Aedes aegypti Handbook Series No. 1

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HANDBOOK OF GENERAL INFORMATION ON AEDES AEGYPTI ERADICATION

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HANDBOOK OF GENERAL INFORMATION

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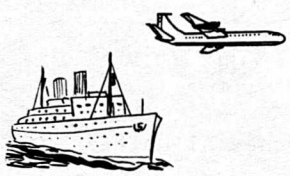
PURPOSE

Eradication of the yellow fever mosquito *Aedes aegypti* from the United States, Puerto Rico, and the Virgin Islands was begun in 1964 as a cooperative program of the state and local health departments and the Communicable Disease Center of the U. S. Public Health Service. The *Aedes aegypti* eradication program will:

1. Eliminate the hazards of epidemics of yellow fever and dengue.



2. Increase the effectiveness of the continuing foreign quarantine measures.

3. Assure that *Aedes aegypti* will not be exported from the United States to other countries from which it has been eradicated (and where it constitutes a greater hazard because of the proximity of jungle yellow fever).

4. Fulfill international commitments of the United States.

This handbook describes the objectives of the yellow fever mosquito eradication program, the present problem, and the organization of effort to meet these objectives.

SCOPE OF PROGRAM

The yellow fever mosquito, *Aedes aegypti*, occurs in parts of 10 southern states--Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, South Carolina, Tennessee, Texas, and North Carolina (Figure 1). These states have been designated as the yellow fever receptive area--that is, the part of the United States where,

because of the continuing presence of *Aedes aegypti*, epidemics of yellow fever or dengue could occur if their viruses were introduced in infected people or mosquitoes. The Aedes aegypti Eradication Program is being conducted in all of these states (except Arkansas, Mississippi, Tennessee, and North Carolina) and in Hawaii, Puerto Rico, and the Virgin Islands. Operations will be extended to the remaining states later in the program.

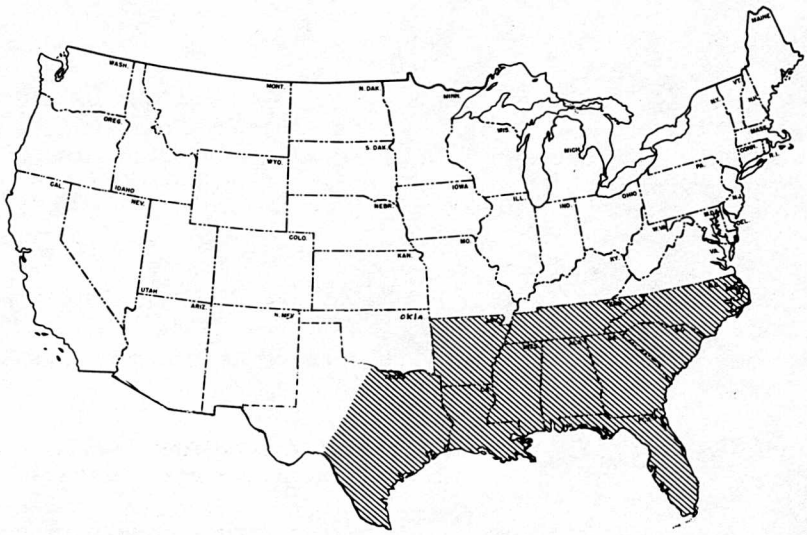


Figure 1. Yellow Fever Receptive Area in the Continental United State

Yellow fever was a devastating disease during the development of this country, and it remains a threat until the mosquito vector is eradicated. This mosquito, in common with the house fly and the Norway rat, depends upon man for its food and preferred breeding places. Therefore the *Aedes aegypti* Eradication Program must deal with the human environment, as well as the inspection activities to discover its breeding sites and the insecticidal program to kill the mosquito.

The mosquito is known to overwinter in the southernmost areas of the United States, and from here it may be carried outward to other areas and states during the summer months. Tires, junk automobiles and other scrap metal, containers of plants, and other water-holding receptacles are shipped to distant points with unhatched *Aedes aegypti* eggs securely attached to their inner surfaces. *Aedes aegypti* eggs can remain alive for many months without water. When water accumulates in these tires or other containers that have been shipped, *Aedes aegypti* hatch in a few minutes and a new infestation has been introduced. Therefore, the eradication of *Aedes aegypti* in its overwintering areas is an important factor in preventing annual infestation in more northern areas.

AEDES AEGYPTI AND DISEASE TRANSMISSION

Yellow fever is a highly fatal virus disease transmitted to man by the bite of the mosquito *Aedes aegypti*. For centuries, it was a serious scourge in the tropical Americas and Africa, extending to temperate areas in violent epidemics during the summers and chiefly in seaport and river cities. Dengue is a virus disease of both the Old and New Worlds that resembles yellow fever in many respects, but, although highly debilitating, causes almost no mortality. Both diseases are transmitted by *Aedes aegypti* and can be eliminated from urban areas by the eradication of this mosquito vector.

In recent years, epidemics of a very severe, dengue-like disease identified as a haemorrhagic fever, have occurred first in the Philippines and Thailand, and later in Vietnam and India. *Aedes aegypti* is believed to be the principal vector involved in these outbreaks. A number of United States and international health agencies have studied these epidemics intensively in an effort to prevent the spread of the virus, particularly in infected mosquitoes or people traveling in jet airplanes to uninfested areas where *Aedes aegypti* occurs.

