dysentery within two weeks. USMC forces deployed to Lebanon in 1982 and 1983 relied heavily upon preventive medicine for protection. This commitment by preventive medicine personnel, which included extensive fly control efforts, resulted in a very low incidence of diarrhea (Daniell et al. 1985).

Flies were a monumental nuisance during the Vietnam War. Reports from one mess hall stated that the fly infestation was so heavy it was difficult to eat without ingesting one or two. It is impossible to estimate the disease transmission that may have been caused by flies in Vietnam, but it was undoubtedly significant. Several factors combined to make flies such a large problem. Many of the flies were breeding in villages near military camps, where they had easy access to animal feces, garbage, and poorly maintained dumps. Garbage collection and land filling, especially at smaller bases, were often inadequate. Human feces in burn barrels were sometimes not completely incinerated. Grease traps were overused or used incorrectly, and heavy rains often interfered with the correct functioning of grease traps and soakage pits. The hot and humid climate was conducive to rapid increases in fly populations. Also, corpses left in the field for several days were heavily infested with maggots, which necessitated application of pesticides inside body bags.

Similar problems were encountered in the Persian Gulf War of 1991 and in subsequent humanitarian relief operations. In 1992-93, relief forces in Somalia faced persistently inadequate sanitation in local villages and cities, resulting in huge fly problems in U.S. military camps. A combination of poor sanitation in Mogadishu and numerous livestock yielded large populations of *Musca* species. The situation was compounded by varying levels of sanitation (particularly in food service programs) between different contingents of the international relief force.

A Korean Airlines jet crashed on Guam in 1997, resulting in over 200 deaths. Victims were still being recovered 10 days after the crash. Preventive medicine personnel from the U.S. Naval Hospital, Guam, used Fly-Tek (Methomyl) in an attempt to protect corpses; however, many bodies had been almost entirely consumed by maggots before they could be recovered.

Flies have impacted both Operation Enduring Freedom and Operation Iraqi Freedom. In these conflicts, there has been a highly variable mix of well-developed infrastructure, which limits the impact of flies to nearly nothing, and primitive expeditionary camps where fly problems are much more significant. In the larger camps in more stable areas, garbage is either burned at a location that is well away from the populated parts of the camp, efficiently incinerated to minimize fly breeding, or hauled off the camp by contractors. In all these cases, fly problems are minimal. However, very often camps are placed in the middle of unsecure population centers. This can lead to the worst of all situations. The security situation is such that trash cannot be hauled away by contractors. That means that it has to be burned at the camp. Unfortunately, these same bases are usually so small that the burn pit is within close proximity of the camp's population. Very often in these cases, the burning in the burn pit is not efficient. Kitchen waste, primarily food items, is too wet to burn. Moreover, food waste gets seared on the outside, forming a crust and sealing in moisture. This can create perfect fly breeding habitat, which is compounded by the fact that the camp's population is close-by.

2-2. Current Literature on Disease Agent Transmission by Filth Flies

Filth flies have been implicated in the direct and indirect mechanical transmission of a number of pathogens responsible for human diseases, especially those causing diarrheal illness. Mechanical transmission is the transfer of pathogens from one location to another, usually passively or unintentionally. Thus, mechanical transmission of disease organisms is facilitated by adult filth flies' habit of walking and feeding on materials that tend to be contaminated, then doing the same on food to be consumed by humans. Secretion of crop contents and defecating while feeding while feeding also increase the potential for transmission of pathogens by flies.

The common factor in the ecology of several species of filth flies is their utilization of decomposing organic materials as food sources for the adults and developmental media for their maggots (larvae). Considering that these materials are often carrion, feces and food wastes (all, potentially, with associated pathogens), the potential for flies becoming contaminated can be quite high. Filth flies have numerous hair-like structures on their legs and bodies that dramatically increase their surface area and aid in harboring pathogens. Their deeply channeled mouthparts and hairy feet, each with sticky pads, can easily be contaminated when in contact with contaminated substrates. Filth flies are potential mechanical vectors of disease-causing organisms because pathogens can be transferred from their contaminated bodies to our food, eyes, noses, mouths, and open wounds.

Filth flies are attracted to a variety of rotting organic materials and feces, but they are also attracted to human foods. In addition to the great number of pathogens filth flies may carry on their body surfaces, they may transmit pathogens to our food in their saliva and feces. Most filth flies have sponging mouthparts and are capable of consuming foods only in a liquid state. Solid foods are liquefied by regurgitating the crop contents (along with any pathogens) onto the food material, allowing the vomit to liquefy the solid food. Flies then suck the liquefied food (along with any pathogens) into their digestive tracts. Flies further contaminate food by defecating on it while they feed. Fecal spots are usually darker than vomit spots. House flies can produce from 16 to 31 spots in 24 hours (most of them vomit spots) after just one feeding of milk. From this it is easy to speculate about how many spots could be produced in a food service facility by 10, 50, or 100 flies having constant access to various food sources. Kobayashi et al. (1999) showed that *Escherichia coli* O157:H7, an extremely virulent serotype of this common bacterium, actively proliferates in the minute spaces of house fly mouthparts, and that this proliferation leads to persistence of the bacteria in fly feces. Based on DNA evidence, they implicated house flies as the source of *E. coli* in an outbreak in a daycare center in Kyushu in western Japan.

Table 1. Significant Pathogens of Human Diseases Known to Contaminate Filth Flies		
amoebic dysentery	Hepatitis virus	*Shigella*
anthrax	intestinal worms	*Streptococcus*
cholera	leprosy	trachoma
diphtheria	Polio virus	tuberculosis
Escherichia coli	rotavirus	typhoid fever
Eyeworms	*Salmonella*	yaws

Over one hundred pathogens that can cause disease are known to contaminate filth flies; the most significant are listed in Table 1. The role that filth flies play in actually transmitting pathogens to humans and to what extent this transmission leads to disease depends on the pathogen and associated environmental factors. In some instances transmission by flies may be significant, while in other instances it is nonexistent. Just because a pathogen is recovered from a fly does not mean that successful transmission is possible.

a. Fly Control and Enteric Bacterial Infections

A growing number of studies have shown a direct association between control of flies in developing countries and reduced morbidity from diarrheal and eye diseases. Graczyk et al. (2001) provides a good review. While shigellosis is felt to be primarily a disease of unwashed hands, Watt and Lindsay (1948) (text box) showed a strong correlation between filth fly populations and *Shigella* rates in humans. Nichols (2005) noted a close association between high filth fly populations and rates of gastrointestinal illness caused by *Campylobacter* in England. The seasonal aspect of *Campylobacter* in England is so well known that these outbreaks are referred to as summer diarrhea. Echeverria et al. (1982) showed that fly populations increased at the same time as the incidence of diarrheal disease in a village in Thailand. Cohen et al. (1991) (text box) reported that after a 65% reduction in housefly density, clinic visits for diarrheal diseases by Israeli soldiers decreased by 42% overall and 85 % specifically for *Shigella*. Emerson (1999) reported 75 % fewer cases of trachoma and 22 % fewer cases of childhood diarrhea associated with a 75 % reduction in fly populations, after 3 months of fly control in villages in Gambia. Chavasse et al. (1999) described dramatic reductions in diarrheal rates associated with fly control in rural Pakistani villages. This is a small number of studies; more study of the effects of fly control on enteric morbidity is needed. Perhaps more significant is the fact that no studies could be found that showed no reduction in enteric morbidity associated with effective fly control.

As the military becomes increasingly involved in humanitarian operations, especially in disaster relief, understanding the role of flies in the spread of disease is critical. Very often, there are debates over how military resources can be used for the most good in disaster relief. Fly control is often necessary after a natural disaster. Aside from the likely reduction in morbidity from fly control, relief from the fly nuisance is of extreme importance. Several studies demonstrate that fly populations increase dramatically after natural disasters. After the South Asian tsunami in 2004, fly populations in rural villages increased dramatically (Srinivasan et al. 2006, Yanagi et al. 2008). These increases were associated both with the immediate destruction caused by the tsunsami, and with the breeding sources associated with more primitive infrastructure in ruined villages and refugee camps.

Relationships between Filth Flies and *Shigella* (from Watt and Lindsay, 1948)

In 1948 in South Texas, near the mouth of the Rio Grande, five of nine towns were selected for fly control using DDT. Towns where flies were controlled had reduced shigellosis rates. After 20 months, the fly control regime was reversed, with control implemented in the towns that had none and ceasing in the towns that had it initially. The resulting shigellosis, reported diarrhea, and infant mortality trends reversed accordingly.

A similar study supporting this work was conducted among military personnel in Israel (Cohen et al. 1991). Two self-contained military field units located several kilometers apart were subjected to two different filth fly control regimes. Both sites had field kitchens and chlorinated water sources with sanitation and hygiene rules enforced. Both camps had slit-trench latrines with wooden superstructures, and hand washing after defecation and before eating was encouraged. Cultures from both latrines were positive for *Shigella* sp. The house fly, *Musca domestica*, was the predominant filth fly (88-98%). Of the house flies, 6% were positive for *Shigella*. Both camps had fly control measures that included exclusion and pyrethroid spot spraying. For the study, intensive control measures (baiting and trapping) were implemented at one camp for eleven weeks. The other camp continued its routine control efforts. After eleven weeks, fly control regimes were reversed. The base with intensive fly control had 64% fewer flies than the base with routine controls. Fly control correlated with 42% fewer diarrhea cases, 85% fewer cases of shigellosis and 76% fewer personnel with antibodies to *Shigella*. Values were lower in 19 of 20 comparisons of fly counts, incidence of diarrheal illness and shigellosis, and rates of seroconversion on whichever base implemented intensive fly control.

There are strong associations between filth flies and several other diseases (yaws, eye disease, polio, tuberculosis, and various parasites). However, the importance of filth flies in causing human illness through transmission of these pathogens remains undetermined.

b. Myiasis

Myiasis is the invasion of tissues or organs of living humans or animals by fly larvae that may feed on the host's living or dead tissue (gangrenous or necrotic) or on food ingested by the host. Host reactions may be asymptomatic, minor to violent, or may even result in death. This review will concentrate on human myiasis, in which almost any exposed part of the body is at risk. Myiasis classification may be based on the parts of the body affected, such as enteric (gastrointestinal, gastric, or intestinal), rectal, urogenital, aural (ear), ocular, cutaneous, nasopharyngeal, and traumatic (wound) myiasis. Myiasis classification may also be based on the separation of myiasis-producing Diptera into the following three groups.

(1) Accidental Myiasis

Accidental myiasis is most often the result of ingesting maggot-contaminated food. Flies in this group don't require or seek a living body to invade. In fact, most ingested fly larvae are unable to complete their life cycles in the human digestive system. However, enteric myiasis can cause malaise, nausea, vomiting, pain in the abdomen, and bloody diarrhea. Living and dead larvae may pass in the stool. Over 50 species of fly larvae are known to cause enteric myiasis. The most common are the house fly (*Musca domestica*), the lesser house fly (*Fannia canicularis*), the latrine fly (*Fannia scalaris*), and the false stable fly (*Muscina stabulans*). One of the most problematic fly species associated with enteric myiasis is the cheese skipper (*Piophila casei*). Cheese skipper females lay eggs on cured meats, old cheese, smoked fish and other materials. The larvae often penetrate the surface fairly deeply, particularly in meat, and go unseen. When humans unintentionally consume cheese skipper larvae, the maggots pass through the digestive system alive, resulting in serious intestinal lesions. Other fly larvae that can survive the human digestive system include the black soldier fly (*Hermetia illucens*) and the drone fly (*Eristalis tenax*). Both species are documented to cause severe gastrointestinal disturbances.

Another form of accidental myiasis is rectal, in which flies that feed and develop in excrement deposit their immature stages in fecal material around the anus of humans living in unsanitary conditions, especially infants and sick adults who are unable to care for themselves. The larvae of excrement feeders, such as the drone fly, lesser house fly, latrine fly, false stable fly, and certain flesh flies (Sarcophagidae), will move into the rectum or terminal part of the intestine to complete their development.

(2) Facultative Myiasis

Facultative myiasis occurs when fly species that normally develop in feces or dead animals lay their eggs or deposit their larvae in the tissues of living humans or animals. Maggots of these flies can develop in a living host by feeding only on dead tissues, but they sometimes invade living tissues as well. Urogenital and traumatic facultative myiasis occur most frequently. Vaginal myiasis is a concern of increased importance because of the larger numbers of women serving in deployed units.

Urogenital myiasis occurs in warm weather when people sleep uncovered. Since the fly species involved are not nocturnally active, eggs are probably laid on affected areas during low light periods of the evening or early morning. Egg laying may be stimulated by discharges from diseased genitals. The result is obstruction, pain, pus, mucus, bleeding, and a frequent desire to urinate. Larvae are expelled with urine. Flies most commonly associated with urogenital myiasis are the house fly, lesser house fly, latrine fly, and false stable fly.

Flies associated with facultative traumatic myiasis are usually carrion breeders. The blow flies (Calliphoridae) are most commonly involved, but flesh flies (Sarcophagidae) and house flies are also known to infest wounds. These flies are normally attracted to odors produced by rotting meat or carrion, and are likewise drawn to foul-smelling, neglected wounds. This can be a potentially serious problem, especially with patients that are to some degree helpless. Infestations can be quite painful. The maggots feed primarily on necrotic tissue, but they may also invade living tissue. Blow flies known to cause facultative traumatic myiasis include the black blow fly (*Phormia regina*), a green bottle fly (*Phaenicia sericata*), the secondary screwworm (*Cochliomyia macellaria*) and several species of *Chrysomya*.

(3) Obligatory Myiasis

Flies involved in obligatory myiasis are incapable of reproducing without a living host for larvae to feed upon. These flies include blow flies (Calliphoridae), flesh flies (Sarcophagidae), and bot flies (Oestridae, Hypodermatidae and Gasterophilidae).

The primary screwworm (*Cochliomyia hominivorax*) is a true obligate parasite. Adult females lay eggs only in living tissues of warm-blooded animals and humans; not on cold-blooded animals like reptiles and amphibians, nor in carrion or decaying meat or vegetables. Females are strongly attracted to and lay eggs in open wounds, sores, and the bite sites of ticks and blood-feeding flies. Individual females may lay up to 2,800 eggs in batches of 10 to 400. Adults are a deep metallic greenish-blue, with three thoracic stripes and cheeks covered with yellow, orange or reddish hairs. Without proper keys, it is often difficult to separate larvae and adults of this species from the secondary screwworm (*Cochliomyia macellaria*) (James 1947).

The primary screwworm is notorious for producing serious morbidity and mortality in livestock. Modern control measures, namely the USDA sterile male release program, have eradicated this fly from the United States to the southern border of Panama. Sporadic accidental re-infestations occur, often through importation of infested livestock. However, *C. hominivorax* still occurs from Colombia and Brazil to northern Argentina and Chile. Human cases are often associated with livestock infestations.

The bot and warble flies (Oestridae) are obligate parasites of animals that often infest livestock and pets. However, they can infest humans who work with or live near infested animals. Adult bot flies are distinguished from other flies by their hairy, bumblebee-like bodies. Larvae are large and often armed with spines that make removal from flesh difficult. In humans, larvae of the horse bot (*Gasterophilus intestinalis*) penetrate unbroken skin. Larvae cause a form of cutaneous creeping myiasis as they burrow freely in the skin. Burrowing is usually accompanied by severe itching. Since humans are not the horse bot's normal host, the larvae are unable to survive past the first stage. However, larvae of the ox warble or cattle grub (*Hypoderma bovis*) are able to complete their larval cycle in humans, often with serious consequences. Cattle grub larvae penetrate unbroken skin and may wander in the tissues of the arms and legs as they develop. As they reach the end of their life cycle, larvae move upward, often causing cutaneous creeping myiasis as they search for a site to form a warble in the skin. Besides the severe pain that accompanies creeping myiasis, localized paralysis may occur if larvae invade the spinal cord. Larvae of the sheep bot (*Oestris ovis*) do not survive for long in humans, although they can invade the eyes, causing ophthalmomyiasis with accompanying pain and inflamation.

The human bot fly, *Dermatobia hominis*, is common in parts of Mexico and southward into South America. Adults resemble blue bottle flies and parasitize a very wide range of animals, including humans. Females capture an insect, such as a mosquito, black fly, horse fly or stable fly, deposit eggs on its body, and release it. Larvae develop in 5 to 15 days and leave the egg when the egg-laden insect visits a suitable host, such as a human. Entrance into the skin is made through a bite wound or hair follicle. The human bot fly larva produces a boil-like lesion (furuncular myiasis) with no prior wandering. It lives in the host for about six weeks, then exits the wound and drops to the soil to pupate. The larva causes an itching sensation when it enters the skin and for about three weeks thereafter. However, at the end of the third week, larvae can become extremely painful.

