Chapter 7

Culex quinquefasciatus and Other Pest Mosquitoes

Culex quinquefasciatus will in most cases be considered pest mosquitoes. In some areas, however, they are vectors of St. Louis encephalitis and bancroftian filariasis. A number of other mosquitoes that are also normally considered pest mosquitoes may be vectors of arboviruses. These mosquitoes are treated superficially because of the variety of larval habitats encountered and because of their limited medical importance. In many cases, they will cause complaints, and some type of action against them may become necessary.

Surveillance

There will be little available baseline information about pest mosquito densities unless it has been collected because of a tourist industry or in a municipal mosquito control program. The pest mosquito population density immediately after a natural disaster may be low as in the case of *Aedes aegypti*. Changes in the environment which occur both during and after a disaster may, however, favor rapid population increases.

Mosquitoes that breed in certain habitats may increase in number within one month after a disaster. These habitats are salt marshes, bogs, fresh-water swamps, mangrove swamps, sewage effluents, semi-permanent ponds, woodland pools, artificial containers, ditches, irrigation wastes, water impoundments, rice fields, and natural containers such as tree holes, rock holes, and crab holes. Although problem species will differ greatly from area to area, they should not go unidentified. Surveillance, if meaningful, must include knowledge of the species and habitats of all mosquitoes encountered.

Checklists of the mosquitoes and other biting insects that have been collected in the area may exist in universities or libraries Basic information about flight range, host preferences. life cycle. larval habitats, adult resting places and specific control methodology, may be obtained from the literature.

Topographical maps and aerial photographs assist in locating potential problems, as they do in the case of *Aedes aegypti*. In areas where there has been some type of environmental management such as diking for purposes of mosquito control, reconnaissance flights provide valuable information about the condition of the control method. (Maps and photographs can also be used to locate sampling stations for use in evaluating population densities.) If topographical maps or photographs do not exist or do not produce the information required, taking simple photographs and making maps while in flight can help in orientation and location of breeding places. Such flights can also be of service for planning chemical control and drainage operations.

Culex quinquefasciatus breeds in highly polluted water. Rapid increases in populations might occur where pit latrines have been constructed as a temporary measure after a disaster has disrupted normal sewerage systems. Refugee camps should, therefore, be examined regarding the placement of latrines, open dumping of garbage in flooded areas, and the existence of any other standing water (especially artificial containers) that might become polluted.

Population sampling can generally be accomplished at weekly intervals in marshes, swamps and impounded water habitats. Biweekly collections of *Culex quinquefasciatus* may be necessary. It must be emphasized, however, that these mosquitoes are unlikely to be a medical problem and sampling should be considered only if staff and resources are already available. Control of most *Culex quinquefasciatus* habitats can be effected without a great amount of surveillance. Complaints from the refugee or resettlement sites may provide sufficient surveillance.

Estimates of Larval Populations

In initial surveys, the collector must assume that wherever there is standing water there are mosquito breeding sites. As the collector becomes familiar with the area, species and preferred larval habitats, the observations can be refined. Entomologists can assist in identification of the specimens.

Larvae are collected with a white enamel dipper, white enamel pans or other water containers or a siphon. Flashlights or mirrors can be used to illuminate breeding places and to locate water and evidence of breeding. Medicine droppers and other types of pipettes can be used to transfer larvae from the collecting device to vials and bottles. For convenience, dips are usually done in multiples of ten, and inspections are made either weekly or every two weeks.

Estimates of the Adult Population

Adult surveys must be designed to show a relationship between breeding sites and the human population. Changes in population densities observed through one or more collecting methods can be used to determine the need for adult control measures, their effect, the extent of the mosquito problem and the possible arboviral trouble spots. As with all surveys, it is essential to have maps of the area, well designed forms for collecting data, use of standard collecting methods and sites, and a well organized and trained staff. Under some conditions, it is possible to use the adult collections to attempt to isolate arbovirus. This should be considered only if there is an indication of Venezuelan, eastern, western, or St. Louis encephalitis or other arbovirus activity in the vicinity of the disaster. There must be a laboratory that can handle the isolation attempts, as well as the necessary field and laboratory entomological equipment, and trained staff available to carry out this type of work.