DISCOVERY OF THE VECTOR

Because of the sporadic occurrence of yellow fever in vast epidemics, the high morbidity and mortality rates it produced, and the mystery concerning its epidemiology, many speculations were made as to its mode of transmission. Among significant workers were Josiah Clark Nott (1804-1873) of Mobile, Alabama, and Carlos J. Finlay (1833-1915) of Havana, Cuba. In 1848 Nott wrote that the cause of yellow fever must "exist in some form of insect life." Dr. Finlay proposed the theory of propagation of yellow fever by mosquitoes in a paper read before the Royal Academy in 1881. In 1900, Dr. Henry Rose Carter of the Public Health Service wrote of the relationship between imported and secondary cases. Working in Mississippi, he showed that "the period from the first (infecting) case to the first group of cases infected at their homes is generally from 2 to 3 weeks."

It was not until scientific investigations, based upon Finlay's studies, were made by Walter Reed, Jesse W. Lazear, James Carrol, and Aristides Agramonte, fellow members of the U. S. Army Yellow Fever Commission in Cuba in 1900-1901, that *Aedes aegypti* was definitely incriminated as the vector of yellow fever. In February 1901 William C. Gorgas, chief sanitary officer in Havana, Cuba, instituted measures to wipe out yellow fever that were based entirely on findings of the Commission. By September of that year the disease had been completely eradicated.

Prior to Reed's experiments it was widely believed that yellow fever was spread by contact with bedding, clothes, and other materials (fomites) that had been contaminated by victims of the disease. The Reed Commission established the following facts from experimental evidence:

1. The *Aedes aegypti* mosquito is the urban disease vector.

2. There is an interval of about 12 days between the time the mosquito takes a blood meal and the time it can convey the infection to another human being.

3. Yellow fever can be produced experimentally by the subcutaneous injection of blood taken from the general circulation of a yellow fever patient during the first and second days of his illness.

4. Yellow fever is not conveyed by fomites (e.g. clothing, sheets, and tableware).

EARLY HISTORY OF YELLOW FEVER

Although many early writers referred to the presence of jaundice in tropical America, the first clear eyewitness account of yellow fever was given by Fray Diego Lopez de Cogolludo in describing the Yucatan epidemic in 1648. An epidemic began in Havana in 1649 and the disease died out in 1655 probably due to the lack of susceptible persons. A ravishing epidemic occurred in Cuba in 1761 when it was reintroduced by prisoners sent from Vera Cruz as workmen, the disease becoming thoroughly established in Cuba at that time.

In view of the slave trade in tropical American areas from almost the earliest days of Spanish settlement it is likely that yellow fever was brought in by African slaves to many places at many times. The fact that it did not spread widely in such a favorable climate, with many susceptible Indians and Spaniards, is a strong indication that the disease could persist only in areas where *Aedes aegypti* had been previously introduced and established. This fact and the discovery that there are many related species of *Aedes* in West Africa are strong evidence that both the disease and its urban vector were introduced from the African Continent. In the late 1920's the West Africa Yellow Fever Commission proved conclusively that yellow fever in that area was caused by a filtrable virus and that yellow fever in Africa and the Western Hemisphere were the same disease.

During the Sir Francis Drake - Carleill expedition to St. Thiago, West Africa in 1585, a thousand men were landed and stayed ten days. The men sickened soon after setting sail again and 200 or more died. That the infection was probably yellow fever is indicated in the high fatality rate, the prevalence on ships anchored near the shore, and the practical certainty that the infection had been acquired at the port.

Dengue, a disease of both the Old and New Worlds, resembles yellow fever so closely in its clinical manifestations that it was not recognized as a separate entity until the late 18th century.

YELLOW FEVER IN THE UNITED STATES

In the United States, devastating epidemics of yellow fever occurred during the period from 1668 (New York) to 1905 (New Orleans), striking seaports and some inland cities from Texas to New England (Figure 2).

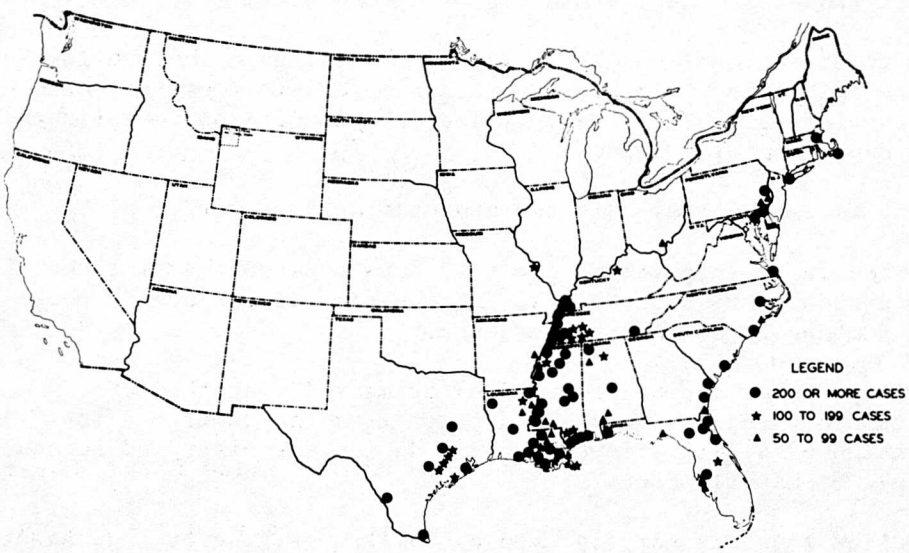


Figure 2. Yellow Fever Epidemics in the United States 1668-1905

Philadelphia suffered 20 epidemics, New York 15, Boston 8, and Baltimore 7. The 1793 Philadelphia epidemic was most severe with 4,041 deaths from August to November in a city of only 40,000. The explosive nature of the outbreaks is illustrated by the 1878 epidemic in Memphis, Tennessee, where approximately 4,000 people died, and by the 1898 epidemic in New Orleans, Louisiana, which produced 13,817 cases and 3,894 deaths. The last epidemic in this country (1905), with 8,399 cases and 908 deaths, struck most heavily in New Orleans, which reported 3,384 cases and 443 deaths. The fact that the 1905 epidemic was much less extensive in New Orleans than that of 1898 was attributed largely to a concerted drive against *Aedes aegypti*, the sole urban vector of yellow fever.