2-3. Filth Flies As Nuisance Pests

The great amounts of filth and carrion encountered by military personnel during combat, peacekeeping and humanitarian operations are capable of producing huge numbers of filth flies. These flies not only disrupt military operations by affecting human health, but in large numbers they can distract personnel from their work and can significantly degrade morale.

The house fly female is capable of producing about 120 eggs 4 to 6 times in her lifetime. Larvae that hatch from these eggs can develop into adults in about 7 days. The potential for a house fly population explosion in warm conditions during contingencies (poor sanitation, large numbers of refugees or prisoners of war, and/or numerous exposed cadavers) is quite high. Stable flies, *Stomoxys calcitrans* (usually), are among the few filth flies that bite. Although they are not associated with disease transmission, they can be a formidable nuisance because both sexes must take blood meals to reproduce.

Numerous anecdotal accounts exist of huge filth fly populations in all wars, and in several operations and exercises involving the U.S. military. In the Vietnam War, the Gulf War and Operations Enduring Freedom and Iraqi Freedom, fly nuisance has arisen as a result of poor waste management. This has happened because of either poor waste management on base or because bases were in the middle of villages or cities where fly populations were high.

It is difficult to quantify the emotional effects of large numbers of flies on personnel in an already stressful environment. However, large populations of filth flies certainly distract personnel from their duties. Proper management of latrine wastes, garbage, and dining facilities will significantly reduce fly numbers. This, in turn, will result in more attentive and effective personnel, greatly improving the chances for successful operations in garrison, onboard ship, and in the field.

SECTION 3.
IMPORTANT FILTH FLY SPECIES: BIOLOGY AND BEHAVIOR

3-1. General

Generalized life cycle: The term “filth fly” refers to several species of true flies (Diptera) that belong primarily to the families Muscidae, Calliphoridae and Sarcophagidae. All flies have a complete metamorphosis, with egg, larval, pupal and adult stages (Figure 1). Larvae (maggots) of these families complete 3 instars before pupation. Keys for identifying flies are available in Appendix A. These include the Pictorial Key to Common Domestic Flies in the United States and the Key to Adults of the Non-biting Muscoid Fly Genera. The key to genera should be used outside the United States. The reader is also referred to the keys of Pont and Patterson in Greenberg (1971). These keys can be used for the identification of the species of the genus *Musca*, including the four subspecies of *M. domestica.* Keys are divided by geographic region. More recent keys may be available.

Development of immature flies is dependent upon the temperature and moisture level of the substrate. Variations in developmental time within a species are usually related to these two factors. Climatic changes, such as the onset of the rainy season, can have a dramatic effect on fly populations, largely on the rate of development. Filth flies are very strong fliers, with house flies and stable flies capable of flying 8 kph for several kilometers. Developmental sites can be long distances from areas where adults are causing problems (Hogsette and Farkas 2000).

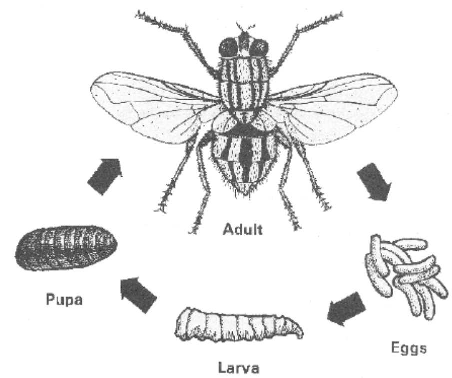

Figure 1. Generalized filth fly life cycle

One aspect of filth fly biology that has an impact on their role as mechanical vectors of pathogens involves their potential to disperse. Distances up to 20 miles have been documented for house flies (Murvosh and Thaggard 1966). Further, in this study the researchers noted that the flies would readily disperse, even with adequate food and larval development sites available to them. Studies done in both rural and urban areas of Savannah, Georgia (Quarterman et al., 1954a; Quarterman et al. 1954b), resulted in flies being recaptured up to 5 miles from a rural release point in 24h and up to 7.5 miles in an urban setting. The practical implications of these observations are that flies can potentially disseminate microbes, including pathogens, from remote areas, such as garbage dumps, wastewater treatment and agricultural operations, resulting in negative impacts on human health.

3-2. *Musca domestica*, the house fly

a. Importance: Usually the most common filth fly invading homes. House flies are suspected of mechanically transmitting numerous pathogens, especially diarrheal agents.

b. Distribution: Worldwide.

c. Biology and Life History: Females lay eggs in a variety of organic materials, including manure, carrion, decaying fruits and vegetables, kitchen refuse, garbage-pile drainage and cesspool material or other decomposing substances. Moisture content is critical for development. Substrates that have completed the degradation process are not suitable for larval development. Females lay 4 to 6 batches of 100 to 150 eggs in a lifetime. Large numbers of eggs are laid in suitable locations, resulting in huge larval masses. Eggs hatch in 18 to 24 hours when temperature in the substrate is around 25^{o} C. Lower temperatures can increase hatch time and decrease hatch rate.

Larval development is temperature dependent. The first and second instars can be completed in 18 to 24 hours, and the third instar in 48 to 60 hours. Temperatures above or below 25 to 30^{o} C lengthen the cycle and increase mortality. Third instar larvae leave the substrate and search for suitable pupation sites. Adults emerge from pupal cases in 4 to 5 days under optimal conditions. Under adverse conditions several weeks may be required for completion of the life cycle. Adults mate at 3 to 5 days of age and egg laying (oviposition) begins 2 to 4 days afterwards. Adults feed on a wide range of materials, including feces, garbage, fresh and decaying fruit, and most human food. *Musca domestica* adults are very strong fliers.

3-3. *Musca sorbens*, the eye fly/bazaar fly

a. Importance: Adults are attracted to humans, especially unsanitary and malnourished persons. This fly is often associated with refugee camps established after natural and manmade disasters, such as flooding, earthquakes, war, and other situations in which sanitation levels in large populations are substandard. *Musca sorbens* adults feed on mucous secretions around the faces and eyes of humans, and are also attracted to wounds and ulcers. They are particularly troubling to famine victims, who often lack the energy to keep the flies from feeding on their nasal and ocular secretions. Adults also feed on carrion and garbage. *Musca sorbens* adults transmit epidemic conjunctivitis and are mechanical vectors of several enteric pathogens. This species is often the most common filth fly present in the field, especially in hot, dry regions.

b. Distribution: Old World tropics and subtropics, Australia and Pacific Islands.

c. Biology and Life History: In certain areas, *M. sorbens* adults are found almost exclusively outdoors, but they are found both indoors and outdoors in other regions. Females generally show a strong ovipositional preference for human feces, while other types of excrement are used less frequently. *Musca sorbens* is reported to be a common species around privies. However, it apparently does not develop there, preferring instead to oviposit in more open, drier spaces. Pupation occurs in the drier soil beneath the substrate. Females lay up to 80 eggs in 3 or 4 batches. Complete time of development is 8 to 9 days at 30^{o} C and 15 to 16 days at $17\text{-}20^{o}$ C. In the laboratory, average longevity for males and females is 18.5 and 21 days, respectively (Greenberg 1973).

3-4. *Musca autumnalis*, the face fly

a. Importance: Important pest of cattle; however, they can be a significant nuisance to humans when in close proximity to pasture and barnyard areas.

b. Distribution: Found from Great Britain to western Siberia and south into North Africa and the Middle East. Introduced into North America in 1952, and now present from northern Georgia to Nova Scotia and southern Canada west to California.

c. Biology and Life History: Adult face flies cluster in large numbers around the face and nostrils of cattle and feed on mucous and watery secretions. Tear production is stimulated when flies rasp ocular tissues with their well-developed prestomal teeth. Face flies are facultative blood feeders and readily take blood exuding from wounds made by biting flies. Flies found on cattle are predominantly female. Protein from dung and blood is necessary for ovarian development. Males feed primarily on nectar. In temperate climates, highest populations are seen in late summer. Adults are active during the day only, resting on vegetation at night. *Musca autumnalis* annoy cattle and humans standing in shady areas.

Over much of its range, the face fly breeds almost exclusively in fresh cattle dung, though bison or pig dung is used occasionally. Mating occurs 4-5 days after adults emerge, and eggs are laid 2-5 days later. Eggs hatch in 24-29 hours and larval development takes 7 days at 15-20 ^{o} C. Third instar larvae disperse away from fecal breeding material to pupate. Pupae develop in 12 days. The total life cycle from egg to adult requires about 2-3 weeks. Adults will live for 30 days in the laboratory, but probably no more than 11 in the field. Face flies overwinter as adults in protected areas.

3-5. *Fannia canicularis,* lesser house fly; *F. scalaris*, latrine fly; other *Fannia* spp.

a. Importance: *Fannia canicularis* often vies with *M. domestica* as the most important pest fly in households. In cooler seasons this species is often more common than *M. domestica*, but in warmer seasons *Fannia* spp. tend to disappear. *Fannia canicularis* and *F. scalaris* breed commonly in latrines and cesspools. Both species have been associated with intestinal and urinary tract myiasis.

b. Distribution: Worldwide.

c. Biology and Life History: Female *F. canicularis* and *F. scalaris* prefer to breed in excrement but also lay eggs in decaying animal and plant matter. *Fannia scalaris* breeds in deep semi-fluid latrine material. Its larvae are dorsoventrally compressed, with feather-like processes that act as a flotation device. Larvae of *F. canicularis* appear to be covered in spines and prefer a drier medium than *F. scalaris*.

Mating and oviposition in *F. canicularis* take place 4-6 days after emergence. Eggs hatch in 1.5 to 2 days. Development of the three larval instars requires about 8-10 days at 27 ^{o} C and 65% relative humidity, and pupation is completed in 7 days. Larvae leave the semi-liquid or liquid substrate for somewhat drier places to pupate. The period from egg to adult is from 15 to 30 days. Breeding can be continuous in moderate climates. *Fannia* spp. seem to overwinter in all stages except the egg, but they are most commonly found as third instar larvae and pupae, usually 5 to 8 cm below the soil surface.

3-6. *Stomoxys calcitrans*, the stable fly

a. Importance: This species is a major pest of confined livestock throughout its range. It is particularly damaging to cattle and confined dogs. Stable flies will also feed on humans, especially around bodies of water. It is a vicious biter, causing a sharp pain.

b. Distribution: Worldwide.

c. Biology and Life History: The bite of the stable fly is particularly painful, and both sexes must feed on blood to reproduce. The stable fly prefers to oviposit in decomposing vegetation, especially in animal bedding such as straw or hay with high dung and urine content. Residues from large, round bales of hay are a primary breeding site, as are sugar cane residues and silage. In an urban setting, mulches, compost piles and grass clippings from homes and golf courses can produce large numbers of stable flies. Eggs may be laid in media that are loose and porous, or significantly compacted, but with relatively high moisture content and in an active state of decomposition.

Females begin mating and laying eggs 3-5 days and 5-8 days after emergence, respectively. Approximately 60 to 800 eggs in clutches of 60 to 130 can be produced during the life of one female. Larvae burrow into the breeding material, following moisture inward as the substrate dries. Under favorable conditions, the entire egg to adult life cycle is from 14 to 25 days. Cycle length can be as long as 78 days in unfavorable conditions or in cool climates. Before pupating, the third instar larvae disperse to drier parts of the medium or burrow into the soil. Some stable flies have been found to overwinter as larvae or pupae, but most overwinter in the adult stage. Adults are strong fliers and have been shown to travel up to 225 km with weather systems. Adults are not active at night.

3-7. *Chrysomya bezziana*, the Old World screwworm

a. Importance: Larvae are obligate parasites of living flesh (human and domestic or wild animals). Cases of human myiasis associated with the Old World screwworm are more common in India and other parts of the Oriental Region than in Africa, but cases of animal myiasis are common throughout its range.

b. Distribution: Afro-tropical and Oriental Regions extending south into Indonesia, the Philippines and New Guinea.

c. Biology and Life History: Females are attracted to wounds that are several days old. Oviposition begins late in the afternoon, on the high, dry side of the wound. This allows egg development to be completed during the dark hours. Eggs are deposited in batches of 100 to 250 and hatch 12-16 hours later. Larvae feed on blood and serum, lacerate tissues with their mouth-hooks, and burrow up to 15 cm into the tissues. Larvae emerge from the host as prepupae in 6-8 days and pupate in the ground for 8-10 days. The life cycle from egg to adult can be completed in 15-20 days. Several females may oviposit at the same site, resulting in 3,000 or more larvae in the same wound (Kettle 1995).

Females are autogenous and can produce the first batch of eggs without a protein meal. While ovipositing, females can ingest enough protein to produce a second batch of eggs. In domestic animals, areas of fly invasion include the navels of newborn animals, surgical wounds produced during castration, docking and de-horning, and bite sites of ticks.

3-8. *Cochliomyia hominivorax*, the New World screwworm, primary screwworm

a. Importance: Larvae are obligate parasites of living flesh (human and domestic and wild animals). Human cases of myiasis associated with this species are common in areas where infestations are prevalent in cattle.

b. Distribution: From Colombia and Brazil to northern Argentina and Chile.

c. Biology and Life History: Females may lay 2,800 eggs in their lifetimes in batches of 10-400 eggs. Approximately 300 eggs can be laid in a wound in 4-6 minutes. Eggs hatch in 11-21 hours and the larval development period is from 3.5-4.5 days or more. Pupation takes place in the ground in about 7 days. The life cycle from egg to egg required about 24 days under optimum conditions (Mullen and Durden 2009). See also Obligatory Myiasis above.

3-9. *Phormia regina*, the black blow fly

a. Importance: One of the most common flies associated with wound myiasis, especially in livestock. Larvae are also common in garbage cans and animal waste.

b. Distribution: Throughout cooler regions worldwide; at high elevations, as far south as Mexico and Hawaii (on Oahu to 1,000 feet).

c. Biology and Life History: Larvae normally feed on dead tissue, developing in animal carcasses and wounds. They are commonly found in castration and dehorning wounds in livestock and are considered a common sheep maggot fly in the southwestern U.S. In cases of myiasis, larvae sometimes cause a bloody discharge, indicating a certain amount of destruction of living tissue. Larvae also breed in garbage cans and animal waste. Adults begin mating 3-7 days after emergence. Females lay batches of 12-80 eggs, which hatch in 16-52 hours. The larval stage takes 4 to 15 days, with a pupal development period of 3-13 days. Growth from egg to adult takes from 10 to 15 days. Adult life span can range from 45 to 68 days in the laboratory.

Phormia regina is more common in the spring and fall and scarce in the summer. Cool weather favors development. These flies overwinter as adults. Adults emerge for brief periods throughout the winter on warm days. In warmer climates breeding is continuous.

3-10. *Calliphora* spp, *Phaenicia* spp., *Lucilia* spp.

a. Importance: These are the familiar blue, green or bronze bottle flies. They can cause traumatic myiasis in humans and animals, and play a minor role in sheep myiasis.

b. Distribution: Best represented in the northern parts of the Old and New Worlds and in the Australian region, although two species, *C. croceipalpis* and *C. vicina*, occur in the Afrotropics.

c. Life cycle: Adult *Calliphora* oviposit 4-5 days after emergence. Eggs are deposited on carrion or other suitable media. Depending on the species of fly and the season and situation, oviposition can occur immediately after death of the host, or up to 2 days after death. A female can lay 540-720 eggs in her lifetime in batches of up to 180 eggs. Upon hatching, larvae penetrate the skin or hide via natural or unnatural openings (i.e., wounds). Development takes from 15 to 27 days, depending on species and temperature. Larvae leave the corpse in large numbers and pupate in the top 5 to 8 cm of soil, and up to 6 m from a corpse. These flies overwinter as prepupae, pupae, or adults.

SECTION 4.
SURVEILLANCE AND EVALUATION OF CONTROL EFFORTS[1]

4-1. Necessity of Fly Surveys

Filth fly surveys help determine the effectiveness of sanitation practices, identify filth fly breeding sites and determine the need for control measures, such as improved exclusion in mess facilities or pesticide application. Filth fly surveys are also necessary to determine baseline fly populations, track population trends, and evaluate the effectiveness of control measures. Sanitation is the cornerstone of a sound filth fly control program. Unfortunately, breeding areas may be off-post, placing sanitation beyond the charge of preventive medicine, and making it necessary to concentrate on adult surveillance and control.