There are a number of methods that can be used to collect mosquitoes. The following is a listing of possible methods:

(1) For landing/biting collections in which either animals or man are used:
- (a) Determine the biting habits of the vectors
- (b) Standardize the time of day and the location of collection, the length of collecting period, and the type of bait used
- (c) When a vector-borne disease problem is known or the population densities are high, employ landing rates.

(2) For window traps (used if time and staff permit).
- (a) Use either entry or exit traps (the latter are used in some malaria entomological evaluations)
- (b) Employ entry traps (non-blooded mosquitoes only) for virus isolation attempts
- (c) Operate during the night when the bait is in the shelter
- (d) Standardize the number of collections per unit of time.

(3) For animal bait traps:
- (a) Use traps of sufficient size and strength to hold the bait animal comfortably and to permit easy entry and removal
- (b) Operate at night and standardize the time at which the bait is placed in the trap and removed (even early morning temperatures can be uncomfortable for a caged animal)
- (c) If the specimens collected are to be used for virus isolation attempts, use traps that are designed to separate the caught mosquitoes from the bait

(d) If a carbon dioxide trap is also desired, use smaller bait traps like the Lard Can Trap designed by Bellamy and Reeves (*Mosq. News 12*: 256-258).

(4) For light traps:

(a) Choose from several types, the two most popular of which in the Americas are the New Jersey and the Centers for Disease Control miniature light traps, or modifications of them, and if there is no electricity, consider use of battery models

(b) Remember that light traps attract both males and females from considerable distances, and that collection with the CDC light trap can be enhanced with a supply of carbon dioxide or by hanging dry ice nearby

(c) When locating or positioning light traps, take care not to place them in competition with other light sources

(d) Remember that collections can be made of live mosquitoes by attaching a mesh bag, and of dead mosquitoes by attaching a killing jar; and that live collections can be used for virus work

(e) Run traps on a schedule and, preferably, at established sites

(f) Take care in handling and separating material, since many other insects are also attracted to light traps.

(5) In regard to natural and artificial resting stations, it is useful to know that:

(a) Many mosquitoes (especially some species of *Anopheles* and *Culex*) seek out dark, cool humid places to rest during the day

(b) It may take some searching to find natural resting places for different mosquitoes; buildings, especially unscreened ones that shelter man and animals, bridges, culverts, caves, and hollow trees, may serve as resting sites; collections can be made with an aspirator

(c) Artificial resting boxes have been used with some success, but during emergencies that follow disasters their use might not have to be considered

(d) Large mechanical aspirators and vacuum devices may be used for collecting mosquitoes that are resting in vegetation.

(6) Use of the sheet drop technique, described in Chapter 5, is questionable in disaster situations.

The interpretation of larval and adult surveys depends upon the baseline data that are available and the types of vector-borne diseases found in the disaster stricken area. Pest mosquitoes will cause a great amount of discomfort in many postdisaster situations. However, priorities have to be weighed before funds and staff are committed to controlling them.

Culex Control

Larval Control

Environmental management is an ideal method of mosquito control. If a natural disaster highlights pest mosquitoes, long-term environmental management (i.e., filling, draining, stabilization of water, and source reduction) should be considered in the future. Immediate corrective measures, however, are most likely to take the form of a type of chemical control directed towards adults or the larvae.

In addition to the usual chemicals (i e., organophosphorus, carbamates and chlorinated hydrocarbons) petroleum oils, nonpetroleum monolayers, synthetic pyrethroids and insect growth regulators are available as larvicides. The selection of a larvicide should depend on insecticides, the susceptibility of the target mosquito to the chemical, the effect of the larvicide on nontarget organisms, the type of habitat that is being treated, and the relative costs. To avoid the development of resistance, it is recommended that a different chemical be used for larviciding than that used for adulticiding.

