reporting for informational and budgeting purposes. A schematic map is used for orientation and for locating and recording larval breeding places and adult sampling stations. A contour map should show streets, roads, railroads, as well as ponds, lakes, streams, and other water areas.

The schematic map (Fig. 31) illustrates the type of information needed for a small project. When larger areas are to be protected, it is best to have a master schematic map and large-scale area maps showing details for planning drainage and other control operations in the field. Urban mosquito control programs require detailed maps in which each block is numbered. The master schematic map will show the areas to be protected, the possible flight range of mosquitoes from different larval habitats, and the degree of penetration into areas to be protected. All larva and adult stations are shown by symbols and numbers. Counts made at these stations at regular intervals permit evaluation of the mosquito problem at any time by indicating the abundance of mosquitoes, the species involved, the flight range, and the areas requiring high priority for treatment.

ADULT MOSQUITO SURVEYS

Purpose

The number and relative abundance of the various mosquito species in a community can be estimated by surveys of the adults. By consulting references on the habits of the different species, the vector control specialist can determine where to look for the larval habitats and decide the need for a control program. Adult mosquito information indicates the best times and places to use space spray equipment. It is also a source of reports to supervisors and the public concerning the extent of the problem and results of control operations. Interpreting mosquito survey reports correctly results in the most efficient use of manpower, materials, and equipment.

Equipment

The equipment required for a survey consists of a collecting tube (also known as an aspirator), a killing tube, pill boxes, cases for live mosquitoes, field record forms or notebook, flashlight, and map (Fig. 32). Various kinds of traps and other collecting devices can also be used.

The killing tube can be made from a glass or plastic tube of any convenient size. Test tubes about 1-inch diameter by 7 inches long are preferred. Pour about an inch of plaster of paris mixed with water into the bottom of the tube and allow the plaster to dry. Add sufficient ethyl acetate to saturate the plaster of Paris. Then press two or three discs of blotting paper (cut slightly larger than the tube) down over the plaster. Close the tube with a cork or rubber stopper. The collecting tube will stay effective for several weeks and can be recharged when necessary by removing the discs and adding more ethyl acetate. Some workers wrap the base of the killing tube with adhesive tape to lessen the chance of breakage: some add a paper cone (base up) inside the mouth of the tube to trap specimens more easily. The addition of crinkled tissue paper to the tube helps keep specimens dry, and, by preventing their getting broken, makes identification easier.

A simple aspirator is prepared from a section of rigid plastic (or glass) tubing 12 inches long with an inside diameter of about 3/8 of an inch. One end of the tube is covered with fine cloth netting or metal gauze and then inserted into a piece of rubber tubing 2 to 3 feet long (Fig. 32). A flashlight-battery-operated aspirator is described by Sudia and Chamberlain (1967).