4-2. Five Elements of Effective Filth Fly Surveillance

a. Surveillance to identify the presence, species, and size of fly populations and conditions that favor breeding.

b. Sustained monitoring of fly populations and conditions that favor breeding.

c. Evaluation of survey results.

d. Initiation of control measures when established thresholds have been exceeded and notification of appropriate units responsible for conducting control measures.

e. Continued surveillance to determine the success of control measures.

4-3. Surveillance Program SOPs

Surveillance programs should be documented in Standard Operating Procedures (SOPs) or protocols. Information should include:

a. Who will do the surveillance? Specify the responsible units.

b. How will the surveillance be conducted? List the techniques and procedures that will be used.

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[1] Information extracted from TB MED 561, Occupational and Environmental Health Pest Surveillance, Headquarters, Department of the Army, June 1992.

c. Where are the surveillance locations? Clearly identify all locations on a map.

d. When will the surveillance be conducted? Include the rationale for the frequency of surveillance and when complaints are evaluated.

e. What are the criteria for initiating control measures? Identify the thresholds to be used and the recommended control measures.

4-4. Threshold Values

An effective surveillance program must have a way to determine the need for control measures. The presence of flies does not automatically initiate a recommendation for control. Thresholds are established to help predict when control measures are needed. The threshold value itself is an index calculated from surveillance data. Continuous surveillance over an extended period of time may be required to establish reliable threshold values. Long-term surveillance data may also reveal identifiable trends that will protect personnel by allowing control measures to be initiated just before a serious fly problem occurs. Threshold values will vary at different geographical locations depending on such factors as species, area involved, habitat, collection technique, number of complaints, and disease potential. In certain regions, such as developing nations in the tropics, fly problems may be abundantly apparent even without surveillance. Still, fly surveillance is necessary to determine effectiveness of control measures and to identify seasonal fluctuations and temporal population trends. Thresholds are only indicators and therefore should not be the only factor used in the decision to recommend control measures.

4-5. Initiating Filth Fly Surveillance

a. Develop lists of all sites where adult flies could potentially feed and where immature stages could develop. A listing of facilities that receive sanitation inspections, including mess halls, latrines, dishwashing areas and soakage pits, is a good place to begin. In addition, include landfills, stables, kennels, and garbage handling areas. Surveillance and control at off-post facilities, such as landfills and sewage treatment facilities, may be necessary, especially to protect those that are occupied for several months or more.

b. Conduct a preliminary survey at all potential filth fly infestation sites listed. The purpose of this survey is to identify existing filth fly infestations.

c. Contact units or activities that are (or should be) concerned with fly control. Because sanitation is so important, successful filth fly control efforts require close coordination with all personnel involved. All personnel must be aware of the objectives of the surveillance program and their role in it. Meet with the appropriate units/activities to discuss:

(1) what is being done for filth fly control.

(2) how to integrate efforts.

(3) what criteria are used to initiate control measures, such as:
- surveillance data.
- schedules.
- service orders.
- complaints.

(4) what facilities are or have been particular problems for filth fly control.

(5) meeting with managers of food handling facilities and personnel from other activities that generate wastes that could be used by flies. Cooperation of these personnel is necessary for a successful filth fly control effort.

d. Select methods, as described later, and frequency for sampling fly populations. Fly collections are necessary to determine the species present and fluctuations in fly populations within a given area.

e. Initiate filth fly surveillance that consists of routine surveys for:

(1) the presence and number of flies.

(2) favorable larval development sites.

(3) adequate exclusion at food handling facilities and other potential filth fly aggregation sites.

Survey personnel should be alert for such conditions as properly bagged organic refuse, closed dumpsters or trash container lids, clean dumpsters/trash containers, and properly screened windows and doors. Contractors, especially in foreign countries, must be monitored to ensure that food wastes are disposed of properly and that garbage bags and dumpsters are collected frequently. The effectiveness of sanitary practices may be determined by these surveys.

f. Develop thresholds and control options (do not forget non-chemical measures) and a policy for dealing with complaints. Write an SOP. Document all aspects of filth fly surveillance. Include maps to show fly sampling sites (consider using GPS to accurately identify sampling site locations).

g. Sampling Methods and Surveillance Data

(1) There are many techniques for sampling adult filth flies. For our purposes, the most appropriate are based on counting the number of flies on resting sites or those caught by sticky traps. Sampling should be conducted at a standardized time and at the same locations. The number of flies caught strongly depends on the location of the trap. Locations must be accurately identified so the trap will be placed in the same location for each subsequent survey. Weekly fly surveys should be conducted throughout the fly breeding season.

(a) Fly Grill. The fly grill technique (Scudder 1947 & 1949) is the most versatile and widely used of the counting techniques. The grill (Figure C-3, Appendix C), often referred to as a Scudder grill, consists of 16-24 wooden slats, fastened at equal intervals to cover areas of from 0.8 m^2 (big grill) down to 0.2 m^2 (small grill). The big grill is for outdoor use but is impractical for indoor use. For general use, a small or medium-sized grill is suitable. Place the grill where there are natural fly concentrations and count the number of flies landing on the grill for a given period of time (usually 30 seconds or l minute). In each locality, counts are made on 3 to 5 or more of the highest fly concentrations found and the results averaged. With practice it is possible to sight identify the fly species that land on the grill.

(b) Fly Bait Technique. Use this technique to determine fly densities indoors. A square card 30 cm on a side that has been painted with a mixture of molasses and vinegar (1:2) should be placed near a location frequented by flies. The number of flies attracted to the card over a specified time (e.g., five minutes) is recorded. Other baits, such as syrup, molasses or milk may be used, but in order for fly counts to be meaningful, uniformity of bait and technique is necessary.

(c) Sticky Tapes. Sticky tapes or strips are used for assessing fly densities, particularly indoors. They may be exposed to flies from 2 hours to 2 days (one day is recommended). In order for data to be meaningful, the length of time and time of day must be uniform from observation to observation. Sticky tapes should be located near doorways or trash receptacles. They should not be placed over food preparation or serving areas.

(d) Live Traps. These are recommended only when live specimens are required for identification or resistance testing. They provide quantitative data for fly surveillance but are not as convenient as sticky traps and Scudder grills for routine surveillance because of the problem of disposing of the live flies. However, these traps may also be baited with poison bait to serve as effective local devices (e.g., Figure C-1, Appendix C).

(e) Sweep Nets. Catching flies with a sweep net yields samples for identification, but this technique does not provide reliable quantitative estimates of the fly population.

(f) Traps from drink bottles. Empty plastic water or soft drink bottles may also be modified for use as traps (Figure C-2, Appendix C). However, it can be difficult to replicate this method at different sites, so data obtained this way may not be statistically comparable.

(g) Visual Counts. Visual counts can be made of flies landing on a given surface, such as a table top, tent pole, appliance, or even a person in the area. Counts on the same selected surfaces should be made at the same time of day each time a count is made.

(h) Spot counts. Index cards (3 x 5 inches) can be attached to walls or doorways in buildings or tents where flies tend to rest, usually in areas near the ceiling. Flies will rest on the cards and leave vomit and fecal spots. By collecting the cards on a uniform routine basis and counting the spots, a relative index of fly population fluctuation can be obtained.

(2) Recording surveillance data. A permanent record should be kept of all filth fly surveillance data. Maintain files of such data on a form such as the Filth Fly Survey Form shown in Figure C-4.a, Appendix C, or an equivalent that provides a record of the number of filth flies counted or trapped, the species observed, and sanitation and exclusion conditions in each facility surveyed. A blank form is provided in Figure C-4.b, Appendix C.

(a) Records of filth flies trapped and counted are useful indices for showing trends in population fluctuation. The surveyor should enter data in a spreadsheet program and make graphs to visually show changes in population levels and dates of pesticide applications.

(b) A composite index for a particular area or installation can be calculated by averaging data from several collection sites. The composite indices should be presented as a graph. After some experience, a nuisance threshold may be established. For example, in residential areas, if fly complaints are numerous when the average grill index is 25 flies per week (or whatever the sampling interval may be), then this may be at or near the nuisance threshold.

SECTION 5. FIELD SANITATION

Sanitation is the key to filth fly management. Fly problems can be expected most often around field messes and latrine facilities. The presence of flies in otherwise clean facilities indicates unsanitary conditions there or at another site. Declining food service sanitation also leads to greater fly problems.

Protocols for sanitation will depend on the infrastructure available to handle wastes. If trash and waste removal is provided by contracted services, pertinent collection and storage guidelines must be strictly enforced. Garbage should be stored in fly-proof containers until removal. Portable toilets and garbage storage containers should be serviced often enough to prevent or minimize fly attraction and breeding. Fly and other sanitation issues that are related to contract services should be addressed through contract adjustments. Fly exclusion and abatement of breeding in situations with and without infrastructure are discussed here. Much of this discussion is drawn from the U.S. Navy Manual of Preventive Medicine, NAVMED P5010, Chapter 9. Detailed instructions on design of all waste disposal units noted in this section are available in Appendix B and NAVMED P5010.

5-1. Food Preparation Area Sanitation

a. Flies must be excluded from food service areas to prevent the spread of enteric diseases and to ensure that messing facilities are a safe and comfortable place to eat. Good fly exclusion methods and proper food handling techniques are always necessary in areas where flies are abundant. If refugee and prisoner of war camps, where levels of enteric pathogens can be quite high, are in close proximity to mess areas, fly exclusion becomes particularly important. In these situations, additional control methods, such as pesticide application and barrier trapping, may be necessary. These methods are discussed in Section 6. However, it cannot be overemphasized that fly control will be unsuccessful in the absence of satisfactory exclusion methods. Similarly, fly control measures will fail if garbage and latrine management, as discussed later in this section, are inadequate.

b. Food Preparation. In all cases, proper food handling techniques are necessary to control flies and prevent fly-borne disease.

c. Fly Exclusion: The nature of food service facilities will have a profound effect on the likelihood of successful fly exclusion. Occasionally, messing facilities are established in permanent buildings with doors and windows that can be easily fitted with screening. More frequently, field messing facilities range from very primitive (where personnel sit on the ground) to semi-permanent tents with piped water. If exclusion is even moderately successful, indoor trapping and/or space sprays with d-phenothrin, as discussed in Section 6, may further reduce nuisance fly levels from barely tolerable to comfortable.

Flies can be excluded from mess tents by placing small pass-through tents with double doors at all entrances. The smaller tents serve as buffers. If at least one door is closed at all times, fly passage from the outside into the food service spaces will be minimized. In hot climates, this system is impractical because it would affect ventilation, making the mess tent unbearably hot. Attempts should be made to screen at least the food preparation and serving areas, or to keep food covered as much as possible in mess tents where fly exclusion is inadequate.

5-2. Garbage, Rubbish and Carrion Disposal

a. Garbage is solid or semi-solid waste generated through preparation and handling of food. Rubbish is dry disposable waste.

b. Disposal infrastructure unavailable. When in a camp 2 to 6 days, garbage and rubbish should be disposed of by burial in a continuous trench. The trench should be 0.5 m wide, 1.5 m deep and long enough to accommodate one day's garbage. When the current day's section is full, contents are covered and mounded; then a new section is dug to accommodate the next day's garbage. In camps that will be used for one week or more, and where the tactical situation allows, incineration is the most common garbage and rubbish disposal method. Wet materials will not burn easily. Liquids must be separated from solids, which can be accomplished by straining garbage through a coarse strainer, such as a 55-gallon drum with holes punched in the bottom. Dry garbage and rubbish are incinerated (Figures B-4 and B-5; Appendix B), ash and non-combustibles are buried.

c. Liquid Waste Disposal. Liquid wastes generated at food service facilities are attractive to adult flies as a food source and fly larvae as a moisture source. Every attempt should be made to keep liquid wastes separate from garbage and rubbish. Liquid wastes drained from garbage should be passed through a grease trap (Figures B-1 and B-2; Appendix B) and disposed of in soakage pits (Figure B-3; Appendix B) or evaporation beds (Figure B-6; Appendix B). These facilities may attract flies unless they are well irrigated, but breeding should not occur. Disposal sites should be at least 30 m from dining facilities.

d. Cleaning garbage cans and dumpsters. Thorough washing of containers each time they are emptied will prevent the buildup of encrusted liquid and solid food materials on surfaces. Garbage cans should be washed after each garbage collection. Wash water must be directed into a sanitary sewer or away from the bivouac area. Wash water allowed to run on the ground will attract flies. Dirty dumpsters indicate that food waste is not being handled properly. Plastic bags that contain food waste must be secured tightly to prevent leakage. Empty food containers must be rinsed before being deposited in the dumpster/garbage can. Dumpsters that are found encrusted with liquid and solid food should be steam cleaned to prevent filth fly breeding.

5-3. Human Waste Disposal

a. Portable toilets are available at almost all heavily used training facilities in-CONUS, where state laws may require their use. Port-a-potties are secured by contract during the planning phase of most OCONUS exercises. More primitive facilities can be developed in training situations where human waste will be minimal. In certain situations where troops are constantly moving or bivouacs are temporary, port-a-potties may be both impractical and unnecessary. The use of port-a-potties or more primitive facilities during exercises must be determined during the planning phase. During operations, latrine facilities follow a continuum from field-expedient cat holes and urine tubes to flushable porcelain toilets. In Operations Enduring Freedom and Iraqi Freedom, logistics personnel have become very familiar with placing toilet facilities on the larger or more permanent bases. In this case, preventive medicine personnel are usually charged with noting whether enough facilities exist given a reported camp population. Preventive medicine recommendations are necessary when camps are first established, particularly when camps are small or will only be occupied for short periods of time.

b. Distance. All latrine facilities should be placed at least 30 m from natural bodies of water, 100 m from messing facilities, and 15 m from berthing.

c. Portable Toilets. Flies will be unable to breed in portable toilets that are cleaned frequently. Cleaning is usually a contracting issue that is best approached during pre-deployment planning. Portable toilets are attractive to flies and must be adequately screened. Placement of these facilities must be in accordance with paragraph 5-3.b above.

d. Urine Troughs and Urinals. In temporary and semi-permanent camps where permanent facilities and chemical toilets are not available, personnel should be encouraged to use separate, specifically designed facilities for urination and defecation. Urine troughs (Figure B-7; Appendix B), urine soakage pits (Figure B-8; Appendix B), and urinoil toilets (Figure B-9 Appendix B) should not present fly breeding problems. Flies will be attracted to urine troughs and soakage pits unless they are well irrigated.

e. Straddle Trenches. Straddle trenches (Figure B-10; Appendix B) are used in temporary bivouacs (1 to 3 days) and less often in semi-permanent camps. Waste should be buried daily under 30-60 cm of soil to prevent fly breeding. However, flies will be attracted to these facilities and pathogen transmission and urinary and rectal myiasis may be a concern. Some manuals suggest treating latrine materials with pesticides before burial.

f. Deep Pit and Burn Barrel Latrines. Several types of latrines can be constructed in camps active for more than 3 days. Factors independent of fly control often dictate which type is most appropriate. Design and maintenance standards will greatly affect a latrine's attractiveness to flies and the extent to which flies can breed. Deep pit and burn barrel latrines should be designed to exclude flies from potential breeding sites. Figures B-11 and B-12, in Appendix B, show proper construction, with adequate fly exclusion, of the two latrines. Seats should be covered with fly-proof, self-closing lids. Any other areas where flies may have access to latrine materials should also be sealed. It is necessary to exclude adult flies from latrine materials, even if breeding is successfully abated through burial or burning. This will prevent adult flies from carrying disease agents from latrines to other parts of the camp and will lower the threat of urinary and rectal myiasis.

SECTION 6. FILTH FLY CONTROL

6-1. Introduction

Integration of control methods is essential in filth fly suppression programs. In many instances, sanitation is the key to long-term control. Pesticide application alone is not sustainable, being limited by both time and money. However, pesticides constitute the most effective immediate solution for reducing filth fly populations and must be considered when a disease threat exists. Moreover, as discussed earlier, fly problems may originate in areas away from a camp and outside the control of military personnel. This will limit options on control techniques.

The bodies of DoD personnel killed during contingencies should not be treated with pesticides to control insect infestations. It is standard DoD Mortuary Affairs procedure that the bodies of dead DoD personnel not be treated to remove insect infestations in the field. Bodies are typically bagged and shipped to an embalming point in hermetically sealed transfer cases. Upon arrival at the embalming point, any infestations are removed using standard mortuary procedures for processing decedent remains. Further, application of pesticides to bodies may interfere with chemical analyses conducted on the remains. See Appendix E for guidance on fly control in mortuary affairs facilities.