YELLOW FEVER IN CENTRAL AND SOUTH AMERICA

Unlike the United States, the countries of South and Central America continued to experience urban epidemics of yellow fever. In 1928 and 1929 the disease reappeared in Rio de Janeiro, Brazil, after an absence of 20 years, with 435 recorded deaths. During the years 1932 to 1954, urban yellow fever occurred in one or more municipalities in Bolivia, Brazil, Colombia, Paraguay and Trinidad. In addition, epidemics of jungle yellow fever occurred in all of the Central and South American Countries with the exception of El Salvador, Uruguay, and Chile.

In 1907 an epidemic in Muzo, Colombia was investigated by Dr. Robert Franco and his associates. Their observations were: (1) jungle yellow fever is contracted in the forest and not in the neighborhood of houses; (2) it is transmitted by Stegomyia calopus (now *Aedes aegypti*) and probably by other related mosquitoes; and (3) infection takes place during the daylight hours, when workers are in these jungle areas.

In 1932 there was a wholly rural epidemic of yellow fever in Valle do Chanaan, Esperito Santo, Brazil, in which *Aedes aegypti* could definitely be ruled out as the vector. Jungle yellow fever was detected repeatedly by Dr. Fred Soper who defined it as "yellow fever occurring in rural, jungle, and fluvial (river area) zones in the absence of *Aedes aegypti*."

TYPES OF YELLOW FEVER

Two forms of yellow fever caused by the same virus are known:

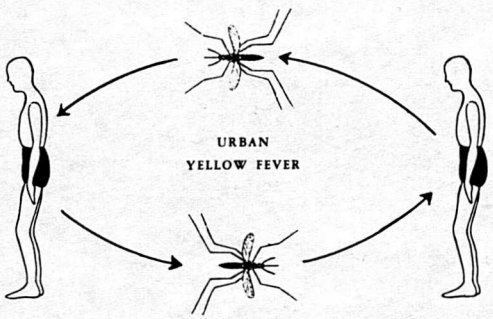


Figure 3. Transmission of Urban Yellow Fever

(1) urban yellow fever (Figure 3), in which the virus is transmitted from person to person by *Aedes aegypti*, and

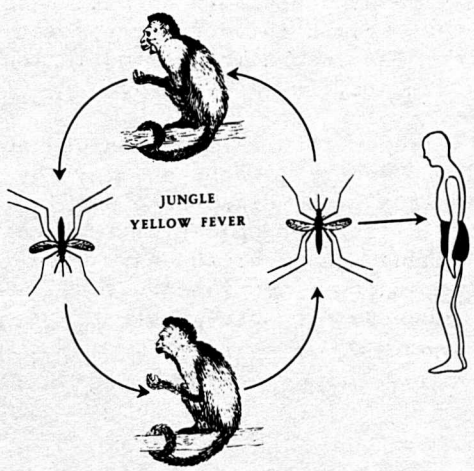


Figure 4. Transmission of Jungle Yellow Fever

(2) jungle yellow fever (Figure 4), in which the virus is transmitted from monkey to monkey and occasionally from monkey to man by Haemagogus and certain other jungle mosquitoes.

The jungle reservoir of yellow fever can be the source of urban outbreaks (Figure 5). When a person becomes infected in the jungle and returns to a settlement where *Aedes aegypti* is present, these mosquitoes may feed on his blood, become infected, and transmit the virus to other persons. Thus, a single case of jungle yellow fever could be the source of an epidemic of urban yellow fever.

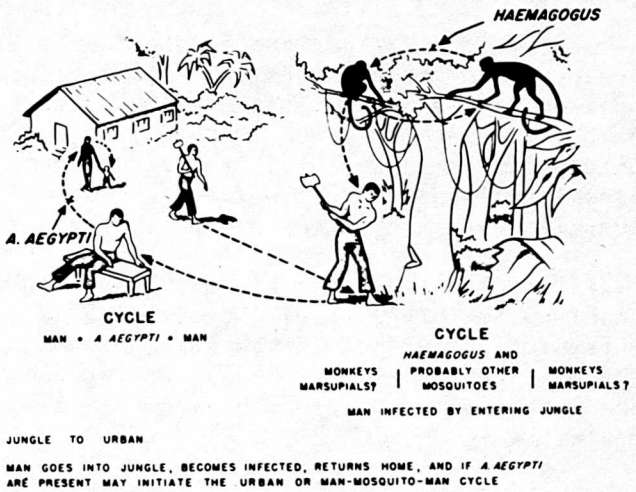


Figure 5. Relationship Between Jungle Yellow Fever and Urban Yellow Fever

An episode of jungle yellow fever in Central America, which began in the late 40's and lasted more than a decade, made the United States increasingly aware that so long as *Aedes aegypti* remains in this hemisphere the threat of yellow fever also remains. Beginning in Panama in 1948, a wave of jungle yellow fever started spreading northward (Figure 6). It swept across Panama that year, reached Costa Rica in 1951, Nicaragua in 1952, Honduras in 1953, Guatemala in 1955, and the Guatemala-Mexico border in 1957. About this time, also, two outbreaks of yellow fever occurred on the island of Trinidad, British West Indies — in 1954 and in 1959.