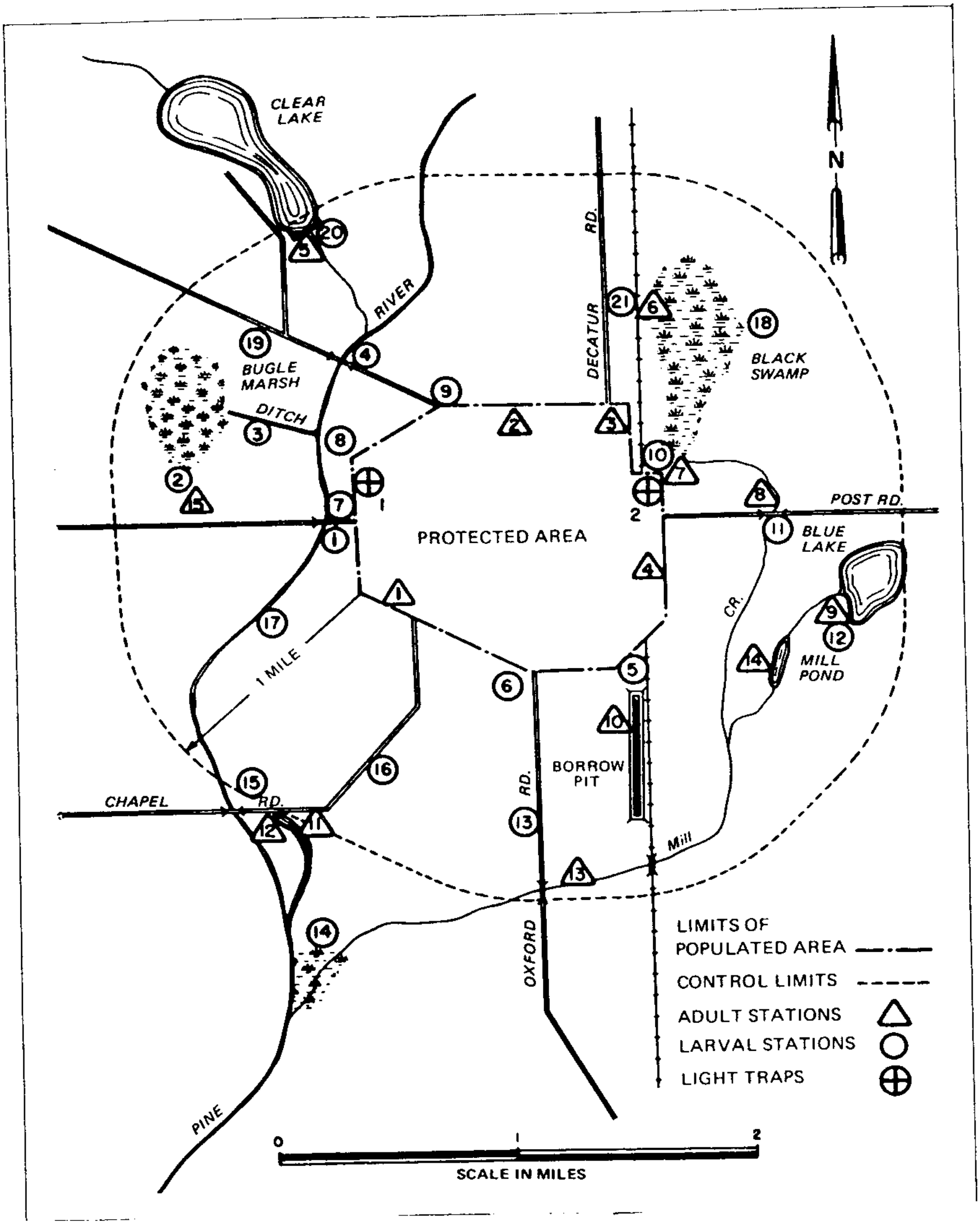


Figure 31. Schematic Map Showing Mosquito Sampling Stations

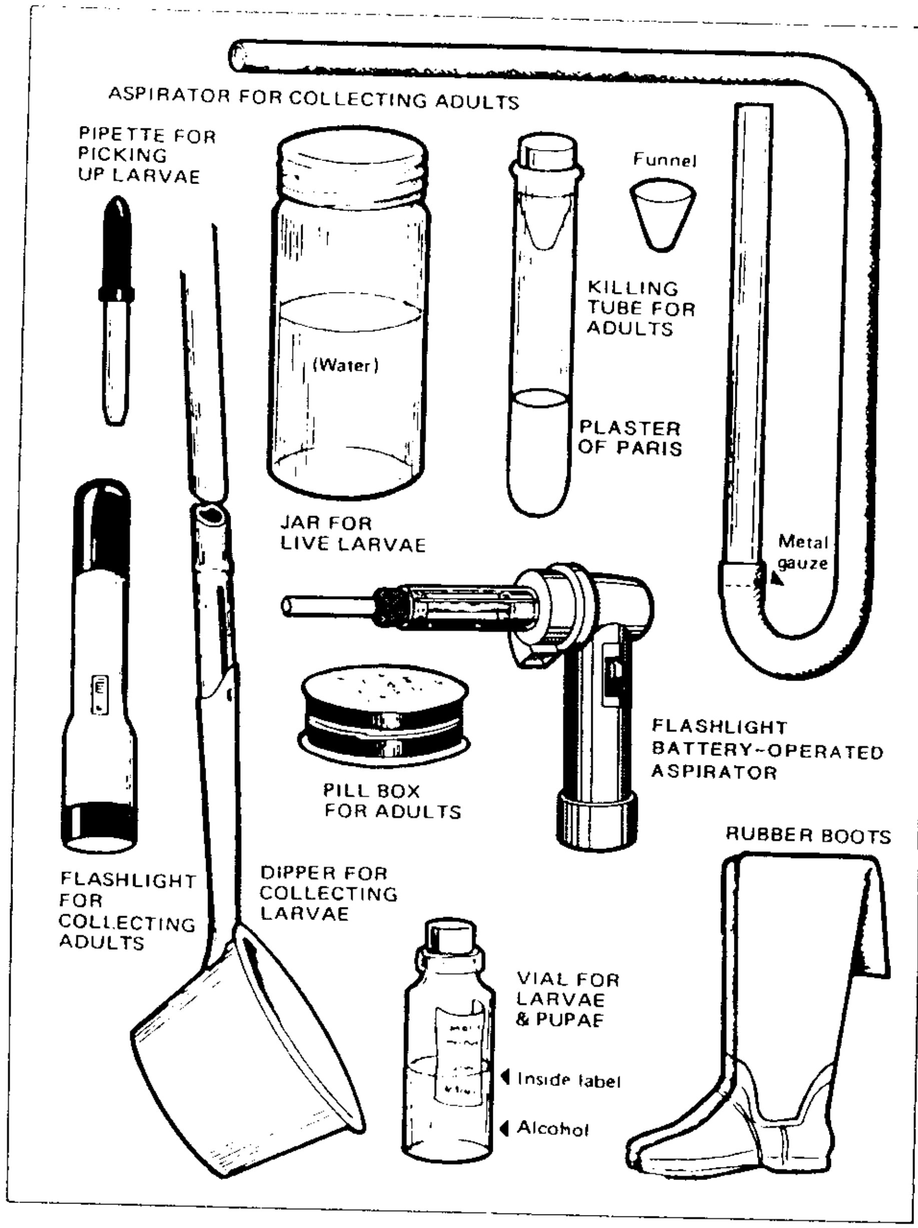


Figure 32. Equipment for Mosquito Surveys

Small pill boxes or salve boxes are convenient for holding dead mosquitoes until they can be identified. The mosquitoes should be placed between layers of facial tissue with enough additional tissue to prevent damage to the specimens as they are carried about or shipped to a laboratory for identification.