Adult Control

The same general space spraying methods used for the control of *Aedes aegypti* (i.e., thermal fogging and ultra-low volume aerosol application) can be used for most pest mosquitoes. Aerial applications of pest mosquito insecticides are used effectively for the abatement of mosquitoes in the United States of America. This type of control should probably not be considered for pest mosquitoes, however, unless aircraft used for public health are readily available. Exceptions are in areas with arboviral diseases in which pest mosquitoes have been incriminated as vectors, or in situations in which malaria vectors and pest mosquitoes are both increasing in number.

Individuals should be encouraged to use repellents, to burn pyrethrin coils at night and to sleep under mosquito nets. Small aerosol dispensers can be used in local situations, including refugee camp sleeping areas.

Chapter 8

Flies, Rodents and Other Vectors

Synanthropic Fly Problems

Synanthropic flies are those that enter and adapt to the human ecological community. The unsanitary habits of man cause this relationship to develop. Increases in the fly populations may be expected after natural disasters, because of breakdown of sanitary services. The presence of synanthropic flies has potential epidemiological and hygienic implications, and the flies are an annoyance interfering with human comfort. The house fly, *Musca domestica,* is both a filth feeder and breeder, and health problems can occur when it comes into contact with human food and drink. The contamination of food and drink by pathogens can take place mechanically, through its legs, body, proboscis and wings.

The pathogens can also be defecated or regurgitated. Flies have been incriminated in the transmission of many of the enteric diseases of man, including dysenteries, cholera and typhoid fever. Yaws, conjunctivitis, enteroviral infections, and intestinal parasites may be transmitted by different species of flies.

Female house flies oviposit in a number of habitats, especially in garbage and animal wastes. When the average outside temperature is between 25° and 30°C, the life cycle of the fly from egg to adult, is approximately one to two weeks.

Surveillance and Survey Methods

Active fly control is not often included in most health programs. The first indication of a fly problem may be that of complaints from people living in refugee areas or who return to their homes in the disaster areas.

There are a number of fly traps, such as sticky paper, that can be used to appraise population densities. Not all synanthropic flies, however, enter houses and thus, markets, garbage areas, and even outdoor resting places have to be included as areas of appraisal. The easiest way of performing a survey is to count flies as they rest on refuse, vegetation, the walls of buildings and other resting places. Comparable information can be obtained with fly grills. (*Ann. Rev Ent l*: 323-346).

There are a number of other diseases of which rodents may be reservoirs. These include rabies, rat bite fever, rickettsial pox, spotted fevers, and rodent associated viral hemorrhagic fevers. For any rodent-borne disease problem, it is essential to determine if the disease is or recently has been in the disaster area. Since many of these diseases are associated with ectoparasites of the reservoir, it is important to know the natural histories of the diseases and to implement an appropriate control program against rodents and their ectoparasites.

Control and Evaluation

Prevention is recommended over control. High priority should be placed on sanitary services in refugee camps because of crowding and other unhealthy conditions. Sanitary services should also be restored to communities as soon as it is possible. Dead animals should be immediately cremated or buried, pit latrines should be made flyproof, and the rooms in refugee buildings, particularly kitchens and eating places, should be screened.

The public should receive health education about ways to prevent fly breeding. Other activities to recommend include burying garbage when sanitary services are not available, and using fabric curtains at doors and windows to limit fly entry. When available, the use of sticky tapes and household aerosol sprays inside of buildings may help to reduce fly numbers.

Chemical control of filth flies over a long period of time is usually not recommended because their resistance to insecticides develops rapidly and is already widespread. During disasters, however, it may be necessary. Residual spraying of indoor resting places may be required and, if available, sugar and syrup baits with insecticides can be utilized once the sanitary program is well underway. Use of diesel oil in pit latrines is a quite effective control measure. Space spraying resting and breeding places with available insecticides (those used for malaria and anti *Aedes aegypti* programs) can help to reduce fly numbers.

Evaluation may be largely based on direct observation. If an insecticide is not causing an appropriate level of mortality, an alternative should be used. Walking through an area, especially around pit latrines, food preparation areas and garbage collection sites, provides a means of visually assessing the reduction of the population. In control operations, it should be taken into account that flies can migrate up to four miles to new food attractants or to breeding areas. More accurate information may be obtained through the use of standardized fly grill surveys.