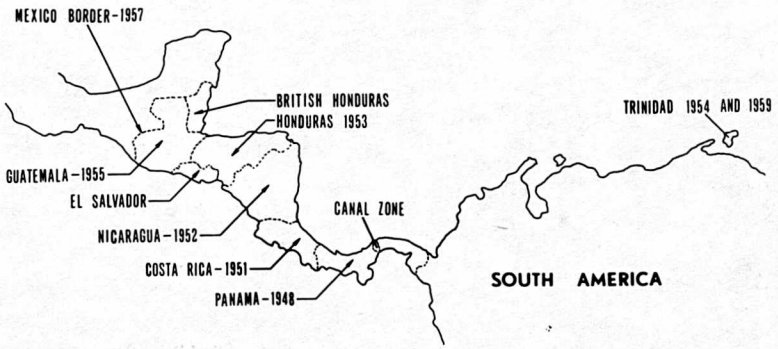


Figure 6. Outbreaks of Jungle Yellow Fever 1948-1959

Yellow fever virus can be carried great distances in man, in monkeys, or in *Aedes aegypti* mosquitoes. Once *Aedes aegypti* are infected, they remain infective for life after an incubation period of 9-12 days, but man and monkeys remain infective for mosquitoes for only a few days after onset of the disease. The incubation period in man is often 3 to 6 days. Following recovery, lasting immunity is maintained.

Despite precautions, mosquitoes sometimes gain access to airplanes, ships, and automobiles and are transported from one community or country to another. If infected *Aedes aegypti* adults are carried in this way to an area with susceptible people and with a sizeable population of *Aedes aegypti*, they can initiate an epidemic. Outbreaks of yellow fever are still reported from Africa. Although no outbreaks have been reported in the Orient, *Aedes aegypti*, and Aedes albopictus, another possible vector, occur in many areas, and several species of Indian monkeys are susceptible to yellow fever in experimental studies.

DENGUE

Dengue, or "break-bone fever", transmitted in this country by *Aedes aegypti* has occurred in epidemic proportions more recently than yellow fever (Figure 7). Dengue is an acute, rarely fatal, debilitating disease with a high attack rate. It is caused by a virus from the same group (Group B) as the yellow fever virus. Man and *Aedes aegypti* are the only known reservoirs of this disease. The incubation period in man is 3 to 15 days, commonly 5 or 6 days. From the day before fever develops until the third or fourth day of the disease the virus is circulated in the blood, and mosquitoes that feed on the patient's blood can become infected. After the patient recovers, short- or long-term resistance to reinfection is maintained by protective antibodies.

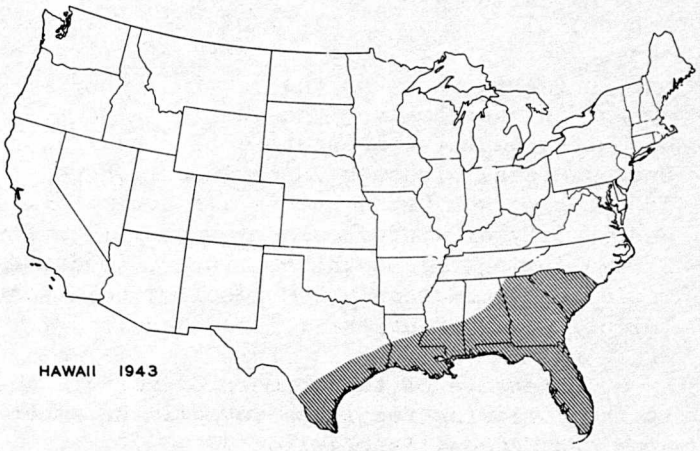


Figure 7. Areas Where Dengue Epidemics Have Occurred 1922-1945

The following major outbreaks of dengue have occurred in the United States and nearby areas:

1922-1923 Florida to Texas - perhaps 2,000,000 cases. The epidemic originated in Galveston, and 500,000-600,000 of the cases were in Texas.

1934 Florida and Georgia - an estimated 15,000 cases.

1943 Hawaii - an estimated 1,400 cases.

1945 Louisiana - several hundred cases.

1963-1964 Caribbean - at least 30,000 cases. These include over 1,300 cases in Jamaica, 27,000 in Puerto Rico, 300 in Antigua (B.W.I.), and 28 cases in persons coming to the United States from epidemic areas (Figure 8).

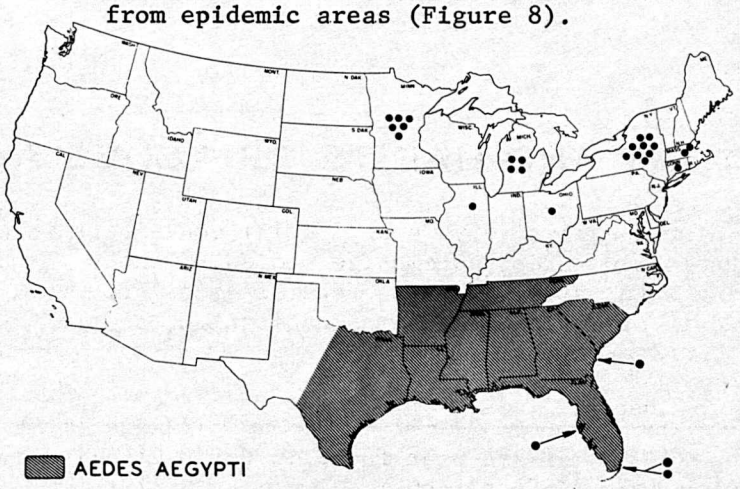


Figure 8. Reported Cases of Dengue Originating in the Caribbean During the 1963-1964 Epidemic