Excellent discussions and pictures of survey techniques and equipment are included in articles by Sudia and Chamberlain (1967); Bidlingmayer (1959); and Service (1976).

Biting Collections

Collecting mosquitoes as they bite or land to bite is a convenient method of sampling populations. In making biting collections or counts, part of a person's body is exposed by rolling up sleeves or trousers, or by removing the shirt. The person should sit quietly for a designated period of time, usually 10 or 15 minutes. Mosquitoes are collected with an aspirator either by the collector or a coworker. In many parts of the tropics it is customary to make biting collections about sundown from a domestic animal, such as a large cow or horse. If collections are made at night, a flashlight is required. Whether counts are made from human beings or animals, it should be recognized that certain individuals are more attractive to mosquitoes than others. It is therefore, desirable for the same person or animal to be used throughout a given survey. Collections must be made at regular intervals and at approximately the same time of day, so that biting rates at different stations may be compared to show trends in mosquito populations.

Biting collections should not be made from humans in areas where encephalitis activity is likely. With day-biting species, the index may be based upon the number of mosquitoes alighting upon one's clothing in a given time interval (the landing rate), rather than those actually in biting position. This is more practical when populations are very high, and is useful for a rapid check of mosquito abundance before and after control efforts. The landing-rate method has been used especially with certain species of *Aedes* or *Psorophora* found in salt marshes, rice fields, and the arctic and subarctic tundras.

Bait Traps

Animal bait traps, or stable traps (Fig. 33), have been used extensively in the West Indies, South America, and other parts of the world. Bait traps are somewhat expensive to build, transport and maintain, but a series of these traps will collect live mosquitoes over a wide area for a whole night, without large numbers of other insects, and in areas where electric power is not available. Animal bait traps must be of sufficient size and strength to hold the bait animal comfortably and permit its convenient entry and removal. A considerable portion of the sides of the trap is covered with screen wire in order that mosquitoes may be attracted to the bait animal. V-shaped entrance slots make it easy for mosquitoes to enter and bite but difficult for them to find their way out after feeding. Two types of openings, the Egyptian and Caribbean (Fig. 33), are widely used. The animal is generally placed in the trap in the evening and left overnight. The trap is inspected early in the morning and the mosquitoes counted and/or collected. Horses, mules, donkeys, calves, sheep, and hogs have been used as bait.

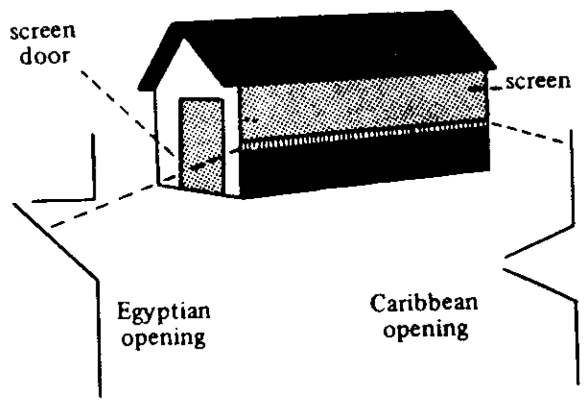


Figure 33. Animal Bait Trap

Window Traps

Window traps (Fig. 34) employing the same principle as the animal bait trap are sometimes used. The humans sleeping inside serve as bait. The entrance slots can be mounted in the windows of the buildings with the screen cages inside to catch mosquitoes as they enter. More frequently, in malaria control programs, the cages are placed outside, for mosquitoes which have rested on an insecticide-treated surface often have the urge to leave a treated house at daybreak.

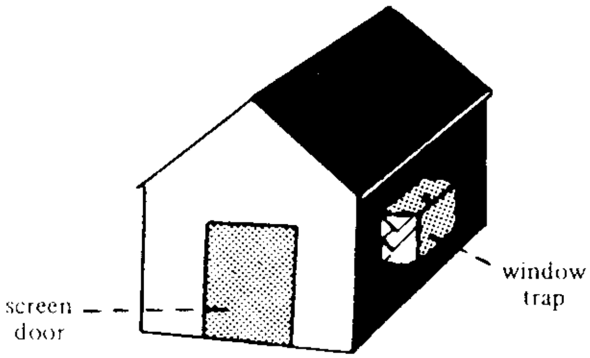


Figure 34. Window Trap

Carbon Dioxide Traps

Solidified carbon dioxide (dry ice) will attract large numbers of some mosquito species. An economical portable mosquito bait trap utilizing dry ice as an attractant has been developed in California. This trap (Fig 35), made from a 12-inch lard can with two inwardly directed screen tunnels, is baited with about 3 pounds of dry ice wrapped in newspaper. It is effective in capturing large numbers of *Culex tarsalis*.