Rodent Problems

The environment of the rodent undergoes the same change as that of man after a natural disaster since their harborage and food sources are also damaged or destroyed. The rodent will consequently be in competition with man for whatever food and shelter remain. Commensal rodents and other animals are more visible to man following a disaster and may migrate into his environment. Unfortunately, what the rodent does not directly consume, it may damage and contaminate.

The rodent species that are of concern are the Norway or brown rat (*Rattus norvegicus* Berk), the roof rat (*Rattus rattus L.*), also known as the ship or black rat, and the house mouse (*Mus musculus L.*). Rodents have been involved in transmission of a number of infectious diseases to man. The most important ones are:

(1) Plague, which is endemic to Brazil, Bolivia, Ecuador, Peru and Western United States, frequently involves rodents other than domestic rats
(2) Murine typhus, cases of which occur throughout the world in areas of warmer climates where commensal rats, especially *R. norvegicus*, are the chief reservoirs
(3) Leptospirosis, with a worldwide distribution, is maintained in reservoirs of commensal rodents, dogs, pigs and cattle
(4) Salmonellosis, which occurs when commensal rodents are infected with Salmonella and the infection is transmitted to man in contaminated foods and liquids, spread by infected fecal droppings or by urine; the house mouse probably plays a greater role than rats in the transmission of food-borne illnesses.

The economic and nutritional importance of loss of foodstuffs because of rodent contamination must also be considered. Damages and losses caused by rodents are substantial, and during natural disasters this extra burden can be serious.

In many cases, since rodent control is not the direct responsibility of the central government, it may be difficult to obtain predisaster information. Rodent surveys and control work are usually undertaken by the port authority in seaports, by the local governments of cities, or by the Ministry of Agriculture. These agencies may be sources of background information, supplies and materials for rodent control, and expertise regarding surveys and the organization of control activities. In the private sector, pest control operators may be an excellent source of assistance and relevant information.

Rodent Surveys

Information about rodents can be collected in interviews with people who live in temporary housing and refugee camps after natural disasters. The location and relative density of rodents sighted should be determined at this time.

If an individual familiar with the signs and traces of rats and mice can be located, a survey of large areas can be performed fairly rapidly. The major signs are fecal droppings, rodent runways, rodent footprints or tail marks in dust and tracking powders, gnaw marks of rats and mice, burrows, and nests. Rodent odors, especially of house mice, and urine stains that can be seen under ultra-violet light are also indicative.

Sightings increase when the cover of the rodents is disturbed. After natural disasters it is possible to obtain information through daylight surveys in affected residential areas and near rescue centers. Additional information can be obtained during dusk and early evening surveys. These may be undertaken at random, or through the selection of potential trouble spots. Strong flashlights can be used to search in such places as under buildings, and in refuse disposal areas. Maps are essential for this type of work and if they are not available, sketch maps should be made by the workers. Record should be kept of potential habitats, such as temporary refuse dumping areas and harborage, and of the number of sightings.

A more detailed survey can be accomplished when pest control operators, biologists or personnel from a rodent control program are available. Forms should be reproduced for recording information in such surveys as: the location of the survey, the type of premise, the condition of the structure, the construction materials, the number of occupants, and the presence or absence of food, water, harborage, rodent signs and traces.

Some surveyors use traps to assess the density and determine species of rodents in an area. Live traps can be used when available; otherwise, snap traps serve the purpose. If food markets or hardware stores are still standing after a disaster, snap traps can usually be purchased locally. Care should be taken not to use large numbers of snap traps if a rodent associated disease exists in which an ectoparasite is a vector.

Control

The World Health Organization document (WHO/VBC/79.726) should be consulted for the selection of rodenticides for control purposes. There are two general types of rodenticides in use. The first is the *chronic type*, a multiple dose, slow-acting compound. The second type is the *acute*, or single dose, quick-acting compound. In general control operations, the rodenticide of choice is considered to be a slow-acting anticoagulant poison. Many acute rodenticides are toxic to man and other animals. Thus, in a disrupted environment, such as that which follows a natural disaster, extreme care should be taken in using acute rodenticides. They should be used only in extreme emergencies and by well-trained control operators. Red squill is an exception that can be used against *R. norvegicus*, but it is not as effective against *R. rattus*. Anticoagulant rodenticides such as diphacinone, difenacoum, brodifacoum or chlorophacinone are available in a number of areas and have been used in emergency rodent control. The immediate needs of the control program should be determined with survey information or through estimates of experts. Locally available supplies of rodenticides should be located, and if inadequate, they should be supplemented immediately.