PUBLIC HEALTH HAZARD TO THE UNITED STATES FROM AEDES AEGYPTI

Although epidemics of yellow fever have not occurred within the United States since 1905, the possibility of the recurrence of epidemics of both yellow fever and dengue persists as long as there are large populations of *Aedes aegypti* on the mainland, and in Puerto Rico and the Virgin Islands. The extensive and explosive outbreak of dengue in Puerto Rico, the Virgin Islands, and Jamaica during 1963-64 adequately demonstrated this threat to public health. Fortunately no epidemics occurred in the United States although 28 cases of dengue of Caribbean origin were reported (Figure 8). As freezing weather destroys all adult *Aedes aegypti* exposed out-of-doors, there is no possibility of winter epidemics of yellow fever or dengue in most of the United States during the months of winter. Under these conditions, existing epidemics would be terminated by the onset of cold weather, and would not recur during the following summer unless reintroduced.

Indicative of the concern of private medicine in this potential health threat is the following report approved in December 1964, by the House of Delegates of the American Medical Association:

> "One of the great discoveries of American medicine was the identification of the *Aedes aegypti* mosquito as the vector of urban yellow fever (as contrasted with sylvan or jungle yellow fever). This same mosquito has been identified as the vector for other human diseases. Through scientific and financial assistance by the United States the control of urban yellow fever by eradication of *Aedes aegypti* in Central and South America has been made possible.
>
> "The one remaining stronghold of *Aedes aegypti* is a 300,000 square mile area involving the nine states* from South Carolina to Texas, and Puerto Rico and the Virgin Islands. So long as these mosquitoes may become infected by persons infected with the jungle yellow fever virus of South America, epidemics of yellow fever are possible in the United States.
>
> "The Board believes that the American Medical Association should cooperate with the Communicable Disease Center of the Public Health Service in promoting eradication of the *Aedes aegypti* mosquito, and recommends that the House of Delegates encourage the state and local medical societies of the states and territories concerned, and the physicians practicing therein, to cooperate in every possible way to insure complete eradication of the *Aedes aegypti* mosquito from the American hemisphere."

LIFE HISTORY AND HABITS OF AEDES AEGYPTI

Aedes aegypti breeds almost exclusively in artificial containers in and around the house. Discarded automobile tires, automobile bodies, buckets, jars, tin cans, and flower pots containing water are preferred breeding sites (Figure 9). Occasionally *Aedes aegypti* will be found in treeholes near human habitation, and in the axils of leaves of traveler's palm, air plants, or bromeliads.

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* A light infestation of *Aedes aegypti* has been found in North Carolina increasing to 10 the total states with known infestations.