Pesticide application must always be done according to label guidelines. Pesticide labels are legal documents. Failure to follow label instructions is a violation of federal law. Also, a memorandum from the Joint Chiefs of Staff dated 1 February 1999 mandates that, except in an emergency as determined by the Joint Task Force Surgeon, only pesticides on the DoD Approved Pesticides List can be used by U.S. military personnel in CONUS and on deployment. All pesticides noted in this manual are authorized for use by DoD-certified pesticide applicators. For global guidelines on fly control with pesticides, see Chapter 4 on Flies (pp. 38-55) in the WHO (2006) manual, http://whqlibdoc.who.int/hq/2006/WHO_CDS_NTD_WHOPES_GCDPP_2006.1_eng.pdf

Pesticides should be used as a backup to sanitation and exclusion. Several methods of pesticide application can be used in filth fly control. Often one or two methods, such as baits and space sprays, will adequately augment sanitation and exclusion. The choice of application method is dependent upon several factors. In most cases, pesticides and pesticide baits should only be used outdoors. Traps can be used indoors and outdoors. In deployed situations, the type and amount of application equipment are often deciding factors. Good planning is necessary to ensure pesticide formulations match application equipment, and that the planned method of application is adequate to accomplish the task. Ordering information for pesticides and pesticide dispersal equipment is available in Armed Forces Pest Management Board Technical Guide (TG) 24, Contingency Pest Management Guide, available on the AFPMB web site.

6-2. Insecticide Baits

a. Active Ingredients and Trade Names:

(1) Granular Baits (see TG 24). If used correctly, these can effectively reduce adult fly populations. Application: For outdoor use only. Bait should be applied following label specifications. Baits can be scattered over specified fly feeding areas daily or as needed or placed in bait stations. Some formulations can be mixed with warm water to form a paint-on application. These baits are effective in and around dumpsters and garbage cans. Distribute bait directly from the container; specialized equipment is not required. Avoid contact with skin.

(2) Fly Abatement Strips (e.g., Quickstrike®). These products are more than the simple sticky tapes or strips of old. They are marketed specifically for control of house flies and lesser house flies, but they will also kill other flies, such as blowflies, that might feed on the bait. These devices contain a cardboard strip that is coated with a sugar-based matrix containing a pesticide. Ampules of house fly sex pheromone and other attractants are attached to the top and bottom of the strip. The strips are often enclosed in a plastic frame and contain a bittering agent to discourage accidental ingestion by non-targets. Toxicity to flies occurs rapidly upon ingestion.

Abatement strips work best in areas with medium to high fly populations. Use at the rate of 1 strip per 9 to 30 m^2, depending on the fly population. Strips should be placed at about shoulder height, or lower, and should be protected from moisture and direct sunlight. Do not mount strips where air flow is high, for example in doorways, or allow them to blow in the wind from the end of cords or wires. Strips should not be used in unventilated areas because the attractant odor may be considered unpleasant. Experience with these strips has shown that they become very much more attractive after flies have landed on them over a period of one to three days. This is especially true if the strips are placed upright in a large can. It is likely that the strips become more attractive because other flies have defecated, regurgitated or died on the strip. The insecticide is very quick acting, so when flies die, they fall into the can, or into a pile, beneath the trap. This pile of dead flies seems to be extremely attractive to other flies. Thus, placing the strips in a can will increase the effectiveness.

6-3. Space Sprays

a. Outdoor Application

(1) Ultra low volume (ULV) application is the most rapid method of outdoor adult insect control. In situations where fly populations must be brought under control immediately, e.g., to reduce the incidence of diarrheal diseases in a refugee camp, ULV pesticide application is the only assured means of immediate control. Space sprays are effective at killing flying insects over large areas, but results are often short-lived, as insects move in from unsprayed areas. More long-term control strategies should be implemented as soon as possible to reduce reliance on space sprays, which are expensive and labor intensive.

(2) Application: ULV systems require specially formulated pesticides for application through thermal and cold foggers. The theory of application is to fill the air with a cloud of small droplets. Droplets in the cloud are so dense that a lethal dose will impinge on all target insects within the treated area. Space sprays are carried through the target area by wind. Shortly after treatment, all pesticides either move or settle out of the treated area. Because pesticides do not remain in the treated area, fly populations may begin to rebuild immediately after treatment. If the treatment area is too small, re-invasion can be almost immediate. Given the prospects for re-invasion, frequent reapplication is often necessary unless or until more sustainable methods are implemented.

b. Indoor Application.

(1) d-phenothrin aerosol can be almost 100% effective indoors when used to augment effective exclusion measures. In the absence of exclusion, indoor treatments may be of little value. d-phenothrin can be used for disinsection of aircraft, ships and vans. Aircraft disinsection with d-phenothrin is no longer permitted when passengers and crew are aboard.

Dichlorvos pest strips should be used indoors and in garbage cans, but they must not be used in food preparation or serving areas. Pest strips may be ineffective inside screened structures, as opposed to buildings with solid windows and doors, because air exchange will prevent adequate buildup of pesticide in the air. The pesticide formulation was observed dripping from dichlorvos pest strips in the hot, humid climate of Vietnam, making this an unacceptable control strategy under similar climatic conditions.

(2) Application: Buildings and tenting can be disinsected by spraying d-phenothrin for 10 seconds per 1,000 ft^3 (30 m^3), per label instructions. Tents will require repeated spraying if attempts are not made to exclude flies. One pest strip should be used every 1,000 ft^3 (30 m^3).

6-4. Residual Insecticides

a. Residual sprays can be used to control adult or larval flies. In both cases, efficacy is often poor, but this approach can be useful in certain situations. Residual pesticides are usually ineffective against larvae unless the larval medium is shallow and the pesticide can penetrate and contact the larvae. Applying residuals to inside surfaces of garbage cans, and other areas where maggots are seen should be included in fly control programs.

Residuals can be applied in strategic resting areas to control adult flies indoors. Flies are attracted to and will rest on vertically oriented strings, electrical cords or strips. These can be treated if suitable materials are available. Surfaces around garbage handling areas are attractive to adult flies and applying residuals in these areas can be useful.

b. Application: Residual sprays are applied with hand can and backpack sprayers. Hand cans are well suited for small jobs where all areas to be treated are easily accessible. Backpack sprayers are necessary where pesticides must be dispersed over large areas.

6-5. Traps

a. Light traps fitted with replaceable sticky cards are available to capture flies and augment sanitation inside buildings. These traps effectively remove the small numbers of flies that enter well-screened buildings, and should be used on deployments of extended duration in permanent and semi-permanent facilities. They work by attracting flies to an ultraviolet light. Whereas 120V electricity is supplied in the Americas, countries in other parts of the world usually have 220V electricity, for which appropriately wired traps are supplied by some manufacturers. Insect electrocution devices are not authorized for use indoors or outdoors on U.S. military installations, because they are likely to attract far more flies and non-target insects than they kill and because electrocuted flies can explode and contaminate surfaces.

b. For food service facilities, non-electrocuting traps that capture flies on glue boards are recommended. Electrocutor grid traps cause insects to explode and small particles of their bodies fill the air, possibly dispersing pathogens and allowing fragments to fall onto food or other sensitive items such as laboratory samples. Therefore, electrocutor traps are not recommended for food service areas or labs. Light traps should be placed where they cannot be seen from outdoors, so they do not attract insects into structures through doors or windows. Traps should be mounted out of the air flow and away from competing light sources, less than 3 feet (one meter) above the floor, where flies tend to be most active. Flies prefer warmer areas of a structure and this is where the traps should be placed. For details and additional strategies on fly control in food service facilities, refer to Hedges (1994) and Snyder (1991).

c. Light traps in food service facilities should not be placed within 5 feet of food preparation areas or in locations where personnel will be working in close proximity to the light for long periods. The FDA has shown that there are no acute health problems associated with long-term exposure to the ultraviolet wavelengths emitted by these lights, but the chronic health effects resulting from continuous exposure to the lights has not been determined. Traps should not be installed in areas where they will be bumped by personnel or equipment, splashed with water or other liquids, or hidden by equipment or stored materials.

d. Light traps in food service facilities should be in operation on a 24-hour basis during the fly season. The ultraviolet wavelengths, which the human eye cannot see and which attract the flies, will diminish after 4-6 months of continuous operation. Therefore, the bulbs should be replaced at least twice each year, even though they continue to produce light in the visible range. The glue boards used in these traps should be replaced as needed, at least monthly, depending upon the number of insects captured and other environmental factors, such as the quantity of dust.

Glue boards should be used only for traps in which they fit properly, and should not interchanged with other traps. If a trap requires two glue boards, change both at the same time. Glue boards should be dated. It should be clearly established, in writing, who is responsible for changing bulbs and glue boards. (note: these traps are often purchased by non-pest management personnel as a quick fix for a fly problem, but then they are not maintained on a scheduled basis.

e. Physical traps are available for purchase or can be constructed from local materials at deployment sites. These basically consist of a cone and chamber into which flies are attracted by bait and from which they cannot easily escape. These traps are inexpensive, dependable, easy to transport and use, and are effective as a supplementary means of fly control, or as the primary if no other means is available under field conditions. See Appendix C for details.

6-6. Physical Control

Fly swatters are always good for supplemental fly control, and are morale boosters for troops who are being pestered or sickened by large numbers of flies. They are a "force multiplier" for preventive medicine troops responsible for pest control. If fly swatters are not available, field expedient swatters can be constructed out of coat hangers and tape. Encourage creativity on the part of troops in custom-designing their own devices. Swatters may range from lightweight "stealth" to heavyweight "anvil" models, depending on the materials available.

6-7. Aerial Spray

a. Aerial spray is necessary when large areas, up to several hundred thousand acres, must be treated in a short period of time. Space sprays or ULV applications are almost always used for aerial fly control. Because of problems with re-infestation from unsprayed areas, large-scale application is often the only feasible method of immediate control.

Specially trained personnel must authorize and manage aerial spray operations. Treatment of large areas in short periods of time increases the potential for large-scale accidents, which may endanger human and environmental health. Moreover, extensive documentation of environmental compliance is necessary for approval of all such missions, except in public health emergencies. During large-scale disease outbreaks, medical entomologists must be consulted. The Air Force’s Modular Aerial Spray System is the only aerial spray platform available within the Department of Defense. It is mounted in a C-130 aircraft and can dispense up to 2,000 gallons (7,500 liters).

APPENDIX A - Taxonomic Keys

Key to Adults of the Non-biting Muscoid Fly Genera

1. Small, usually dark flies; hind tibiae with distinct, curved, shining black, apical or sub-apical spur; third antennal segment globular; arista bare .... *Hippelates*

   Medium-sized or large flies 2

2. Gray, yellowish, or dull-colored flies 3

   Blue, metallic green, or blue-green flies..5

3. Bend of fourth vein absent, reaching wing margin far below third vein; arista bare; anal vein characteristically strongly curved forward as if to intersect the sixth vein ....*Fannia*

   Bend of fourth vein acute, joining margin of the wing close to the third vein; arista with hairs....4

4. Frequently large, gray or yellowish colored flies; abdomen with a "checkerboard" appearance; thorax marked with three dark, longitudinal stripes....................................... *Sarcophaga*

   Medium-sized grayish-black flies; abdomen without "checkerboard" appearance; thorax marked with two or four dark longitudinal stripes ....*Musca*

5. Face yellow with soft yellow pile 6

   Face without yellow pile...7

6. Thorax marked with three longitudinal stripes; lower squama without long hairs above; genus of Western Hemisphere.. *Cochliomyia*

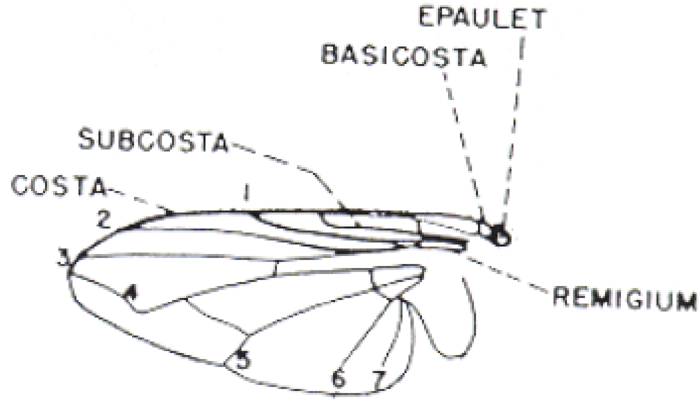
   Thorax without distinct longitudinal stripes; lower squama with long hairs above; confined to Africa and islands of the Pacific, including the Philippines, Australia, and certain sections of Asia .... C*hrysomya*

7. Base of first vein with a row of long, distinct hairs on its upper surface; anterior spiracle with bright orange hairs; dark, metallic blue-black in color...*Phormia*

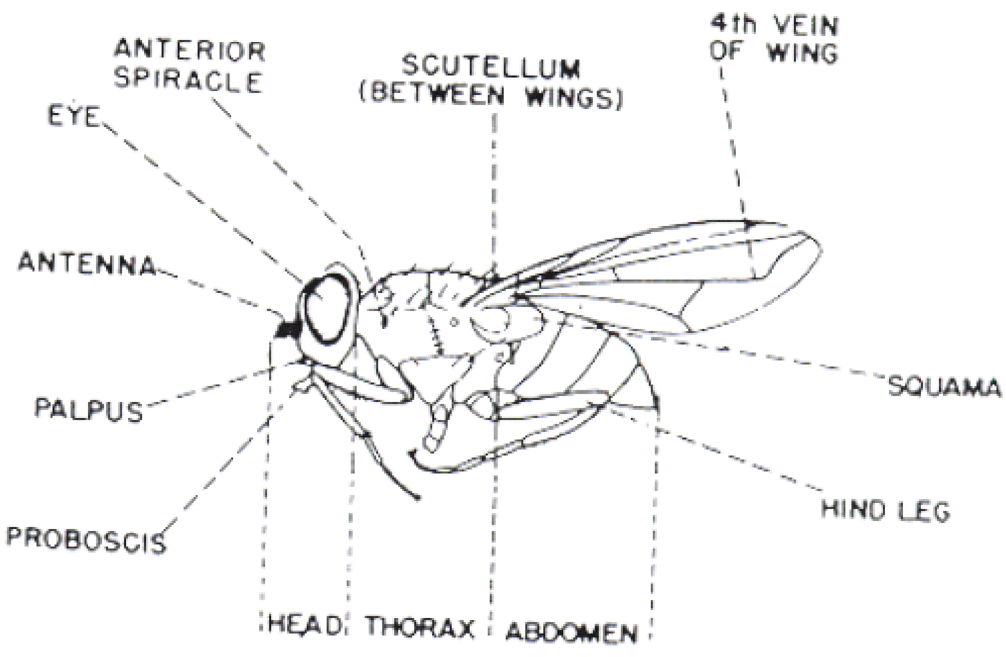
   Base of the first vein lacking, or with poorly developed, hairs on its upper surface; anterior spiracle with dark hairs; blue or green in color 8

8. Usually large flies with a whitish sheen over abdomen; lower squama with long hair above; bluebottle flies ....*Calliphora*

   Usually flies of moderate size; lower squama without long hair above; green or bronze bottle flies.
   .... *Phaenicia* and *Lucilia*