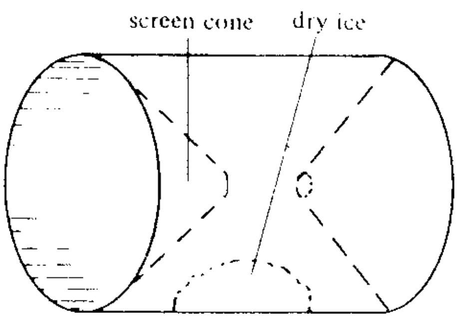


Figure 35. Carbon Dioxide Trap

Insect Nets

Insect nets are used to collect mosquitoes from grass and other vegetation. This type of collection is valuable in determining the abundance of those species, such as *Aedes vexans, Ae. sollicitans, Ae. taeniorhynchus, Ae. nigromaculi,* and *Ae. triseriatus,* which rest on vegetation.

Daytime Resting Places

Adults of many species are inactive during the day, resting quietly in dark, cool, humid places. Careful counts of mosquitoes in daytime shelters give an index to the population density of these mosquitoes. This method is especially useful for anopheline mosquitoes and is commonly used for *Anopheles quadrimaculatus* and *An. freeborni*. It is also of value in estimating populations of some culicines such as *Culex quinquefasciatus, C. tarsalis.* and *Culisela melanura.* The shelters are also a source of specimens for various tests. Mosquito resting stations are divided into two general types: natural and artificial.

Natural Resting Stations

These are the resting stations usually present in houses, barns, stables, chicken houses, privies, culverts, bridges, caves, hollow trees, and overhanging banks along streams. With experience one becomes capable of evaluating the suitability of shelters as adult mosquito resting stations. Dwellings, especially when unscreened, often prove to be satisfactory resting stations. They are especially important when mosquito-borne diseases are being investigated. Under such conditions they furnish an index to the number of mosquitoes which could bite man and transmit encephalitis, malaria, or other disease.

Artificial Resting Stations

Suitable resting stations may not be

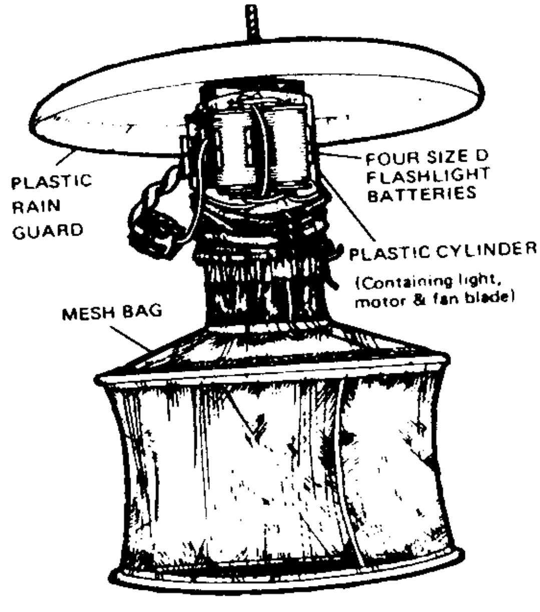
available in sufficient numbers to give a satisfactory evaluation of the mosquito population. It may be necessary to construct special shelters or to use boxes, barrels, kegs, etc., as artificial resting stations. Many different types of artificial shelters have been used. They should always be placed near the suspected breeding places in shaded, humid locations. Mosquitoes enter such shelters at dawn, probably in response to changes in light intensity and humidity and ordinarily do not leave until dusk. Artificial shelters built as boxes, each side one foot long and painted red on the inside, or as artificial privies 4 feet square and 6 to 7 feet high, have been used successfully in the United States.

Light Traps

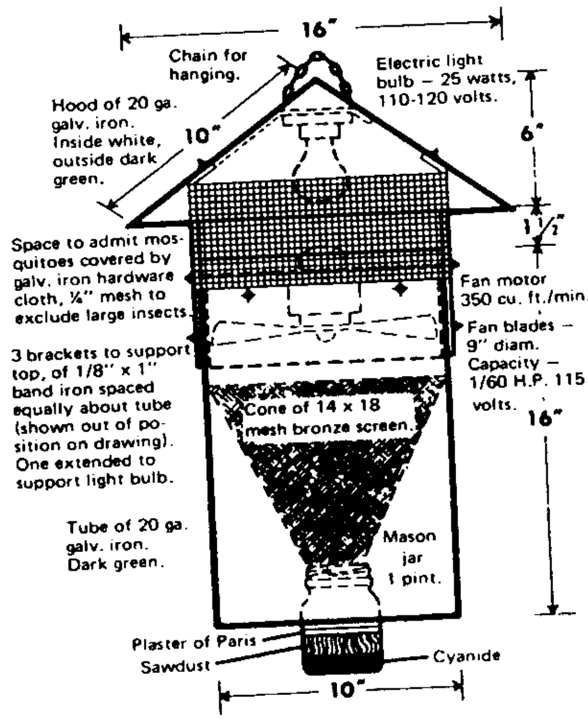
Many mosquito species are attracted to light. This reaction makes it possible to sample adult populations between dusk and dawn. The New Jersey mosquito light trap, developed in the 1930's, has been widely used in obtaining data on the density and species composition of mosquito populations.