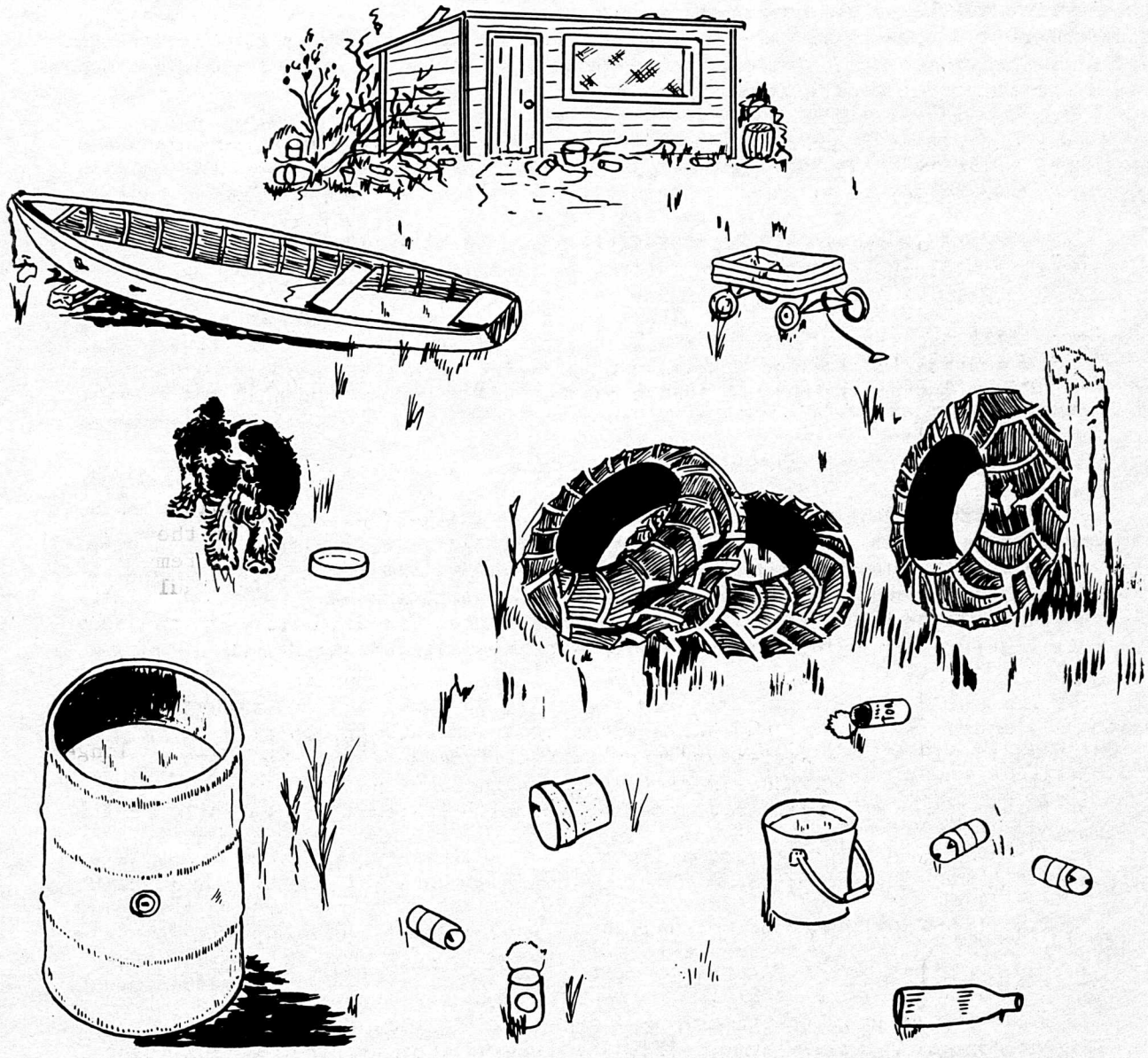


Figure 9. Some Common Water-holding Containers in Which *Aedes aegypti* Breeds

The female lays her eggs (Figure 10) singly in batches of 30 to 50 at intervals of several days, depositing them on the sides of a container at, or just above, the water line. After a few days the water usually evaporates sufficiently to let the eggs dry and cure and be ready to hatch as soon as reflooded. If not flooded, some of the eggs may remain alive more than 6 months and survive short periods of subfreezing weather. In warm weather, these incubated eggs hatch in less than a day after being flooded. Some of the eggs resist hatching during the first flooding but hatch in progressively smaller numbers with each subsequent inundation. A few eggs will still hatch if immersed in water a year or more after being laid.

Development of the larvae or 'wigglers' into pupae (Figure 10) requires from 5 to 10 days in the summer and many weeks in cooler weather. Under normal conditions, the adult emerges from the pupal case after 2 or 3 days. Thus, under the most favorable conditions the entire developmental cycle can be completed in as little as 10 days.

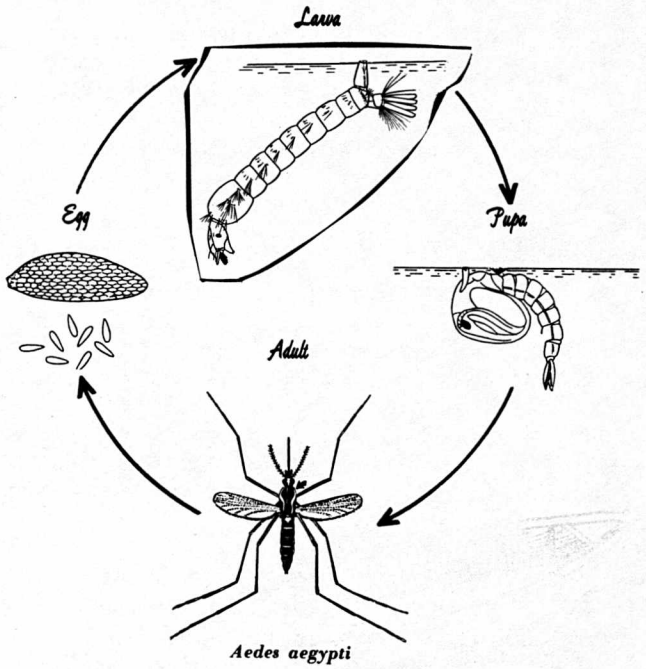


Figure 10. Life Cycle of *Aedes aegypti*

In the tropics *Aedes aegypti* breeds throughout the year, producing a rapid succession of generations; but in the southern United States the time required for the complete life cycle increases with cool weather. During the winter the eggs may remain dormant for several months in the area from South Carolina to Texas. The adults are very susceptible to cold and in the continental United States, except in the southern portion, they can survive the winters only in sheltered situations.

The *Aedes aegypti* males emerge first and remain in the vicinity to mate with the females as they emerge. The females seldom fly more than 25 to 100 yards from the breeding site. They may live for periods varying from 2 weeks to a month or longer.

Only female mosquitoes seek blood, and the *Aedes aegypti* females apparently prefer human blood to that of other animals. They make their attack quietly, usually about the ankles, under the coat sleeves, or at the back of the neck. They bite mainly during the daytime, particularly in the early morning and late afternoon hours.

HISTORY OF AEDES AEGYPTI ERADICATION

Since *Aedes aegypti* is solely responsible for transmission of urban yellow fever from person to person, epidemiologists have long suspected that outbreaks in cities could be prevented by controlling this mosquito. The history of yellow fever in the Americas proves that this concept was correct. Urban epidemics disappeared following intensive *Aedes aegypti* eradication programs in South and Central America, where intensive efforts were coordinated by the Pan American Sanitary Bureau. The last death caused by yellow fever in the United States was reported in October 1924, at Houston, Texas. The infection was probably acquired in Central America. Since that time, urban outbreaks in South and Central America have occurred only when an initial infection was transported from the jungle to an urban area, i.e., from jungle mosquito, to man, to *Aedes aegypti*, to man.

The present philosophy of *Aedes aegypti* eradication was developed in Brazil, where officials determined that it was more practical to eliminate *Aedes aegypti* from all areas than to maintain permanent control measures in the port cities. From the beginning, it was obvious that Brazil could not realize the full value of eradication unless this mosquito was also eradicated from the 10 countries sharing her boundaries; and they, in turn, could not easily be kept free unless the species was eradicated from their adjoining neighbors. To provide lasting protection for any country that achieved eradication meant, therefore, that *Aedes aegypti* must be eradicated from every political unit and island lying between the states of Oklahoma and Tennessee on the north to Argentina on the south.