Rodenticides either come as preprepared bait or as concentrate. The concentrates might prove less expensive to order, but in emergencies either formulation is acceptable. In preparing food baits, it is necessary to know the rodents' food preferences. Contrary to popular belief, rats and mice prefer fresh, palatable food. Food dyes and other coloring materials that do not affect the flavor of the bait can be used as a warning to humans. Great care should be taken in mixing baits, especially those in which acute rodenticides are used. It is best to have a single individual responsible for mixing and/or packaging the bait.

Control operations should be based on the findings of the rodent surveys. Members of field teams need to be trained in placement of the bait and in public relations. Control personnel must be careful to develop positive working arrangements with the populace after a natural disaster. They should carry identification; and they should be trained well enough to understand what they are doing and why, and to communicate this information to the people.

Bait must not be haphazardly placed. Care must be taken to put the bait where the rodent will find it, but where children and other animals cannot When the supply of rodenticides is inadequate, only the more hazardous areas should be treated. These areas include rescue centers, refugee camps, food warehouses, markets, ports and hospitals.

In areas of potential outbreaks of rodent-borne diseases where rodent control is necessary, special consideration should be paid to controlling ectoparasites. Before a trapping program is underway, rodent runs must be dusted with DDT, carbaryl, diazinon, pirimiphos-methyl or some other approved insecticide powder. Special care should be taken in handling and disposing of rodents in these areas.

The use of rodenticides is only a small part of a well-organized rodent control program. During a natural disaster, however, it is of greater importance than during routine operations. Sanitation is another important aspect, and it must be remembered that by creating harborage, the accumulation of garbage and debris encourages the establishment of rodent populations. Refuse and debris should be thoroughly incinerated when sanitary landfills are unavailable, because on-site burning is of limited value.

No control program can be successful without the cooperation of the people it serves. Such programs should always incorporate sanitary education, and other campaigns to enlist the help of community groups and individuals.

Other Vector Problems

Lice, fleas, mites, ticks and other arthropods may produce serious problems following natural disasters, (see Annex III). The lice of medical importance belong to the order Anoplura, or sucking lice. The important species are the crab louse, *Pthirus pubis,* the head louse, *Pediculus capitis* and the body louse, *Pediculus humanus*. Of these, *Pediculus humanus* is the only species that is an important vector. It is the only proven vector of two diseases, louse-borne (epidemic) typhus and epidemic relapsing fever, a spirochete disease. *Pediculus humanus* and other lice can also cause a great deal of discomfort through their bites.

Surveys of human lice, with a reasonable population sample, should be conducted in order to determine the extent of the problem and the number of individuals who require treatment, and to determine the effectiveness of the control program. A louse survey involves searching for the insects and their eggs, or nits. Body lice are found on shirt collars, the waistband, pockets and seams of trousers, and the seams of underwear. Head lice are normally found in the hair of the head, particularly around the ears and nape of the neck. The nits of head lice found within 7 mm of the scalp may be considered viable. Crab lice are usually found in the pubic and perianal areas of the body.

There must be a quick reaction to a serious increase in body louse infestations, with the threat of an epidemic outbreak of disease. In an emergency, the method of choice is that of mass delousing of the population with insecticide dust delivered by a compressed air duster. Use of cans with holes punched in one end will also suffice. Since there is widespread resistance to DDT, the dusting powders of choice include temephos (Abate), malathion, or gamma HCH (lindane). If time permits, the effectiveness of various pesticides should be assessed with the World Health Organization's insecticide susceptibility test. In emergency camps, clothing fumigants such as HCN, methyl bromide or ethyl formate can be used if the fumigation is supervised by properly trained personnel. Mass laundering of clothing is effective *only* if a water temperature of 52°C or more can be maintained. It is necessary to alert the population through public education to the dangers of louse-borne diseases and the need for mass delousing.