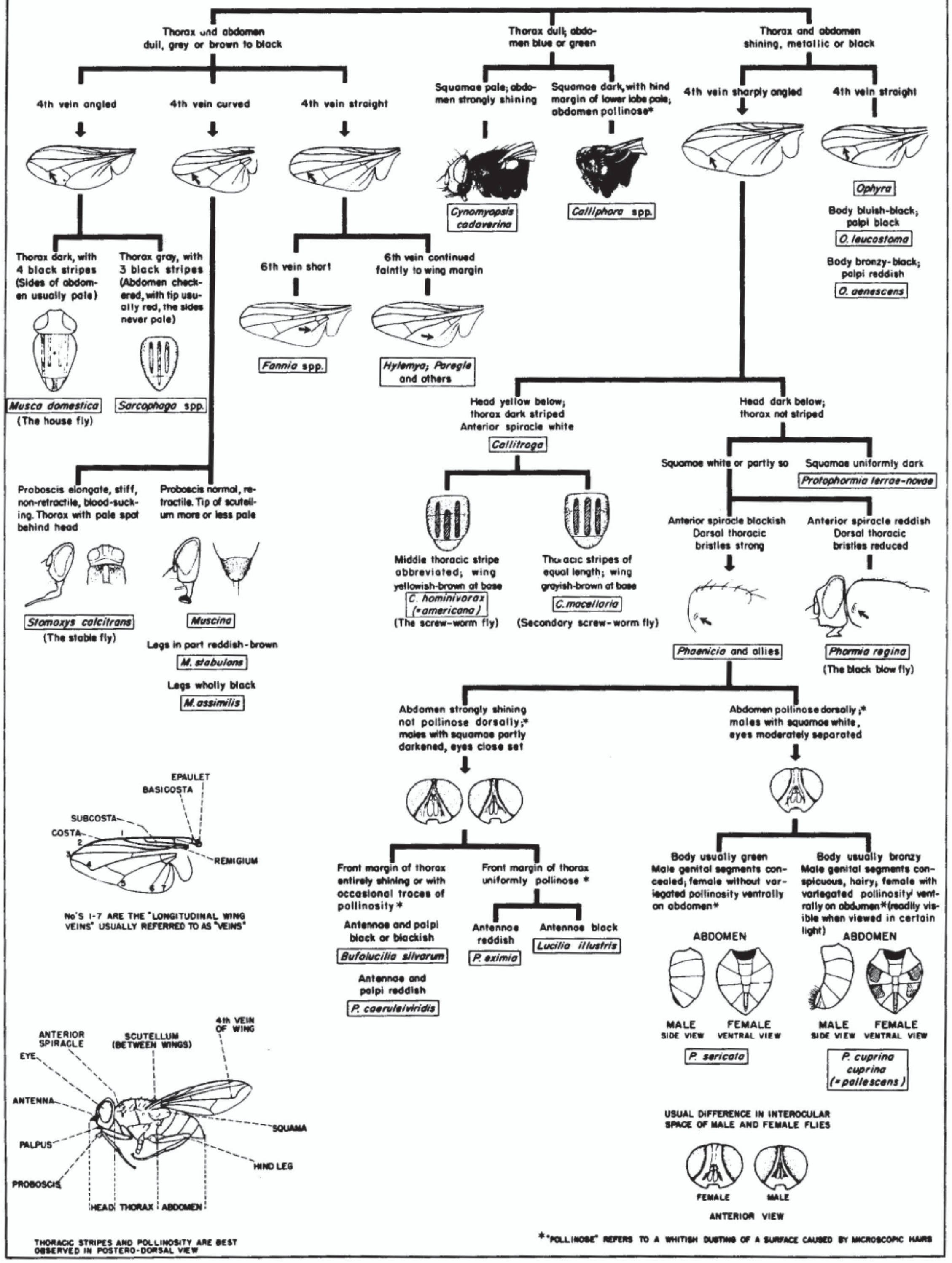


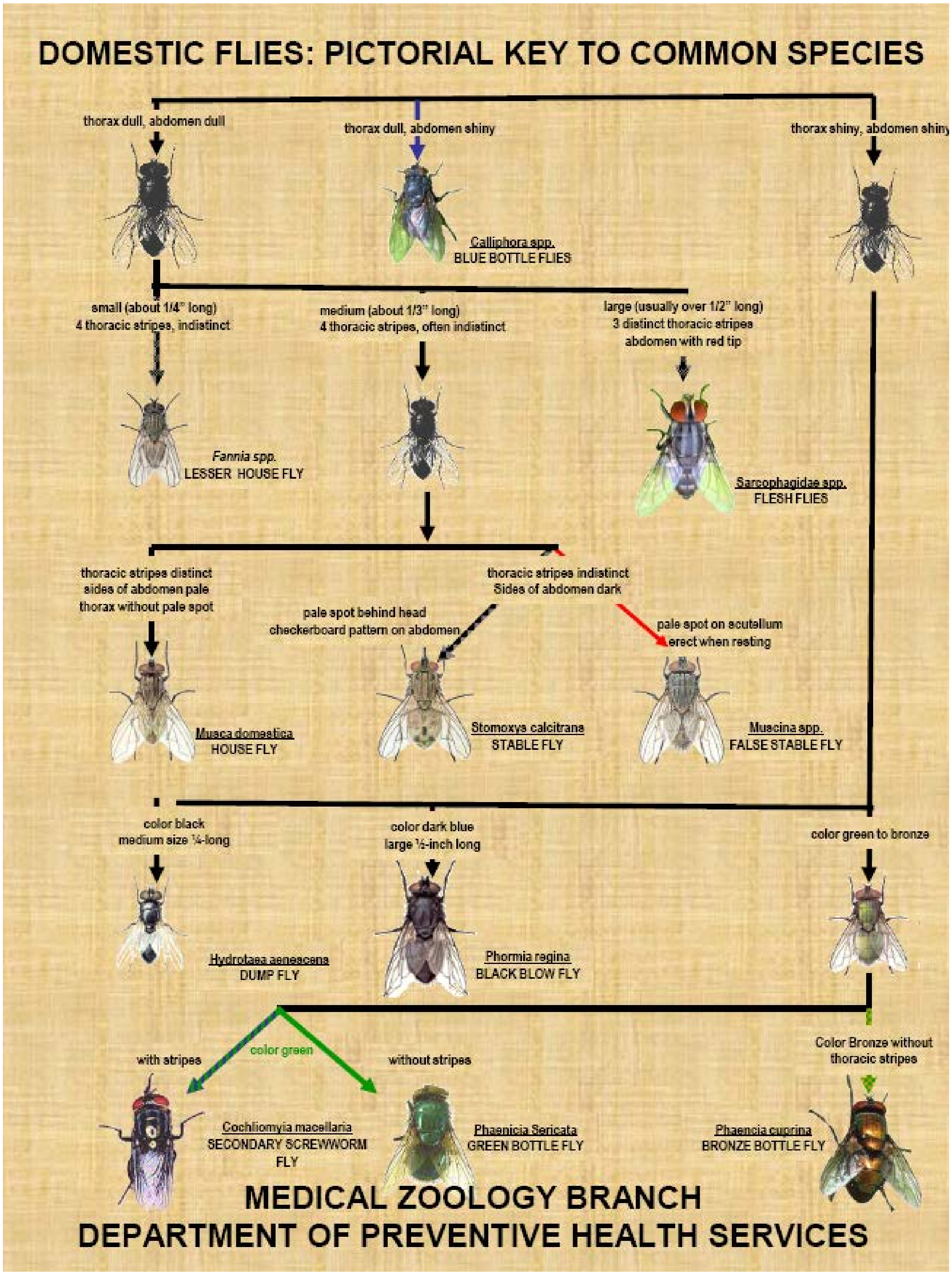
No'S 1-7 ARE THE "LONGITUDINAL WING VEINS" USUALLY REFERRED TO AS "VEINS"



DOMESTIC FLIES: PICTORIAL KEY TO COMMON SPECIES IN THE U.S.

H. R. Dodge




DOMESTIC FLIES: PICTORIAL KEY TO COMMON SPECIES
thorax dull, abdomen dull
thorax dull, abdomen shiny
thorax shiny, abdomen shiny
Calliphora spp.
BLUE BOTTLE FLIES
small (about 1/4" long)
4 thoracic stripes, indistinct
medium (about 1/3" long)
4 thoracic stripes, often indistinct
large (usually over 1/2" long)
3 distinct thoracic stripes
abdomen with red tip
Fannia spp.
LESSER HOUSE FLY
Sarcophagidae spp.
FLESH FLIES
thoracic stripes distinct
sides of abdomen pale
thorax without pale spot
thoracic stripes indistinct
Sides of abdomen dark
pale spot behind head
checkerboard pattern on abdomen
pale spot on scutellum
erect when resting
Musca domestica
HOUSE FLY
Stomoxys calcitrans
STABLE FLY
Muscina spp.
FALSE STABLE FLY
color black
medium size ¼-long
color dark blue
large ½-inch long
color green to bronze
Hydrotaea aenescens
DUMP FLY
Phormia regina
BLACK BLOW FLY
with stripes
color green
without stripes
Color Bronze without
thoracic stripes
Cochliomyia macellaria
SECONDARY SCREWWORM
FLY
Phaenicia Sericata
GREEN BOTTLE FLY
Phaencia cuprina
BRONZE BOTTLE FLY
MEDICAL ZOOLOGY BRANCH
DEPARTMENT OF PREVENTIVE HEALTH SERVICES

Cochliomyia

[Type a quote from the document or the summary of an interesting point. You can position the text box anywhere in the document. Use the Text Box Tools tab to change the formatting of the pull quote text box.]

Key to … Larvae

1. Body with spinous or flesh… …inally .... *Fannia*

   Body smooth or with short… …l processes 2

2. Body with a long slender tail or caudal process capable of a certain amount of extension and retraction .... *Eristalis*

   Body sometimes narrowed posteriorly, but never with a long flexible caudal process capable of a certain amount of extension and retraction 3

3. Larvae more or less grub-like; most species slightly flattened dorsoventrally 4

   Larvae maggot-like, or typical "muscoid" shape, tapering anteriorly, broadly truncate at the posterior end; cross-section more or less circular at all points.. 5

4. Posterior spiracular plate with three distinct slits.. *Dermatobia*

   Posterior spiracular plate with many fine openings ....*Hypoderma*

5. Posterior spiracles within a well-chitinized and complete ring encircling the button area; spiracles never in a distinct depression 6

   Posterior spiracles with the button very slightly chitinized or absent; chitinized ring incomplete; spiracles in a distinct depression or flush with surface 8

6. Button area with spiracular slits nearly straight 7

   Bottom area with spiracular slits sinuous, with at least a double curve 9

7. Principal transverse subdivisions of spiracular slits well marked, usually not more than six in number; both ring and button heavily chitinized, the ring thickened into points at two places between the slits .... *Calliphora*

   Transverse subdivisions of spiracular slits less distinctly marked, from 6 to 20 in number, ring and button less heavily chitinized, the ring thickened into point at only one place between the slits .. *Phaenicia*

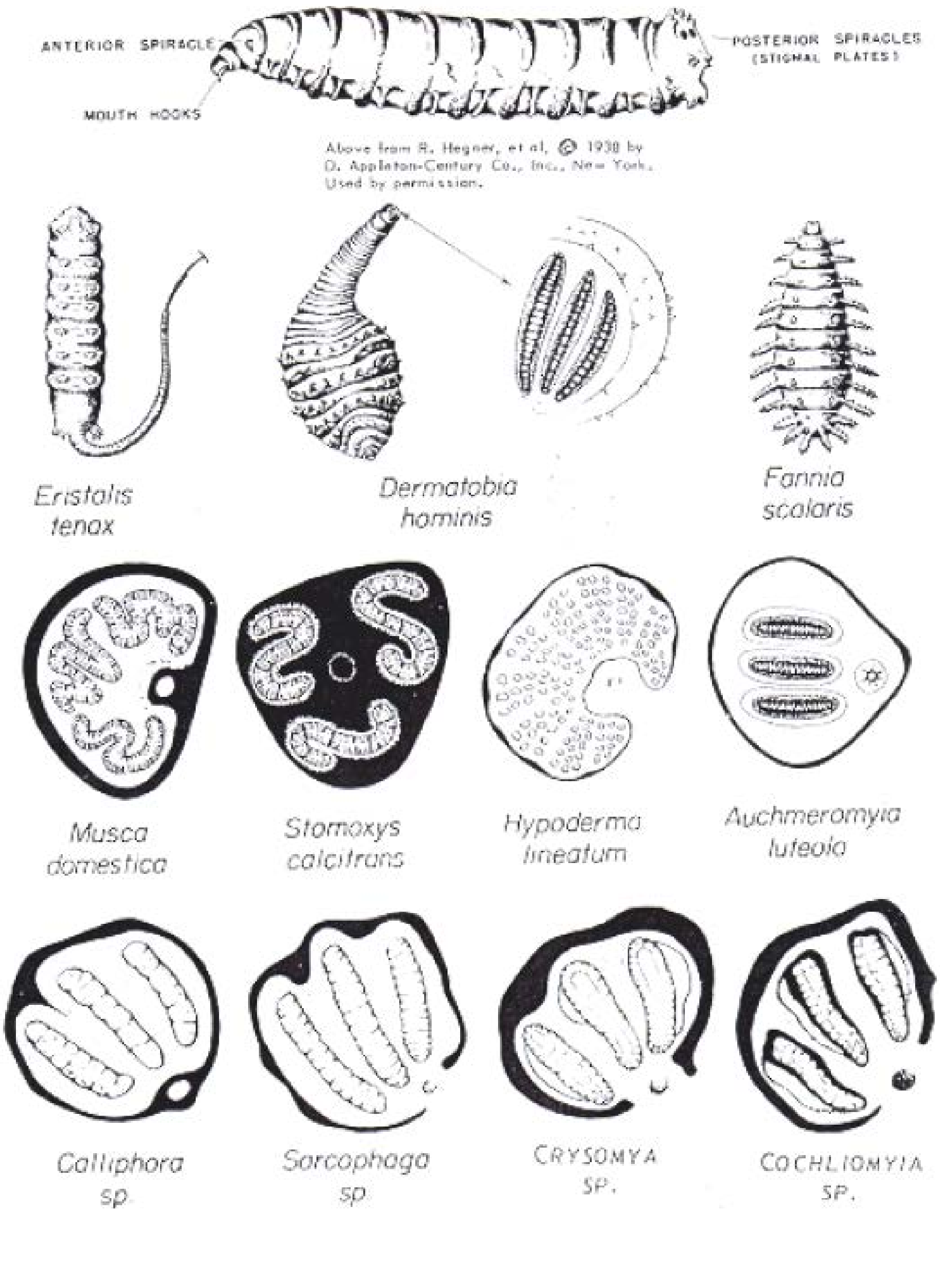
8. Posterior spiracles in a more or less distinct pit or depression, vestigial button usually present; integument rather smooth.. *Sarcophaga*

   Posterior spiracles flush with surface; integument rather spiny (Western Hemisphere) .... *Cochliomyia*

9. Posterior spiracular plates D-shaped, each slit thrown into several loops....................................*Musca*

   Posterior spiracular plates triangular, with rounded corners; spiracular slits S-shaped; button indistinct, centrally placed.. *Stomoxys*

BODY STRUCTURE AND STIGMAL PLATES OF SOME MYIASIS-PRODUCING FLY LARVAE



APPENDIX B - Field Sanitation Device Specifications

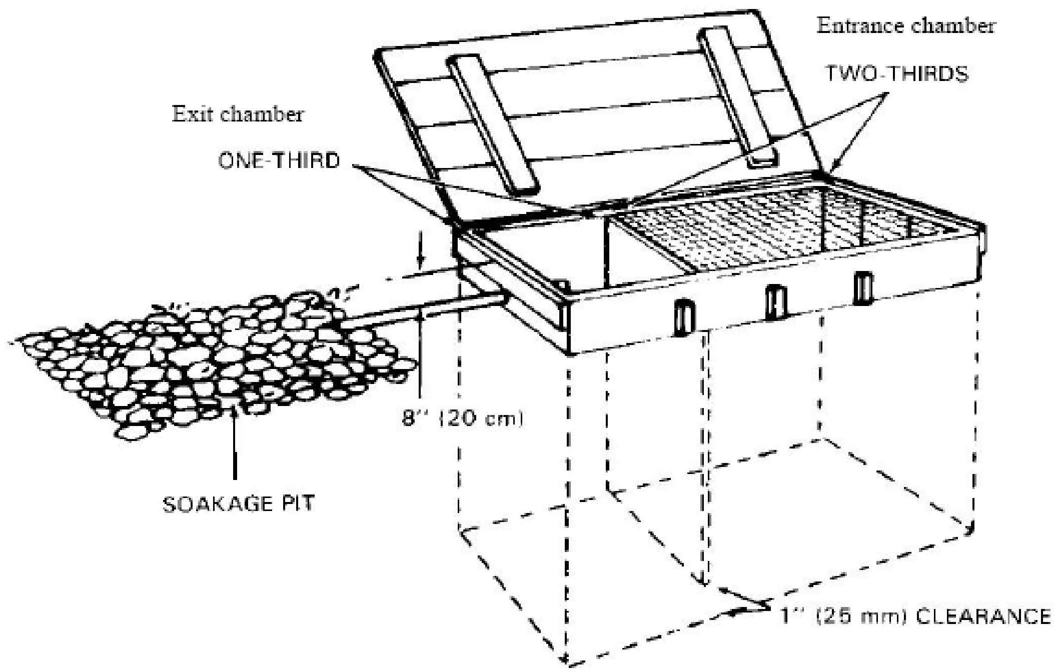


Figure B-1: BAFFLE GREASE TRAP

A baffle may be used in a watertight box, drum or barrel in the construction of a grease trap. Salvage boxes or barrels may be reinforced or treated to serve the purpose. The baffle separates the larger (2/3) entrance chamber from the smaller (1/3) exit chamber and extends to within 2.5 cm of the bottom of the box. Water is poured into the entrance chamber and the grease remains on the surface of that chamber. The pressure of the fluid forces the grease-free water under the baffle board and out of the exit pipe into the soakage pit. The exit pipe should be located about 20 cm from the upper edge of the exit chamber. Adding multiple baffles can increase the efficiency of the trap.