An international program to eradicate *Aedes aegypti* from South, Central, and North America through a program of international cooperation, was first proposed by representatives of Bolivia in 1942 at the 11th Meeting of the Pan American Sanitary Conference in Rio de Janeiro, Brazil, but no action was taken at that time because of other activities during World War II. In 1947, at the first meeting of the Directing Council of the Pan American Sanitary Organization in Buenos Aires, Argentina, a resolution concurring in the desirability of such a program was approved. The United States was a signatory nation to this resolution.

Following this meeting, eradication campaigns were started by many nations in South and Central America. At the present time, eradication has been achieved in 14 nations and 2 territories in the Western Hemisphere. Only certain areas in the United States and the Caribbean remain heavily infested (Figure 11).

Figure 11. Status of the *Aedes aegypti* Eradication Campaign, December 1966

As the member nations of the Pan American Health Organization approached successful conclusion of their programs for *Aedes aegypti* eradication, they became concerned over the threat of reinfestation from areas where the vector is still plentiful. Therefore, in 1961 the Directing Council of the Pan American Health Organization met in Washington and approved a resolution recommending that all nations in the Western Hemisphere initiate and complete eradication by 1966. The United States again was a signatory to this resolution. In 1962, Dr. Luther L. Terry, Surgeon General of the Public Health Service, declared at the 16th Pan American Sanitary Conference at Minneapolis, Minnesota, that "the United States has plans under way for the eradication of the urban vector of yellow fever in those areas of the United States where it exists and in Puerto Rico and the Virgin Islands."

AEDES AEGYPTI ERADICATION BRANCH ACTIVITIES

In 1963 national headquarters for *Aedes aegypti* eradication was established with the development of an Aedes aegypti Eradication Branch (AAEB) in the Communicable Disease Center, U. S. Public Health Service, in Atlanta, Georgia. In 1964 state and territorial headquarters and staffs were set up in Florida, Texas, Puerto Rico,

and the Virgin Islands, in 1965 in Hawaii, and in 1966 in South Carolina, Georgia, and Alabama. Organizational relationships are shown in Figure 12.

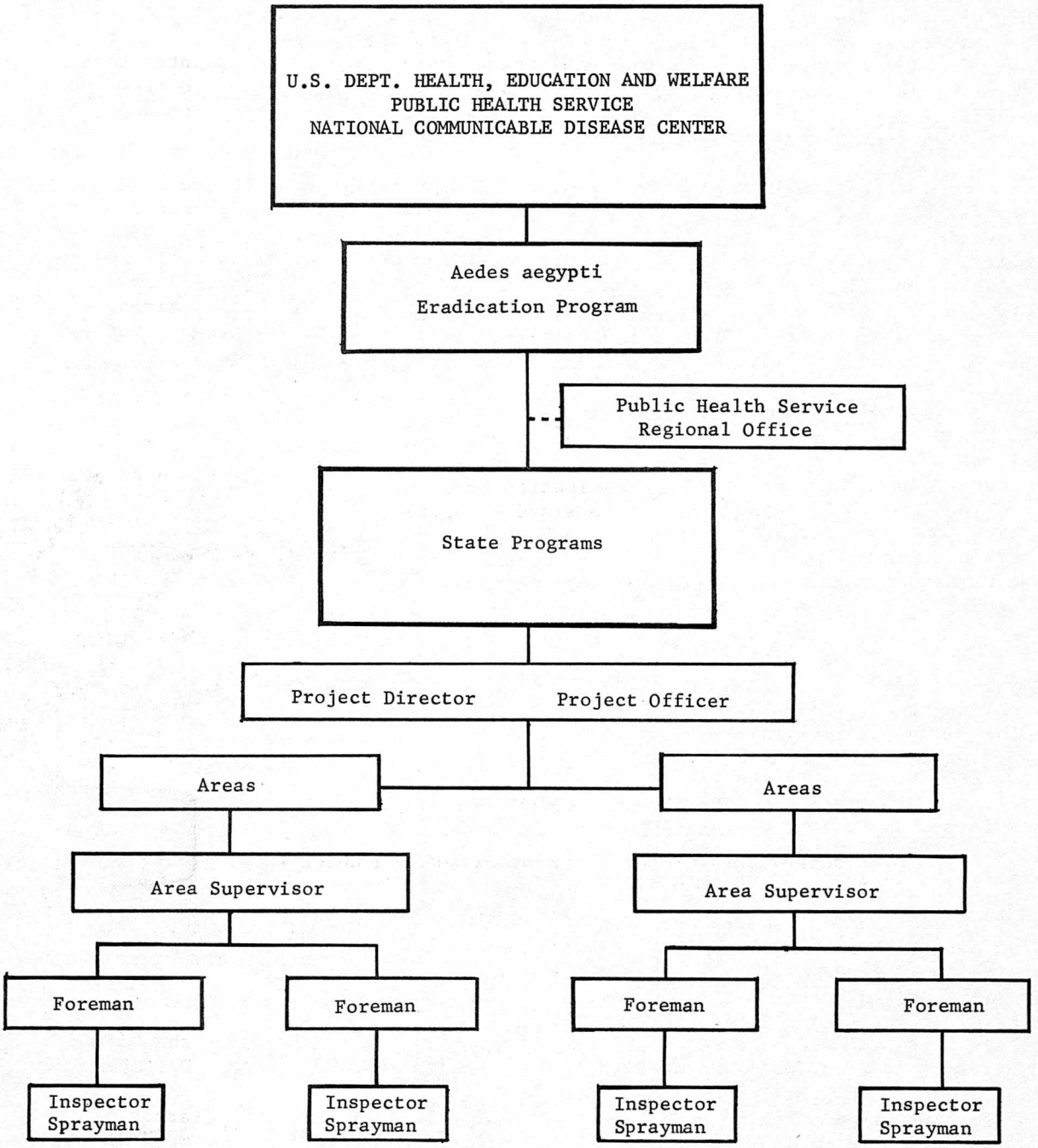


Figure 12. Organizational Relationships - Aedes aegypti Eradication Program

Public Health Service contract funds are used by the state and territorial health departments for the employment of foremen and inspector-spraymen, and for the purchase of equipment and materials.