The American mosquito light trap (Fig. 36) has been developed by the Bureau of Vector Control, California Department of Public Health, as a modification of the New Jersey light trap. It was redesigned to reduce capture of moths and other "trash insects" and to permit construction from easily available parts (Mulhern 1974).

Mosquito light traps attract adults from a considerable area when the traps are placed away from competing light sources. As the mosquitoes reach the light, they are blown downward through the screen funnel into a killing jar or mesh bag suspended below the trap. The light and fan are usually powered by alternating current, but batteries are used for remote locations. The killing jar is made from a pint or quart fruit jar or plastic container. A layer of sodium or potassium cyanide is placed in the bottom, covered with a layer of sawdust



A. CDC MINIATURE LIGHT TRAP



B. AMERICAN LIGHT TRAP

Figure 36. Mosquito Light Traps

or cotton and a layer of plaster of Paris or cardboard. For safety reasons, instead of cyanide, a layer of plaster of paris saturated with ethyl acetate can be used. Some workers use paradichlorobenzene or dichlorvos plastic strips in the killing jar. Frequently a perforated paper cup is placed in the mouth of the killing jar to hold the specimens, keep them dry, and make removal easier.

The mosquito light trap is mounted on a post, or hung from a tree, so that the light is about 6 feet above the ground. It should be located 30 or more feet from buildings in open areas near trees and shrubs. It should not be placed near other lights, in areas open to strong winds, or near industrial plants that give off smoke or other fumes. The traps are operated on a regular schedule from 1 to 7 nights per week. They are turned on just before dark and turned off after daylight. An automatic time clock or photoelectric cell can start and stop the trap, or it can be turned on and off by hand. The collection should be removed each morning and placed in a properly labeled box, sorted and identified.

The CDC miniature light trap (Fig. 36) was developed for greater portability in making live mosquito catches in remote areas which could not otherwise be sampled (Johnston *et al.* 1973). This small plastic trap was field tested, resulting in catches of about one half as many mosquitoes as the New Jersey trap, or its modification, the American light trap used in California. It has been used with success in collecting *Culicoides* and *Phlebotomus*. It collects a high percentage of mosquitoes in proportion to "trash insects" and many more females than male specimens, a desirable feature in collecting mosquitoes for virus studies. Both the American and CDC miniature light traps exclude many large insects.

The CDC miniature light trap weighs only 1 3/4 pounds. It can be disassembled readily for easy transport and has a collapsible catching bag. The large plastic aluminum canopy protects the operating mechanism, even in the heaviest rainstorms. It can be operated with one 6-volt battery or four 1 1/2-volt flashlight "D" cells, which provide sufficient power for one night. The Aristo-Rev No. I motor, which is available from hobby shops, has given between 15 and 25 nights of service before wearing out.

Wide differences have been noted in the reactions of different species of mosquitoes to light. Light trap collections must therefore be used in conjunction with other methods of sampling mosquito populations. They have proven very useful in measuring densities of some of the culicine mosquitoes, such as *Aedes sollicitans*, *Ae. vexans*, *Ae. nigromaculis*, *Culex tarsalis*, and *Coquillettidia perturbans*. Some anophelines, especially *Anopheles albimanus*, *An. crucians*, *An. atropos*, and *An. walkeri*, are also readily taken in light traps. *Anopheles quadrimaculatus*, however, is seldom taken in significant numbers. *Aedes aegypti* is rarely collected in light traps. Pratt (1948) and Provost (1959) have reported that light trap collections of many species of mosquitoes show fluctuations on a 4-week cycle correlated with the dark and bright phases of the moon. The largest collections are made during the dark phase.

LARVAL MOSQUITO SURVEYS

Mosquito larvae are found in all types of aquatic habitats from warm, brackish, seaside marshes to the pure, cold, melted snow water. They are found in such diverse locations as rivers, lakes, ponds, crab holes, pitcher plants, eave troughs, funeral urns, bottles, cans, reservoirs, tree holes, old tires, and junk automobiles.

The inspector must assume that mosquitoes have adapted themselves to a wide variety of aquatic situations. It is necessary to obtain information regarding the general breeding habits of the species known or suspected to be present in the area prior to initiation of larval surveys. An experienced person may be able to spot the probable mosquito-breeding places in a specific area by means of a rapid reconnaissance survey. These places should be carefully numbered and marked on the map. More detailed inspection is then required to determine the specific breeding sites and establish permanent larval sampling stations. Larval surveys show the exact areas in which mosquito larvae occur and their relative abundance. For this reason they are of special value in control operations.