Head lice are not important as disease vectors, so that mass treatment may only be necessary when the prevalence is extremely high. Lotions or shampoos of malathion, pyrethrins or gamma HCH provide effective treatment. When school children are infested, treating of all family members is recommended for successfully controlling infestation. Crab lice that are not disease vectors, may be treated on an individual basis using shampoo, lotion or creme formulations of malathion gamma HCH, or pyrethrins.

Fleas belong to the order Siphonaptera. In the adult stage, all known species are obligate parasites. A number of these feed on the blood of man and his domestic animals. The most important diseases transmitted by fleas are plague and murine (endemic) typhus. Both of these diseases have host reservoirs so that attempts to eliminate the vectors should be coordinated with rodent control programs. Fleas can be collected by hand from the bodies of infested persons or animals. They can also be removed by combing small wild animal hosts, or trapped alive and anesthetized or killed. If a plague outbreak is imminent, rodent runs and burrows should be dusted and bait boxes should be rinsed with carbaryl or diazinon dust. The mass rodent control should begin only after flea populations have been eliminated, so that newly emerged fleas, deprived of their normal hosts, will not seek humans.

Mites are small, sometimes microscopic organisms that belong to the class Arachnida Although they transmit diseases such as scrub typhus and Q fever, in times of natural disasters the disease is not an important factor. The annoyance created by itching and dermatitis can, however, be important. When people are crowded and mammals and birds share the same conditions with man, these animal ectoparasites may flow over to man. Sudden epidemics of the "itch" may thus occur in refugee or temporary camps. An attempt should be made to find the cause of the problem. Ointments exist which can be used to treat individual cases, but the best method of solving the problem is to improve sanitary habits and remove the animal source.

The mite, *Sarcoptes scabiei,* causes an infectious disease of the skin called scabies. In scabies, the penetration of the mite can be seen in visible papules or vesicles, or tiny linear burrows which contain the mites and their eggs. Scabies may be widespread during disasters. This is particularly true in developing countries. The disease is transmitted through prolonged intimate contact with scabietic skin, especially during sexual intercourse. Treatment on a coordinated mass basis involves the use of gamma HCH, crotamiton (Eurax), precipitated sulfur in petrolatum, or an emulsion of benzyl benzoate. A second course of treatment is necessary within seven to ten days. Case finding efforts should be extended to the screening of whole families, and soap and facilities for mass bathing and laundering should also be made available.

Ticks belong to the order Acarina. Ticks are vectors of Rocky Mountain Spotted Fever, Colorado Tick Fever, Q fever, tick-borne relapsing fever and several other diseases. Certain species also cause tick paralysis. Tick surveys involve either collecting specimens from wild animal hosts, or using a tick drag. A tick drag is a piece of white flannel which is slowly pulled over the vegetation along trails and road ways for a specific distance, and is then examined. A tick problem can be reduced by clearing the vegetation fifty to one hundred feet around a refugee camp. In chemical control, an area is treated with an insecticide such as chlorpyrifos or tetrachlorvinphos.

Ants, spiders and scorpions may cause problems, especially during flooding. Since these arthropods seek high ground, they often invade houses and other shelters. Their bites can be painful; some produce intense suffering for which therapy must be considered. Health education may help to alert people of this danger. Through such efforts people should be asked to shake out clothing, check shoes before dressing and turn back bedding before retiring. Removal of debris and improvement of all general sanitation can also be of help. Insecticides can be used, especially in temporary housing, to limit the problem. Severe infestations of bedbugs may also occur under crowded conditions. Bedbugs can be easily eliminated by spraying malathion in infested areas with a hand compressed air sprayer.

Poisonous snakes seek high ground during flooding and may enter houses. The chance that they will come into contact with man is therefore increased. Occupied areas should be cleaned of debris and grass should be kept as short as possible. Universal antivenin should be available for members of the staff who clear debris, for vector control field staff, and at temporary housing camps