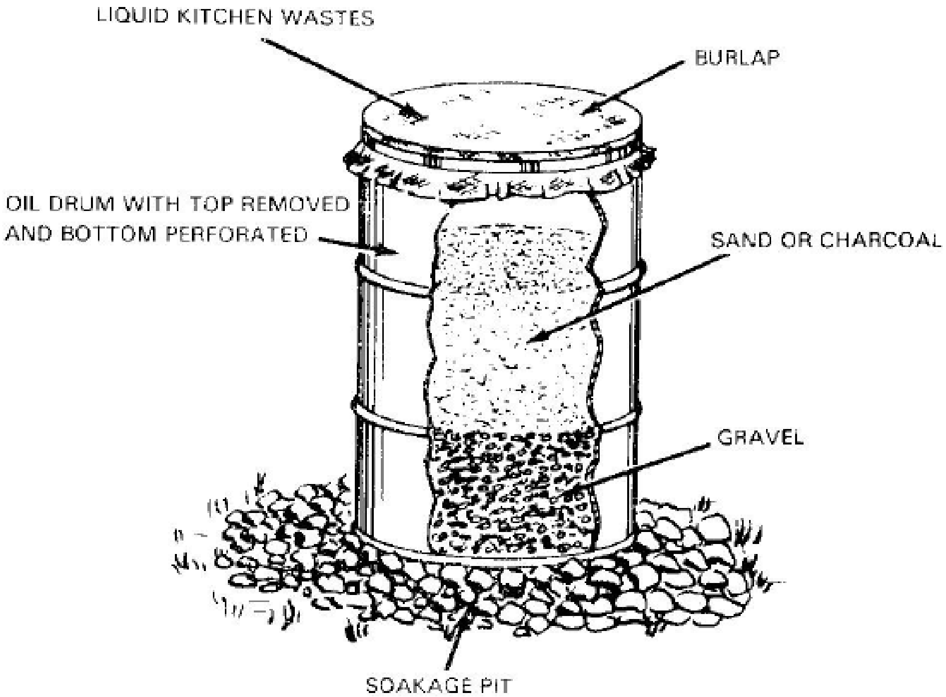


Figure B-2: FILTER GREASE TRAP

This grease trap may be used in place of the baffle trap though it is not as efficient in removing grease. Fill the lower 1/3 of the barrel with crushed rock or coarse gravel. Fill the middle 1/3 with coarse sand, finer gravel or charcoal. Finally, add a 15 cm layer of filtering material such as fine sand, ashes, charcoal or straw. This filter layer will need to be removed and buried frequently (once or twice a week) and replaced with fresh filter material. The burlap (or other fabric) filtering cover should be removed daily, buried or burned, and replaced with a clean fabric filter.

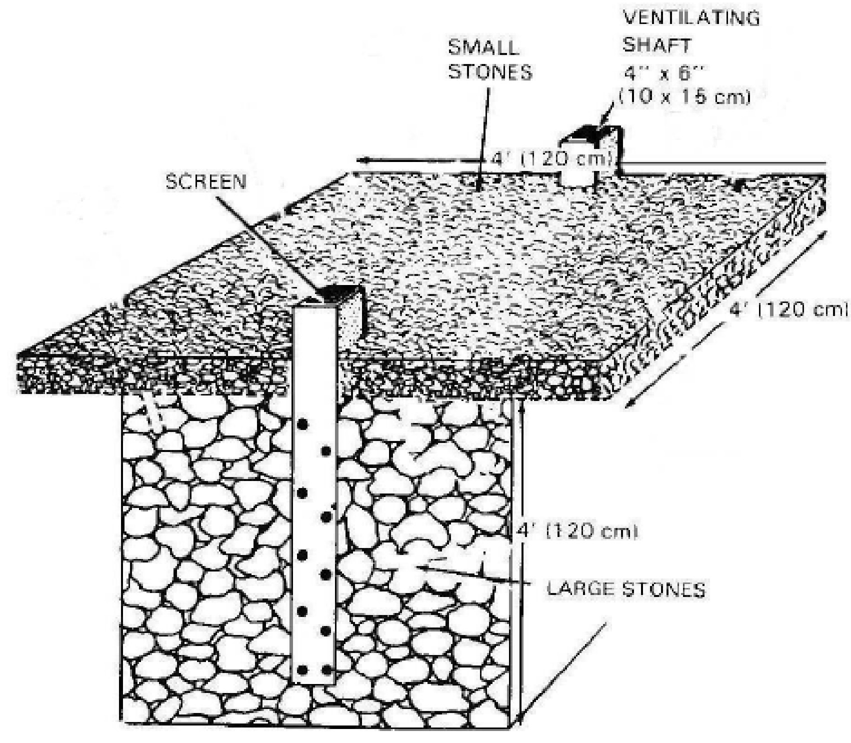


Figure B-3: SOAKAGE PIT

The soakage pit is used to dispose of all types of liquid wastes where the soil is capable of absorbing moisture. The pit is dug 0.5 m^2 and 1.5 m deep. The hole is filled with any of the following materials: rocks, flattened tin cans, rubble, bricks, broken bottles, or other suitable contact material. The liquid waste is held in void spaces until it seeps into the ground. A layer of small gravel or crushed stones may be placed on the surface of the stone filling the pit.

Ventilating shafts made of scrap materials 10 to 15 cm square may be used but are not essential to satisfactory operation of the soakage pit. When shafts are used to introduce air into the pit, they extend 15 to 30 cm above the surface and to within 15 cm of the bottom of the pit. Numerous holes are punched in the sides of the underground sections. The tops of these shafts are covered with screen, straw or grass.

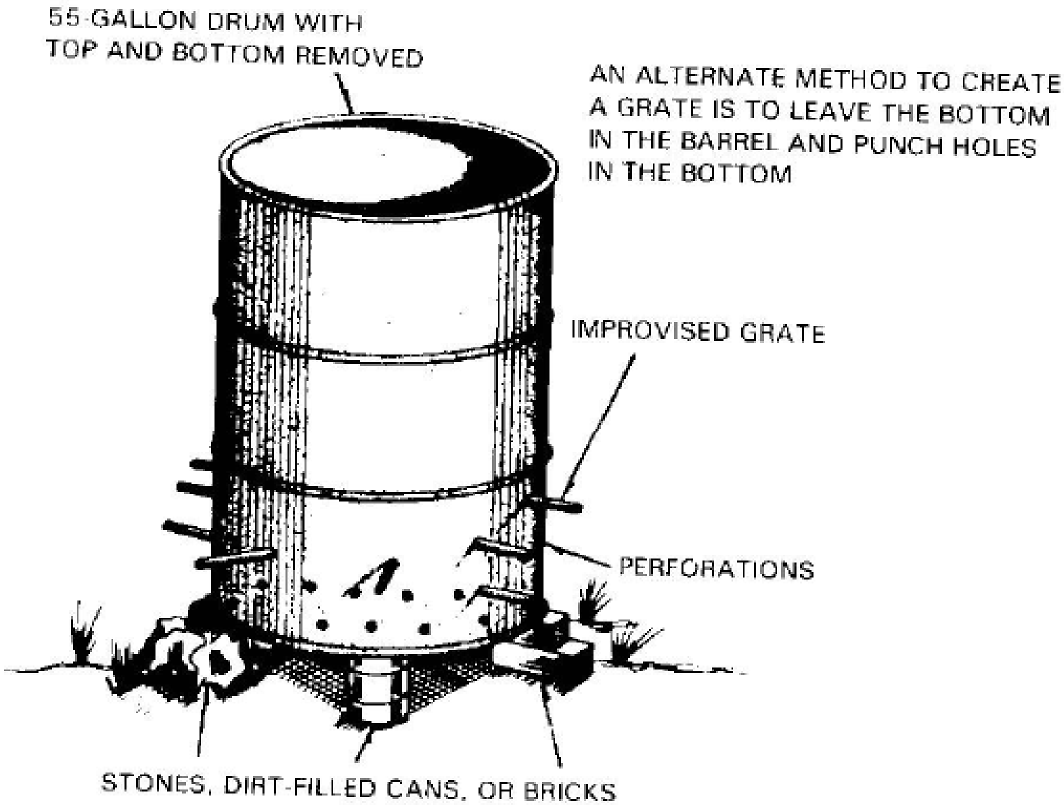


Figure B-4: BARREL INCINERATOR

This incinerator is easily improvised and will effectively consume small amounts of garbage and combustible refuse. A grate is made of scrap pipe inserted in the holes, as shown. An alternative method is to create a grate by simply punching holes in the bottom of the barrel. Instead of trenches to supply draft, the barrel could be elevated on supports of bricks or stones.

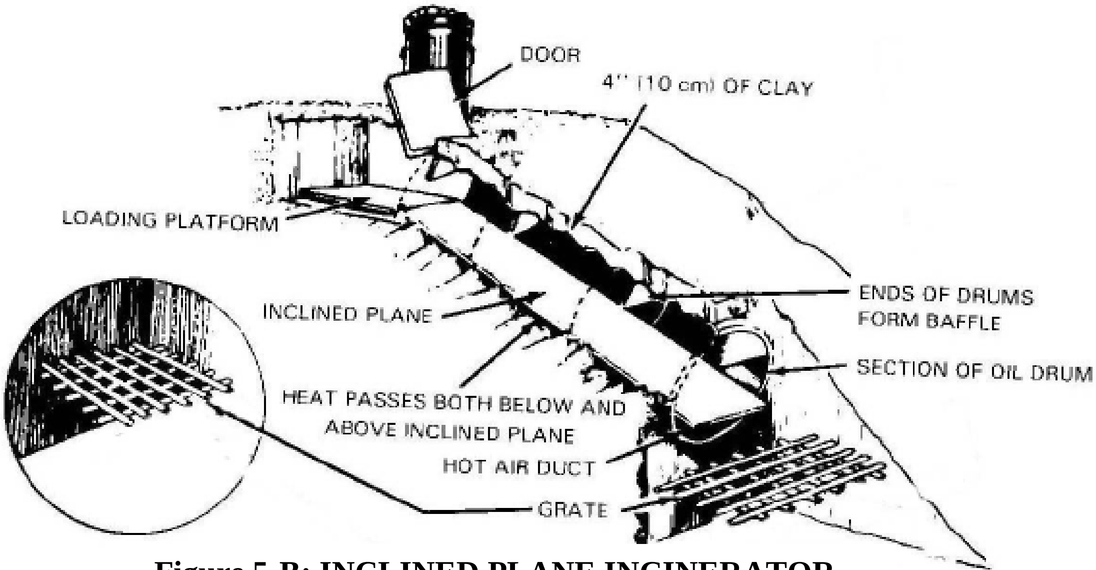


Figure 5-B: INCLINED PLANE INCINERATOR

This incinerator can be very useful in temporary camps. Garbage is placed on the loading platform and fed continuously down the inclined plane toward the grate. This device is particularly useful for burning wet garbage in places where it cannot be buried.

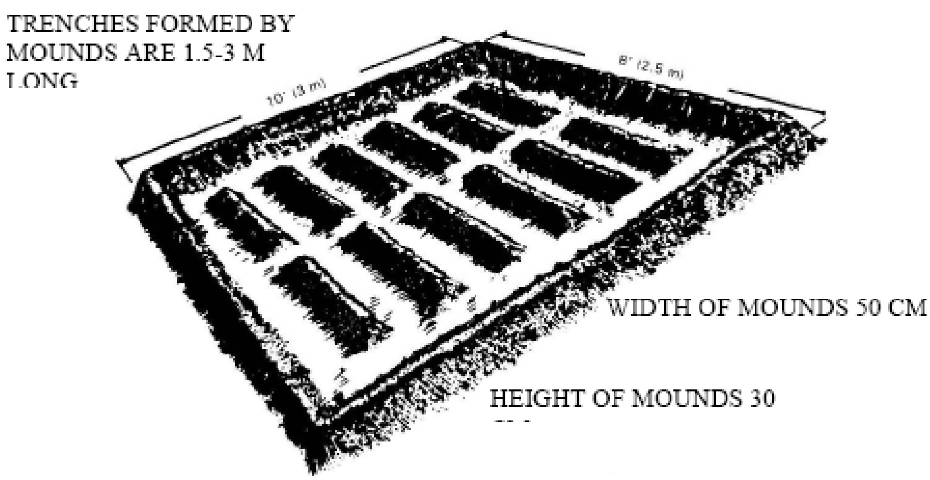


Figure B-6: EVAPORATION BED

This sanitary device is used to dispose of liquid kitchen waste in locations where soakage pits and grease traps are impractical. Evaporation beds are recommended for short stays in a hot, dry climate where soakage pits cannot be dug or where the soil is too hard (frozen or rocky) to absorb moisture.

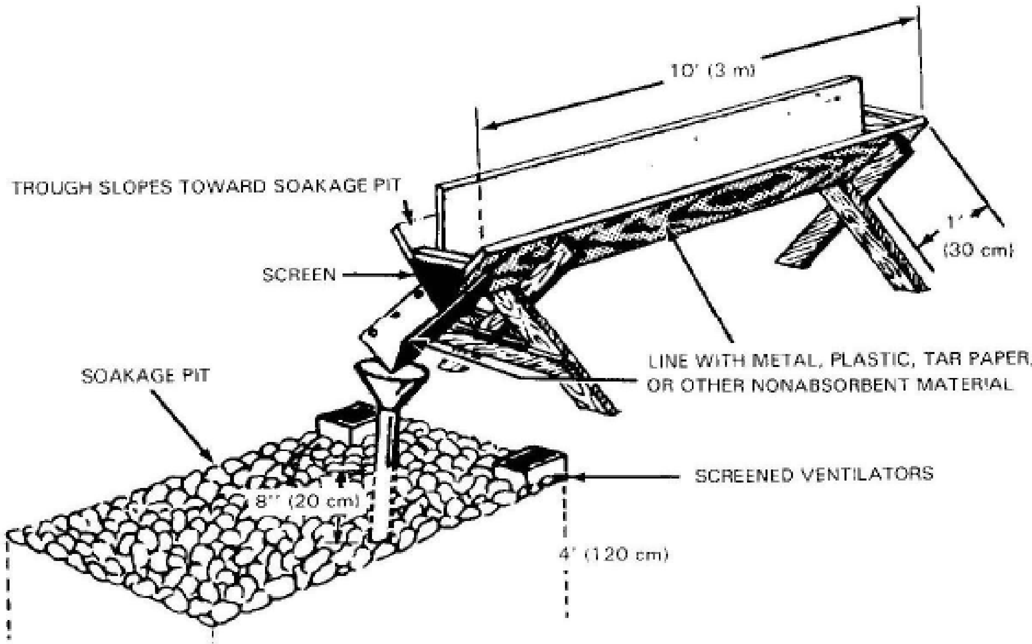


Figure B-7: TROUGH URINAL

This figure illustrates a trough urinal with splashboard and soakage pit. This urinal is made of wood and tarpaper, but equally effective troughs may be made of tin, galvanized iron, or any other suitable material.