Equipment for Larval Mosquito Surveys

A white enamel dipper about 4 inches in diameter is most often used for collecting mosquito larvae (Fig. 32). The handle of such a dipper may be extended to a convenient length by inserting a suitable piece of cane or wood. Many special dippers are used for specific purposes, being designed so that their capacity can be directly related to the water surface area examined. Thus, the number of larvae per square foot or square meter may be computed with reasonable accuracy.

Some inspectors prefer white enamel pans to dippers. A convenient size for a pan is about 14 inches by 9 inches by 2 inches deep. Such a pan is used to sweep an area of water until half full. It will then float in the water while the larvae are removed.

Inspection of small artificial containers or cisterns can call for a flashlight or mirror with which to reflect light into the shadowed area. Largebulb pipettes, siphons made of rubber tubing,' or suction bottles (Fig. 37) are sometimes used to remove water from small, inaccessible locations such as tree holes. The water can be put in a dipper or pan and the larvae counted and collected. Wide-mouth pipettes (eye droppers) are used for removing larvae from a dipper or pan. Small vials, preferably with screw caps, will hold the larvae until they can be identified or mounted on slides. Screenbottom spoons or tea strainers can be substituted for pipettes if the larvae are to be transferred to widemouth bottles or disposable polystyrene (e.g., Styrofoam (R) cups. Either 95% alcohol, or 100% cellosolve, is a satisfactory preservative, but 70% alcohol is in common use. An extensive account of equipment for collection of mosquito larvae is given by the World Health Organization (1975).

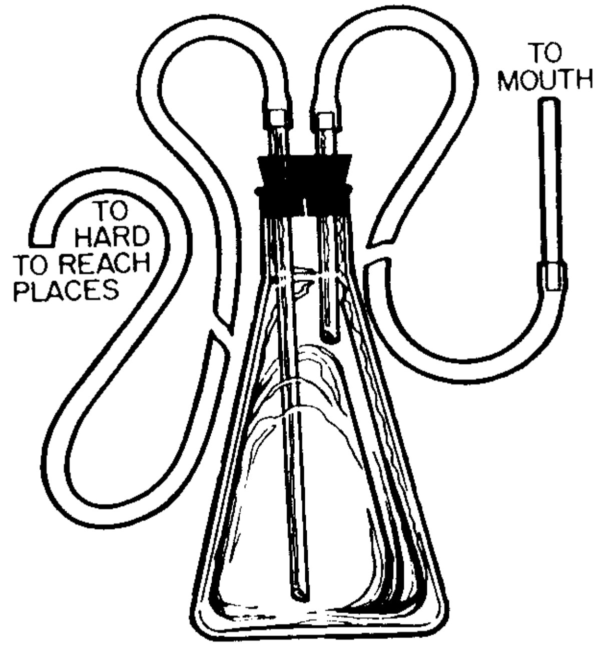


Figure 37. Suction Bottle

Inspection Procedures

In the larger ponds and lakes, mosquito larvae are usually found where surface vegetation or debris are present--ordinarily only in the marginal areas. It is necessary to proceed slowly and carefully in searching for mosquito larvae. If the water is disturbed, or a shadow is cast on them, the larvae often dive to the bottom. Anopheline larvae are collected by a skimming movement of a dipper with one edge pressed just below the water surface. The stroke is ended just before the dipper is full, because larvae will be lost if the dipper runs over. Where clumps of erect vegetation are present, it is best to press the dipper into such clumps with one edge depressed so that the water with the surface-floating *Anopheles* larvae flows gently into the dipper. Culicine larvae such as *Aedes vexans, Ae. stimulans, Ae. sollicitans, Ae. taeniorhynchus,* or the species of *Psorophora,* require a quicker and deeper motion of the dipper, since these larvae hang down from the water surface and are more agile. Some species, e.g., *Ae. aegypti,* are more likely to dive below the water surface when disturbed.

Inspection for *Ae. aegypti* requires a careful search for, and examination of artificial containers in which these domestic mosquitoes breed. Such inspections are usually made premises-by-premises, checking bottles, tin cans, automobile tires, and all other water containers. The *Ae. aegypti* index is obtained by dividing the total number of premises inspected into those in which larvae are found. Collection of the *Ae. aegypti* larvae can be made with a dipper, but it is more frequently accomplished by means of a wide-mouth pipette.

Inspection for *Ae. triseriatus* and *Ae. sierrensis* involves searching for tree holes and artificial containers in which these larvae occur. Such breeding places are often too small to admit an ordinary dipper, but water can be removed by means of a suction bottle

An inspector should always record the number of dips and the number of larvae found, as in the record form on Figure 38. The larvae are transferred to small vials by a wide-mouth pipette and preserved for later identification. It is possible to get an approximate idea of the larval density by computing the number of larvae of each species per dip. The number of dips required will depend on the size of the area, but for convenience they should be made in multiples of 10. Inspections should be made at intervals of one to two weeks during the breeding season because areas which are entirely free of larvae at one time can have many larvae at other times. Laboratory identifications of specimens are tabulated on the record form as shown in Fig. 39.