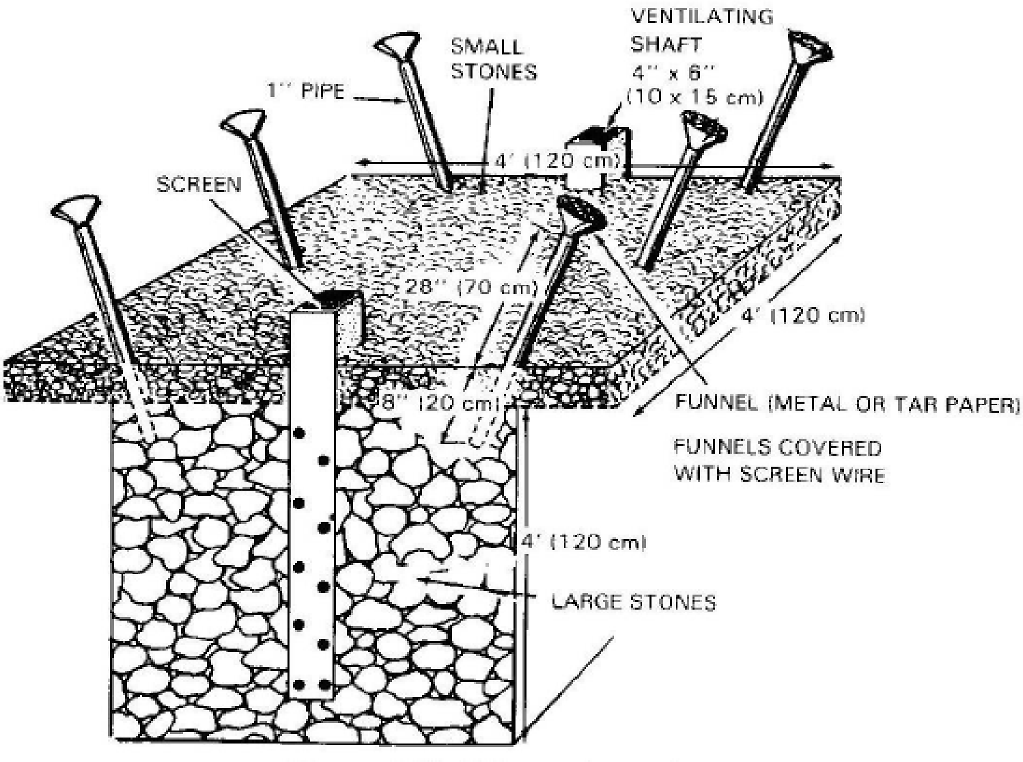


Figure B-8: URINE SOAKAGE PIT

This figure shows salvaged pipe and improvised funnels and depicts a soakage pit in cross section showing construction. The pit is filled with rocks, flattened cans, broken bottles, bricks and other material. The walls of the ventilation shafts that extend below ground level are perforated with 2.5 cm holes.

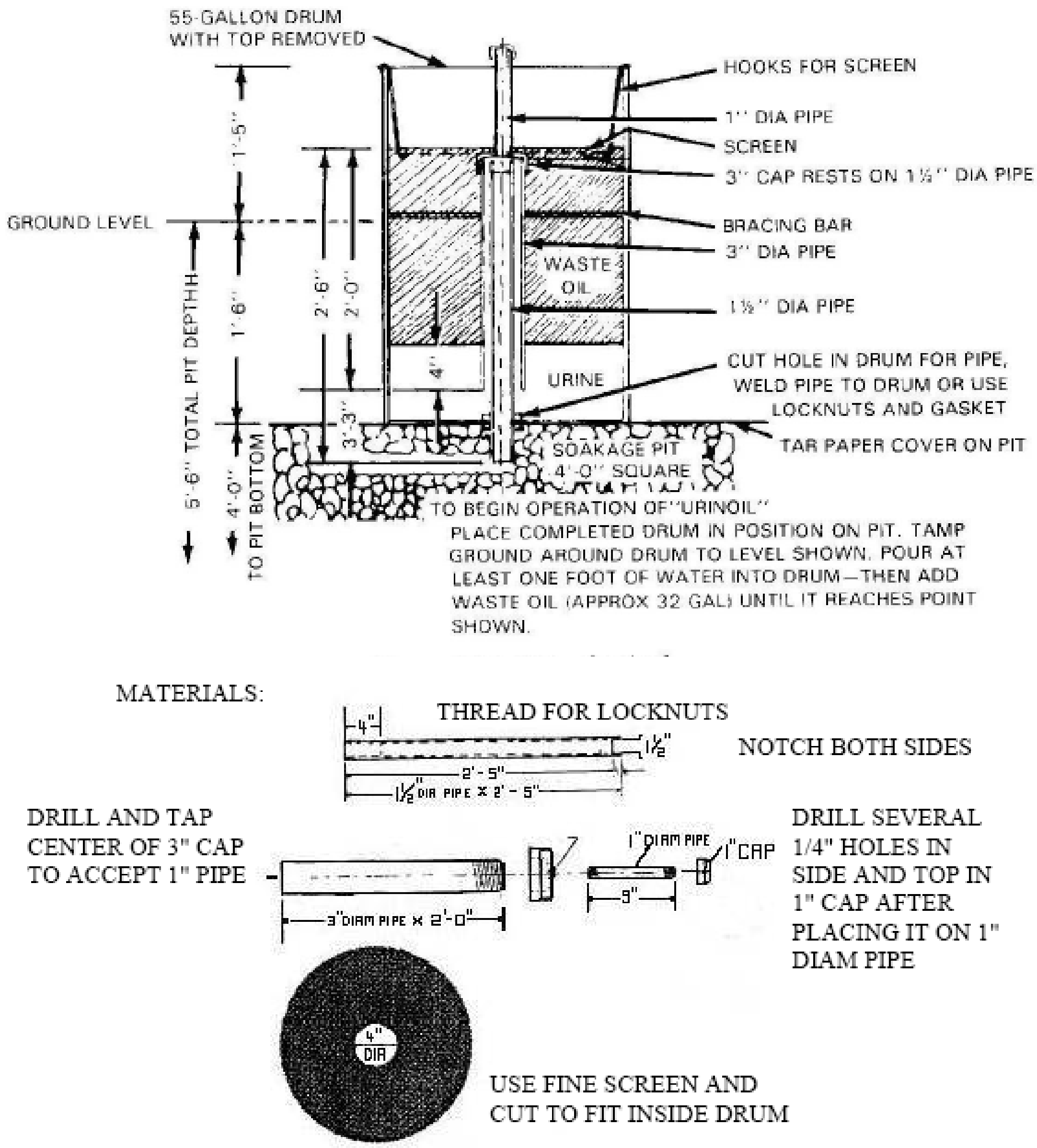


Figure B-9: URINOIL URINAL

> This urinal may be improvised from a 55 gallon drum, as shown in the drawing. It should be placed on a soakage pit when possible, or installed with a French drain.

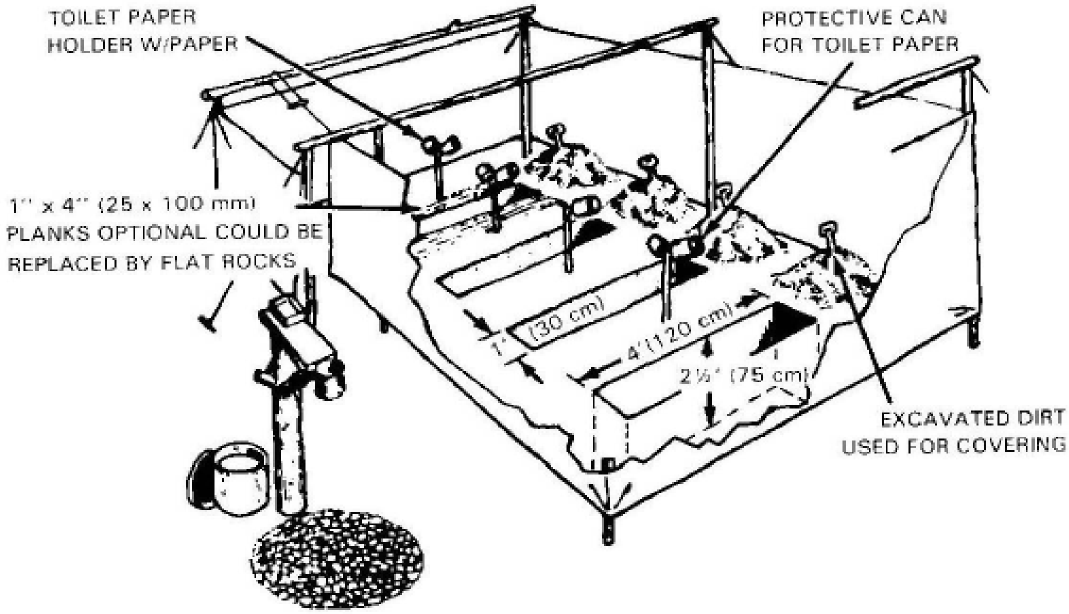


Figure B-10: STRADDLE TRENCH

Trenches are built 0.3 m wide, 1 m deep and 1.5 m long. Boards may be placed along both sides of the trench to provide footing.

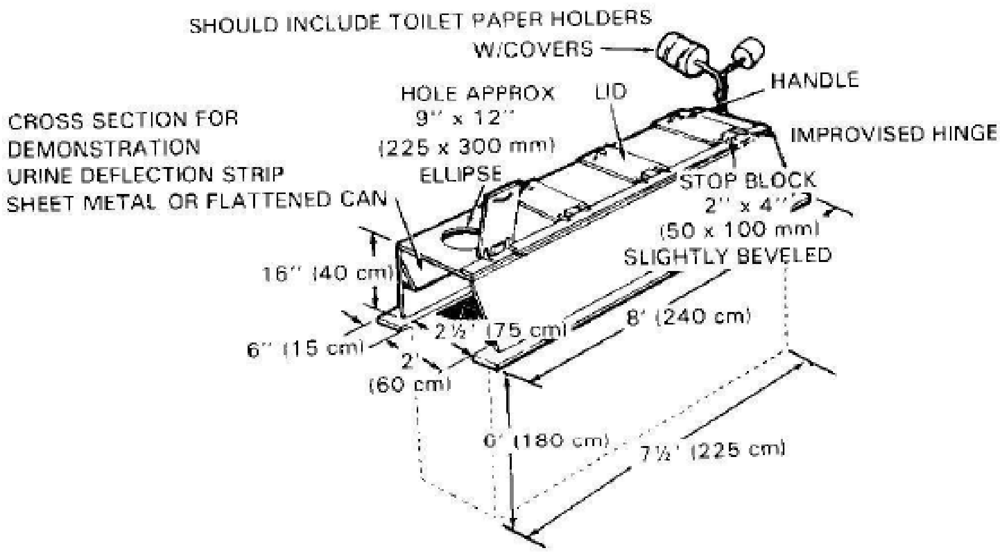
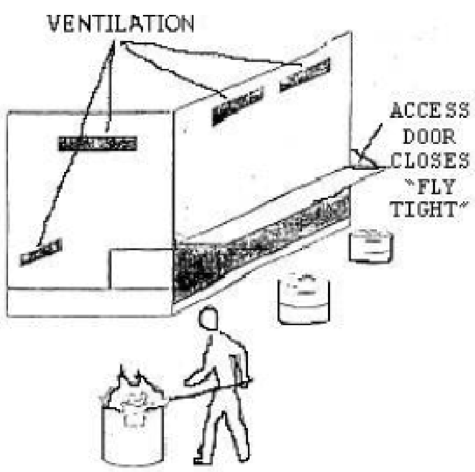
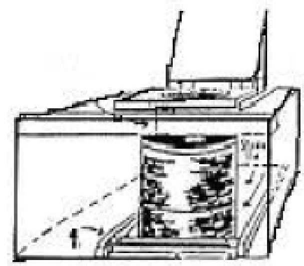


Figure B-11: DEEP PIT LATRINE

Dig a pit 2.5 m long and 0.6 m wide that conforms to the standard size latrine box, which is 2.5 m long and 0.75 m wide. The depth of the pit will depend on the length of stay. The illustration shows stop blocks to ensure self-closing lids, a metal urine deflector strip, and a method of keeping the toilet paper dry, such as tin can covers. Provide a separate urinal at each deep pit latrine.





1. FORWARD EDGE OF HOLE SHOULD BE WELL BACK FROM THE EDGE OF BENCH (6-15 CM).
2. TOP OF BARREL SHOULD BE NO MORE THAN 5 CM FROM UNDERSIDE OF SEAT (MORE THAN 5 CM WILL RESULT IN SPLASHING AND SPILLAGE INTO COMPARTMENT).
3. THE BARREL SHOULD BE PUSHED ALL THE WAY BACK AGAINST THE BACKSTOP, WHICH HELPS TO CENTER THE CAN UNDER HOLE.
4. RUNNERS HELP TO CENTER BARREL UNDER HOLE.

Figure B-12: BURN BARREL LATRINE

APPENDIX C - Fly Trap Specifications and Surveillance Forms

C-1: BAITED FLY TRAPS

Baited fly traps have been designed by preventive medicine personnel to help control fly populations in and around base camps and troop living areas in Saudi Arabia. The trap works by attracting flies to bait, which is placed in a tin in relative darkness. Flies that have entered the darkened tin feed and lay eggs on the bait and then are attracted to the light above. The flies follow the path of the wire gauze cone through a small opening at the top of the cone into a large cage trap where they die from starvation and exhaustion within a 24-hour period.

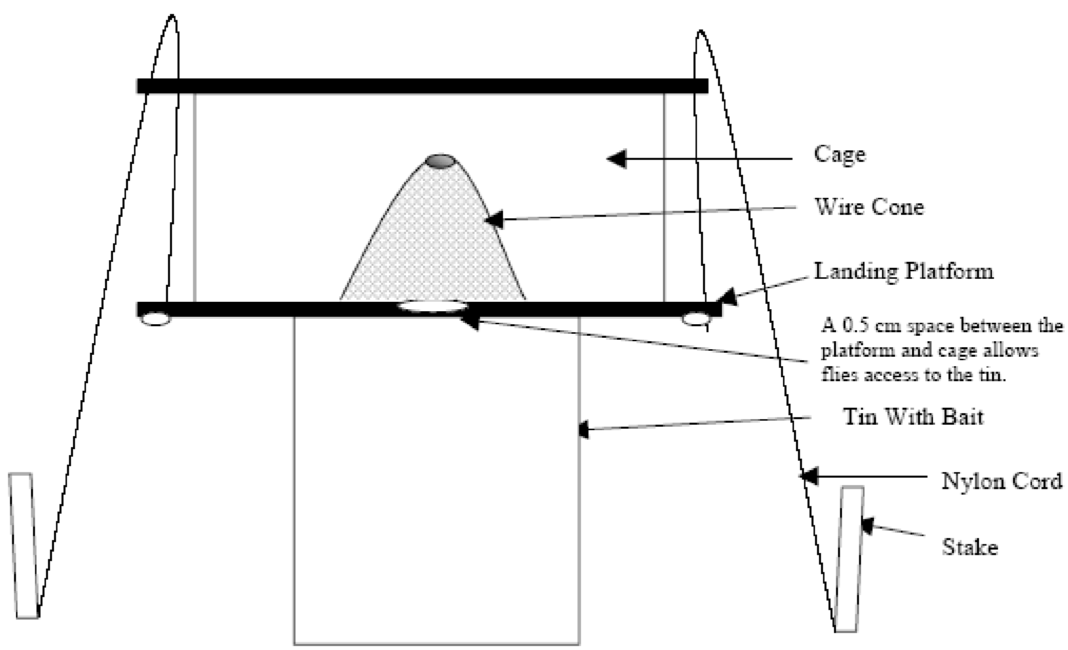


Figure C-1: Baited Fly Trap

OPERATION AND MAINTENANCE: The bait should be bulky and moist and fill the tin half-way. The bait is selected from the contents of a kitchen swill bin, with scraps chosen from items such as meat or fish. Raw chicken parts in water have been found to attract many flies. Attraction to chicken intestines, due to the fermentation of food in the intestines and the microorganisms they contain, is quite strong. Other baits include 1 kg of brown sugar in a gallon of water, fruit such as dates, grapes and bananas, or a combination of foodstuffs. The bait should be changed at regular weekly intervals. The old bait should not be buried but instead burned along with dead flies.

The trap is emptied when fly corpses reach the height of two thirds of the cone. Living flies may be killed by pouring boiling water over the trap or by using a reserve trap cage and waiting 24 hours for flies to die.

Fly traps should be positioned outdoors and given the maximum exposure to sunlight. Traps should not be sited closer than 300 meters from each other. Secure traps by running nylon cord through holes in the top and bottom platforms and then fastening the cords to a stake in the ground. Stabilize the bottom tin by shoveling sand or gravel along its basal perimeter. Traps will attract large numbers of flies and should therefore be positioned away from mess halls and living areas.

The platform will become fouled with fly vomit and excreta and should be cleaned at least once a month with soap and water. The wire gauze will become fouled as well and should be cleaned with an old toothbrush. The bait tin may be used repeatedly, provided it is cleaned out thoroughly each time. Remember that success of the fly trap depends on maintaining a high standard of sanitation in and around base camps.

C-2: FIELD-EXPEDIENT BOTTLE TRAPS

Fly traps can be fashioned from disposable plastic water bottles. The simplest of these is constructed by cutting off the top and inverting it to form a cone leading into the body of the bottle, where a bait is placed. Flies attracted to the bait are trapped inside the bottle and disposed of when the bottle becomes too full to be effective (see Figure C-2.a). Baits may consist of spoiling fruit or meat, food residue, and similar fragrant items. Once flies are attracted into the bottle, their natural pheromones increase attractiveness of the trap to other flies. These traps can be hung (no higher than 2.5-3 m) or placed on the ground out of traffic areas.