Variations in the procedure described above are required when inspecting for certain species. For example, *Mansonia* and *Coquillettidia* larvae remain below the water surface throughout their development. These larvae are found by pulling up aquatic plants (cattail, sedges, pickerelweed, etc.) and washing them in a pan of water. A search of the bottom muck and trash from the area where the host plants have been uprooted can be productive. This material should be scooped up and examined in pans of clear water. Other methods for collecting *Mansonia* larvae are described by Bidlingmayer (1959).

MOSQUITO COLLECTION RECORD

Locality Smithville Date July 20

Collector John Doe Supervisor J.B. Jones

LARVAL COLLECTIONS

Station Number	Date of Collection	No. of Dips	No. of Larvae Collected	Larvae per Dip	Larval Collections	Description Collection Site
1	July 19	10	15	1.5	Rain Barrel	Backyard 101 Main Street
2	July 19	30	75	2.5	Temporary Rain Puddles	South end of Bugle Marsh
12	July 19	60	30	0.5	Grassy Margin	South end of Blue Lake

(Front side)

ADULT COLLECTIONS

Station Number	Date of Collection	Type of Collection	Females per Trap Night	Landings per Minute	No. of Females (Resting Station)
1	July 20	Light Trap	6		
15	July 19	Biting Collection		45	
9	July 19	Daytime Resting Station			20

(Reverse side)

Figure 38. Mosquito Collection Record

MOSQUITO IDENTIFICATION RECORD

Locality ___Smithville___ Date Received ___July 20___

Determined by ___George Abbot___ Date ___July 24___

Station Number	Date of Collection	Type of Collection	Mosquito Species	No. of Larvae	No. of Males	No. of Females
1	July 19	Larval	*10 Aedes aegypti* *5 Ae. triseriatus*	15		
2	July 19	Larval	*50 Ae. vexans* *25 P. ferox*	75		
12	July 19	Larval	*12 A. quad.* *18 A. punct.*	30		
1	July 20	Light Trap	*5 Culex pipiens* *1 A. quad.*		*1 Culex pipiens*	*5 C. pipiens* *1 A. quad.*
15	July 19	Biting Collection	*40 Aedes vexans* *5 P. ferox*			*40 Ae. vexans* *5 P. ferox*
9	July 19	Daytime Resting Station	*20 A. quad.*			*20 A. quad*

Figure 39. Mosquito Identification Record

MOSQUITO EGG SURVEYS

Egg surveys are undertaken primarily to locate the larval habitats of salt-marsh, floodwater, and irrigated field mosquitoes in the genera *Aedes* and *Psorophora*. These mosquitoes lay their eggs on damp soil in places subject to intermittent flooding, not on the surface of standing water, as do *Anopheles* and *Culex*. Therefore, two entirely different types of egg surveys have been carried out with these temporary pool mosquitoes: sod sampling and egg separation.

Sod Sampling

Sod sampling was carefully studied and reported by Bradley and Travis (1942). They cut samples containing 8 square inches of soil and vegetation, trimmed to a thickness of about an inch, and stored them for a week or more to allow the embryos time to develop within the eggs. The sod samples were then placed in glass jars and flooded with water and the larvae were identified as they hatched. The use of sod sampling as an adjunct to larval surveys in delimiting breeding areas has led to important economies in larvicidal and ditching operations. Frequently sod sampling has revealed much heavier concentrations of salt-marsh mosquito eggs in higher areas of the marshes subject to intermittent flooding, overgrown with salt-marsh bermuda *(Distichlis* *spicata)* and salt-meadow cord grass *(Spartina patens)*, than in the lower areas where water stands for longer periods of time characterized by growths of rushes *(Juncus spp.)* and marsh grass *(Spartina alterniflora)*. These results have been confirmed by later research of many workers including Elmore and Fay (1958) who have worked out characters for identifying first stage larvae of the salt-marsh mosquitoes (*Aedes solicitans* and *Ae. taeniorhynchus)*.

Egg Separation Machines

Egg separation machines were developed as early as 1938 by C.M. Gjullin for separating eggs of *Aedes vexans, Ae. sticticus,* and *Ae. dorsalis* from soil and debris. Horsfall (1956) developed an entirely different technique which involves mechanical agitation, washing, screening out, or sedimentation of debris and flotation of the eggs in saturated salt solution. The samples of sod, leaves, and other ground material are taken by cutting around a board 6 inches square with a sharp trowel. They are then put into plastic bags and stored, sometimes for months, in a cool room. The various species of *Aedes* and *Psorophora* can be identified by microscopic examination of live or preserved eggs (Ross and Horsfall 1965). This egg-separating technique has been used by many mosquito control districts to locate prolific breeding places of *Aedes* and *Psorophora* mosquitoes. These areas are then treated with insecticides, often by prehatch treatment.