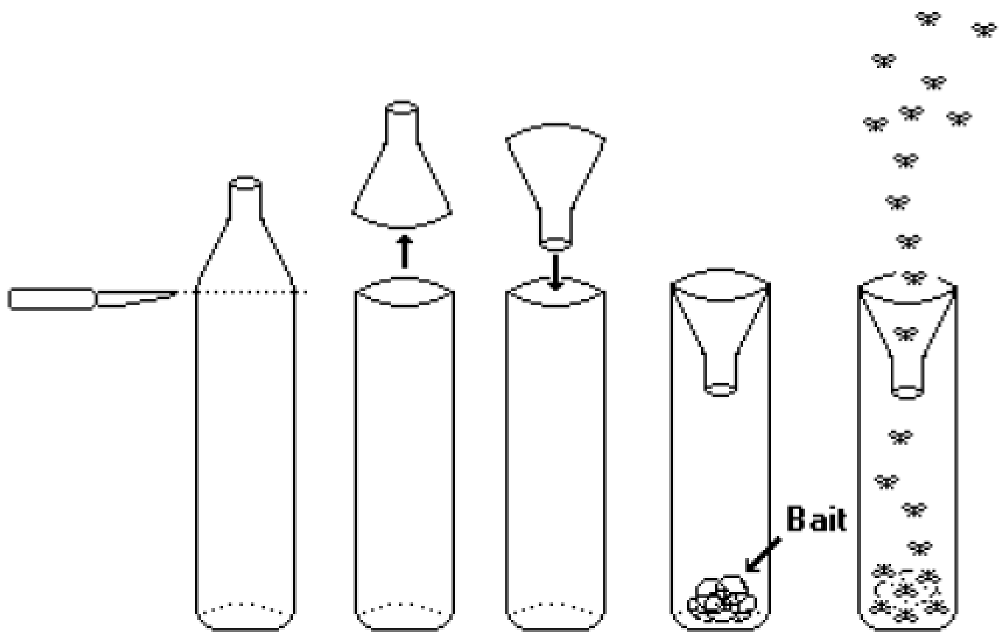


Fig. C-2.a. Plastic water bottle fly trap (inverted cone model)

Under adverse environmental conditions, such as constant high wind, rain, or dust storms that prevent fly baits from being fully effective, it may become necessary to employ alternatives for dispensing baits. One such is to add poison bait to the trap illustrated above, or fashion a trap that is filled to a depth of 5 cm with poison fly bait and in which four 6 mm holes are cut near the top of the bottle to allow the flies access (see Figure C-2.b).

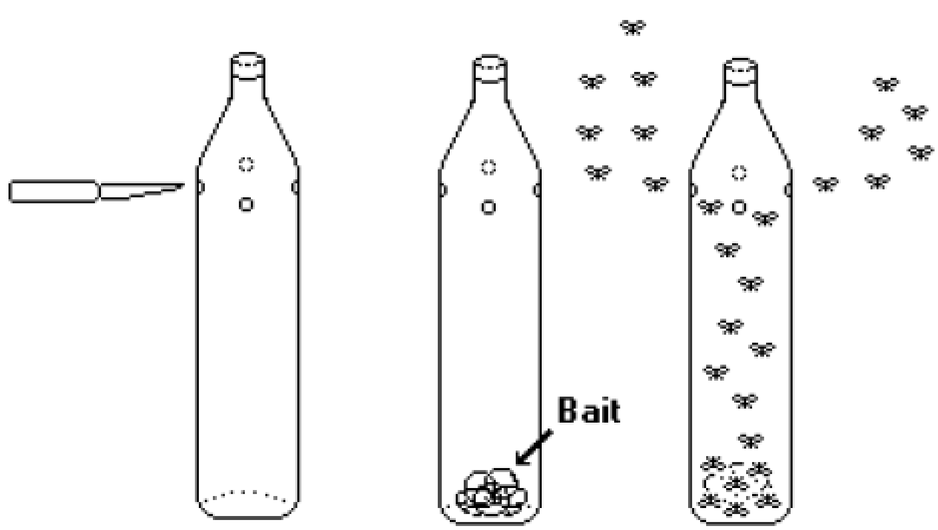


Fig. C-2.b. Plastic water bottle fly trap (multi-hole model)

The trap should be hung between 1 and 3 m above the ground. These traps work well indoors. The contents must be shaken periodically so that dead flies do not accumulate on the surface of the bait, inhibiting contact between newly attracted flies and the poison. Another technique is to place the bait in a box to keep it from blowing away or becoming soaked or dust-coated. Simply put a granular fly bait in a flat box constructed from scrap wood, clearly labeled with the appropriate warning, and place the box on the ground where flies can access it. Such boxes should be checked periodically to dump dead flies and recharge them with bait. Dead flies should be disposed of with waste material, ideally with medical waste when possible. An added advantage to this method is that it prevents troops from collecting and misusing the bait. These bait stations work well when placed near latrines, showers, and waste disposal sites (burn locations, dump sites, etc.). Do not place them near dining facilities, even though flies attracted to the bait seldom leave it before dying.

C-3: THE SCUDDER FLY GRILL

The Scudder fly grill is used outdoors and is the most versatile of the counting techniques. The grill consists of 16-24 wooden slats, fastened at equal intervals to cover areas of from 0.8 m^2 (big grill) down to 0.2 m^2 (small grill) (see Figure C-3). The big grill is for outdoor use; it is impractical for indoor use. For general use, a small or medium-sized grill is recommended. Place the grill over natural fly concentrations and count the number of flies landing on the grill for a given period of time (usually 30 seconds or l minute). In each locality, counts are made on 3 to 5 or more of the highest fly concentrations found and the results averaged.

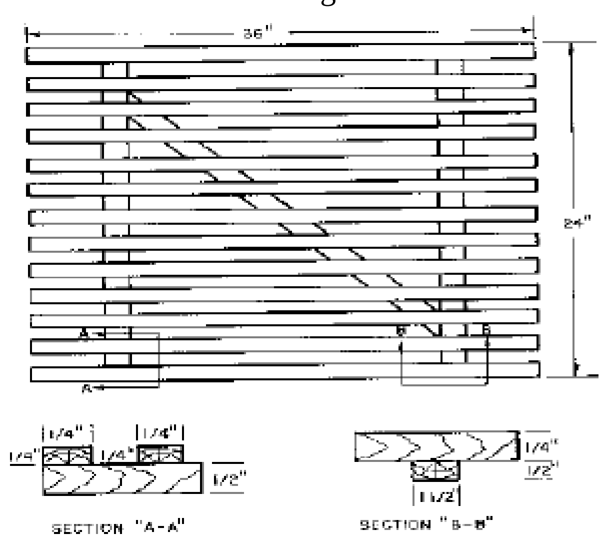


Fig. C-3: Scudder Grill

C-4: FLY BAIT TECHNIQUE

Fly densities indoors can be determined using this technique. Place a square card 30 cm on a side that has been painted with a mixture of molasses and vinegar (1:2) near a location frequented by flies. Record the number of flies attracted to the card over a specified time (for example, 5 minutes). Other baits, such as syrup, molasses or milk, may be used, but in order for fly counts to be meaningful, uniformity of bait and technique is necessary.

C-5: TRAPPING

Sticky tapes or strips can be used for assessing fly densities, particularly indoors. These devices should be exposed to flies for a period of 2 hours to 2 days (1 day is recommended). Place them near doorways or trash receptacles, but not over food preparation or serving areas. In order for the data to be meaningful, the length of time and time of day must be uniform from observation to observation.

SAMPLE	**FILTH FLY SURVEY FORM**	**SAMPLE**

1. Building	2. Organization	
5454	1st Bn / 1st Inf	
3. Date	**4. Time**	**5. Person Contacted**
6 July 2000	0900	SGT Cook

6. Food Handling Facility		7. Quarters		
a. Meals/ Day	b. Days Open/Week	a. Single	b. Multiple Unit	C. Other
600	7			

8. Sanitary Conditions *(check one)*				9. Exclusion *(check one)*				10. Air Curtains Present (*circle one*)	
a. Very Good	b. Good	c. Fair	d. Poor	a. Very Good	b. Good	c. Fair	d. Poor	Yes	No
	X					X			X

11. Operational/Effective		12. Windows Screened		13. Fans Screened		14. Doors Screened	
Yes	No	Yes	No	Yes	No	Yes	No
		X			X	X	

15. Other

Doors propped open

16. Refuse Disposal {*Yes (Y) or No (N)*}				17. Sampling Method (*check one*)			
a. Container		b. Lids/Doors		a. Grill	b. Sticky Trap	c. Live Trap	d. Sweep Net
(1) Clean	(2) Rodent-Proof	(1) Closed	(2) In Good Repair	X			
N	Y	N	Y				

18. SURVEY DATA

a. Location	b. Number of Flies Counted / Trapped / Caught
Next to dumpster	# per min. 4 / 15 / 3
Garbage can washing area	# per min. 10 / 15 / 13

Specimens Sent for Identification to:

19. Date	20. Species

21. Comments:

SAMPLE **SAMPLE**

Fig. C-4.a: Sample Filth Fly Survey Form

FILTH FLY SURVEY FORM

1. Building	2. Organization	
3. Date	4. Time	5. Person Contacted

6. Food Handling Facility		7. Quarters		
a. Meals/ Day	b. Days Open/Week	a. Single	b. Multiple Unit	c. Other

8. Sanitary Conditions *(check one)*				9. Exclusion *(check one)*				10. Air Curtains Present (*circle one*)	
a. Very Good	b. Good	c. Fair	d. Poor	a. Very Good	b. Good	c. Fair	d. Poor	Yes	No

11. Operational/Effective		12. Windows Screened		13. Fans Screened		14. Doors Screened	
Yes	No	Yes	No	Yes	No	Yes	No

15. Other

16. Refuse Disposal {*Yes (Y) or No (N)*}				17. Sampling Method (*check one*)			
a. Container		b. Lids/Doors		a. Grill	b. Sticky Trap	c. Live Trap	d. Sweep Net
(1) Clean	(2) Rodent-Proof	(1) Closed	(2) In Good Repair				

18. SURVEY DATA	
a. Location	b. Number of Flies Counted / Trapped / Caught

Specimens Sent for Identification to:

19. Date	20. Species

21. Comments:

Fig. C-4.b: Blank Filth Fly Survey Form

APPENDIX D - WHO Filth Fly Resistance Testing

There are several methods for assessing pesticide resistance in filth fly populations. Each method has its merits and shortcomings. In general, resistance testing is time consuming, labor intensive and best conducted in a laboratory environment. In order to obtain accurate test results, uniform fly populations (same sex, similar age distribution, reared on standard diet) and controlled environmental conditions (temperature and humidity) must be maintained during the test. It is hoped that a more field-expedient "screening method" will eventually be developed.

The standard method for detecting pesticide resistance in adult filth flies is the micro-applicator method published by the World Health Organization (WHO, 1981). In this method, batches of adult flies are treated topically with different concentrations of insecticides and the mortality at each level is determined. This test is conducted periodically, with two to five replicates each time. Resistance is determined by comparing the results to established baselines.

The micro-applicator test is conducted by anesthetizing adult flies by chilling them on ice or exposing them to CO_2 or ether vapors. Use a micro-capillary tube to apply a set quantity of pesticide to the dorsal surface of the thorax of each fly. Treated flies are then placed in a clean, well-ventilated holding cage. Results are obtained by counting mortality after 24 hours.

Other methods of determining resistance include the Sheppard and Hinkle (1986) test for pesticide resistance in horn flies, which involves anesthetizing flies with CO_2 and exposing them to various pesticide residues on the surfaces of glass petri dishes. This technique was compared to the topical application of pesticides by Hinkle et al. (1985) and resulted in similar findings. Sheppard and Hinkle (1987) later modified this technique with the use of pesticide-treated filter paper and disposable plastic petri dishes. Although not recommended by the WHO, this test appears to be more useful under field conditions.

APPENDIX E – Fly Control in Mortuary Affairs Facilities

<u>Purpose</u>

The purpose of this Appendix is to provide guidance to preventive medicine personnel, installation pest control operators, and mortuary affairs personnel on how to prevent and control fly infestations associated with decedent remains.

Control of flies during mortuary operations presents unique pest control challenges. Bodies recovered after combat operations, accidents, natural disasters, or terrorist attacks are often infested with fly eggs or larvae before they can be placed in containers to protect them from these pests. Preventive medicine personnel are sometimes asked to apply chemicals to control flies on dead bodies in the field. Pest control personnel may also be asked to control flies that emerge from decedent containers (i.e., Human Remains Pouches (HRP), Transfer Cases (TC), etc.) opened in mortuary affairs facilities. Care must be exercised both before and after human remains are recovered and returned to a mortuary affairs facility to ensure that forensic evidence and analytical procedures associated with processing the remains are not disrupted by pest control actions.

<u>Fly Control in the Field</u>

In general, no pesticide applications should be made on bodies found at the sites of combat operations, accidents, natural disasters, terrorist attacks, or crime scenes. There are a variety of reasons for this restriction. First, the sensitivity of DNA testing often used to identify remains can be decreased or eliminated due to the presence of pesticides. Pest control chemicals can also negatively affect various chemical analyses associated with the autopsy process. Finally, insects associated with human remains can provide valuable forensic evidence for either a crime investigation or simply to help determine a person's time of death. Treatment of human remains with pesticides will alter the normal development of any insects that are infesting the remains, thereby altering this forensic evidence. For these reasons, neither human remains, nor the containers in which they are placed for transport to a mortuary affairs facility should be treated with pesticides.

A distinction is made for pre- and post-medical/legal preparation. No treatments should be used on human remains pouches and/or transfer cases containing human remains until after medical/legal preparation.

<u>Fly Prevention and Control in Mortuary Affairs Facilities</u>

Exclusion Measures

This is the first line of defense against fly infestations from the local area. Keep all doors and windows closed unless there is a need for them to be opened. If there is a need for doors and windows to remain open during operating hours, ensure screens in proper repair are in place to exclude adult flies.

Close all doors as quickly as possible when moving human remains into or out of facilities to minimize entry of local flies. Where practical, electrical air or fly curtains should be installed above doorways that must routinely be left open without screen doors. These devices provide a fast flowing "curtain" of air to restrict the ability of adult flies to enter a facility when doors are temporarily opened.

Large doorways in loading areas may have exclusion devices that do not restrict human movement, such as clear plastic strip doors (used to keep birds out of industrial and food facilities). These strips will reduce the entry of adult flies while the large door is opened for on-going operations. The door should be closed when loading operations are complete.

Facility Sanitation

Keep the facility as clean as possible inside and outside. Facility personnel need to ensure that discarded human remains, as well as dead adult and larval flies, are cleaned up and properly disposed of, especially at the end of the workday. Proper sanitation will eliminate any potential breeding source for flies as well as any odors that may be attractive to local flies.

Fly Control (Larvae and Adults)

Flies that emerge in decedent containers while they are in transit from the field to a mortuary affairs unit may infest the facility. As mentioned previously, pesticides and other chemicals applied to control flies may interfere with a variety of analytical procedures, so these chemicals should not be applied to bodies in the mortuary. If live larvae are present on the body, only chemicals approved for their control in mortuary affairs operations should be used. Only mortuary affairs personnel should apply such chemicals and should do so in accordance with internal standing operating procedures.

Adult flies that emerge from opened decedent containers, as well as flies that may enter the facility from local sources, should be controlled using fly traps. Light traps (e.g., black light/UV) designed to catch flies attract these pests very effectively and are the preferred method of adult fly control in mortuary affairs facilities. Light traps using either sticky devices or containers to trap the flies attracted to the lights should be used. Pheromone-baited sticky traps can also be useful indoors. Do not use electrocuting light traps because the electrical shock used in them causes flies to explode, which scatters fly body parts and possibly decedent DNA (from fly feeding activities) in the room. This could lead to contamination of work surfaces, analytical tools, tissue samples, or human remains being processed.

In the rare case that exclusion, sanitation, and trapping do not control a fly infestation in a facility, pesticides may have to be applied in the facility itself. Non-residual space sprays labeled for indoor adult fly control should be used rather than applying residual pesticides. No decedent remains, open containers, analytical samples, or sampling devices should be exposed to the space spray. Facility personnel should clean all horizontal work surfaces before decedent containers are opened and autopsy procedures are resumed to ensure pesticide residues do not contaminate work surfaces. Facility personnel should properly dispose of all dead adult flies or larvae remaining after the space spray treatment. Do not use automated pesticide dispersal systems in mortuary affairs facilities.

APPENDIX F - References

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