Oviposition Traps

In a study of container-breeding mosquitoes, Fay and Perry (1965) showed that several species of mosquitoes were attracted to black jars containing water and would lay eggs on a hardboard paddle placed in these oviposition traps or "ovitraps" (Fig. 40). Technicians were trained to identify the eggs of *Ae. aegypti* from those of *Ae. triseriatus* and other container--bleeding mosquitoes. The eggs of *Aedes (Stegomyia) aegypti* and *Aedes (Stegomyia) albopictus* are very similar. In surveys they are listed as *Aedes (Stegomyia)*. The only way to separate them is to hatch the eggs and identify the larvae or reared adults. The ovitrap method of surveying or surveillance appears to be more sensitive and economical than larval or adult surveys of *Aedes aegypti*. It was used extensively in the United States, Puerto Rico, and the Virgin Islands in 1967 and 1968 during the *Aedes aegypti* Eradication Campaign, in Thailand in 1968 and 1969, and in dengue control on Guam in 1975.

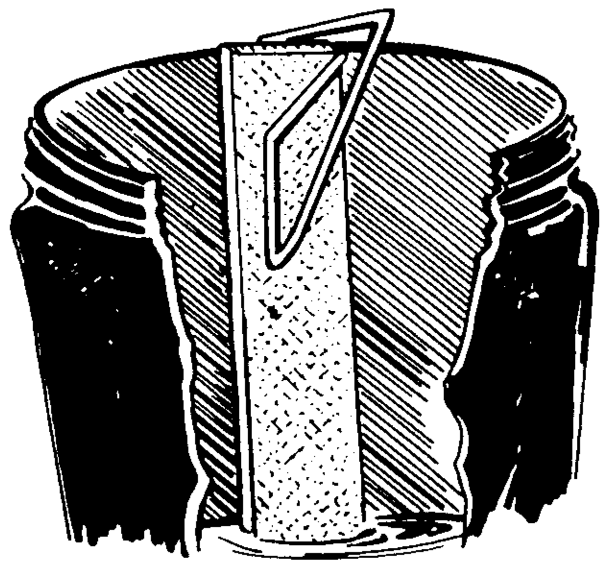


Figure 40. Oviposition Trap with Paddle

Reiter Gravid Trap

The Reiter gravid trap samples female *Culex* mosquitoes as they come to ovipost (Reiter, et al., 1986). It therefore is selective for females which have already taken at least one blood meal. If mosquitoes are being collected for virus isolation, there is a higher probability of collecting infected mosquitoes. Gravid trap counts might also have a higher correlation with disease transmission. The

Harris County Mosquito Control District in Houston, Texas has used these traps successfully in their SLE surveillance program.

UTILIZATION OF SURVEY DATA

Data from surveys are correlated with reported disease prevalence or complaints of pest mosquitoes. It is only after reviewing all of this information that the health officer or vector control specialist can make an intelligent decision as to the need for a control program and the type of control operations that will be most effective and economical. The conclusions, together with a request for funds, can then be presented to the appropriate local officials.

Inspections must be continued routinely once a mosquito-control project is under way. Information from such inspections serves to show the progress of the control operations. The effectiveness of a mosquito-control project cannot be measured in terms of the number of feet of ditches constructed or the number of gallons of insecticides used. While these are useful statistics, it is the actual population of mosquitoes that is significant. If the mosquito population is reduced to a satisfactory level, there should be accurate data showing this reduction. On the other hand, if mosquito populations remain high, these facts should be known so that control work can be intensified. It is always advisable to inspect some comparable breeding areas beyond the control zone at regular intervals in order to learn the normal fluctuation of various species throughout the season.

During World War II, malaria control officials felt that "satisfactory control"--i.e., the mosquito population level at which malaria would not be transmitted--would be reached when resting station collections of *A. quadrimaculatus* contained no more than 10 females per station in the control zone. Similarly, Reeves (1965) has indicated that little or no transmission of Western equine or St. Louis encephalitis occurred in California when light trap collections of *Culex tarsalis* contained no more than 10 females per trap per night.

Some authorities have worked out a correlation between mosquito annoyance and the numbers captured in light traps. In New Jersey, for example, it was determined that general annoyance did not ordinarily occur until the number of female mosquitoes of all species exceeded 24 per trap per night. Standards for biting-or landing-rate collections, as well as for other sampling methods for adult mosquitoes, can also be established. It must be cautioned, however, that survey data are seldom absolute and interpretations must be made for each specific situation. Numbers of mosquito larvae found in surveys are more difficult to correlate with pest problems or disease hazards. However, larval surveys reveal the specific sources of mosquito production. This information is helpful to the control supervisor as it enables him to apply effective larvicides to the right places at the right times. Data over a period of time may also serve to justify the use of permanent control measures. The more expensive operations, such as filling and draining, should be undertaken only after due consideration has been given to the effect on the local environment in relation to the benefits realized from the mosquito control.