Program direction, management and information are provided by personnel of AAEP Headquarters in Atlanta. Personnel training in inspection, spraying, and breeding-source reduction are provided by the Training and Consultation Section of the Program through the use of field courses, handbooks, specially prepared films, and other training aids.

The Technical Development Laboratories at Savannah, Georgia, with a Biology Section, a Chemistry Section, and an Engineering Unit, provide technical guidance to the operational program based upon laboratory and field studies of disease vectors and pesticides. Scientific and operational equipment is designed and evaluated for use in operating programs.

The Evaluation Section serves as the focal point within the Program for the evaluation of program in eradication and the definition of technical or operational problems that may be retarding progress. It evaluates the effectiveness of prescribed methodology of eradication and appraises the necessity of modification.

The Operations Section provides assistance in planning the eradication activities with the State programs. It advises on appropriate distribution of manpower, equipment, and supplies. It is responsible for determining that program operations conform to approved plans and for effecting satisfactory progress toward eradication. It keeps the state programs informed concerning Aedes aegypti Eradication Program policies. This Section analyzes operational results and informs the Program concerning the current status of eradication and special problems and difficulties.

STATE PROGRAMS

The eradication programs in each state or territory are conducted as cooperative endeavors with state, commonwealth, territorial, and local departments of health. Programs are directed by a Project Director, a state employee responsible for establishment and operation of the program in accordance with state policy; and a Project Officer on the Program staff responsible for the detailed technical direction of program activities within the state.

LOCAL PROGRAMS

Area supervisors, Federal employees working under the Project Director and Project Officer, are responsible for conducting and directing eradication activities in each project county or municipality. Inspectors, spraymen, and their foremen are state, commonwealth, or territorial health department personnel, employed with Federal contract funds, and assigned to local areas under the direction of area supervisors. Principal items of equipment and supplies are provided through direct obligation of Federal funds. Efforts are made to obtain the maximum assistance of state and local agencies in supporting the Program, especially in the reduction of *Aedes aegypti* breeding sources within the infested communities.

Inspections are made on a premises-to-premises basis utilizing the city block as a unit in the application of insecticidal and breeding-source-reduction measures in urban areas. As progress is achieved, operations are expanded outward from centers of heavy infestation. This expansion will continue until the limits of yellow fever mosquito infestations are reached in the eleven states (including Hawaii), and the territories of Puerto Rico and the Virgin Islands.

ERADICATION MEASURES

Eradication of *Aedes aegypti* is being achieved by means of three primary operational measures:

1. Entomological inspections to disclose the infestations in an area, indicating their extent, distribution, and severity.
2. Insecticidal spraying of *Aedes aegypti* larval breeding sites in artificial and natural water containers, and selected adult resting sites.
3. Source reduction activities to free the human environment of water-holding containers such as used tires, cans, pails, old automobiles, and other junk, and to achieve proper management of useful items such as bird baths, boats, and wheelbarrows.

Entomological Inspections

Entomological inspections involve a careful search for actual and potential breeding containers on individual premises to find mosquito larvae (wigglers) and pupae (Figure 13) and, when necessary, a search for *Aedes aegypti* adults.

Infestations are recorded on the spot and specimens are taken to the area office for identification. Eradication planning and operations are developed from knowledge obtained from these surveys.

As *Aedes aegypti* mosquitoes are eliminated from a city or county, intensive inspections over a considerable period of time are needed to evaluate the problem, and to verify the fact that complete eradication has been achieved.

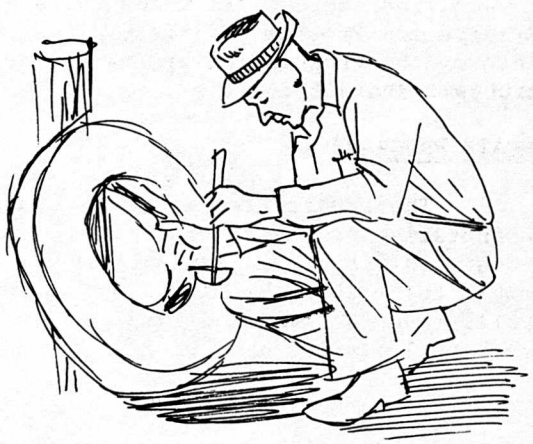


Figure 13. Inspection for *Aedes aegypti* Larvae

Insecticidal Treatments

Insecticidal applications are confined chiefly to artificial containers in which *Aedes aegypti* mosquitoes breed, thus reducing the application of chemicals to a small fraction of the total environment. Some resting places of adult mosquitoes, such as the dark, damp, undersides of houses, are also sprayed. In addition to savings in manpower and cost of chemicals, this focusing of insecticides on the breeding sites and most favored resting places produces an immediate reduction of *Aedes aegypti* without grossly contaminating the environment.

Power sprayers (Figure 14) are used to apply a 1¼-percent water suspension of DDT to containers in poorly sanitated areas where containers are too abundant for hand sprayers to be effective. In most of Puerto Rico and the Virgin Islands where *Aedes aegypti* are not susceptible to DDT, a 2½-percent malathion emulsion is employed. This material is very effective, but only for a short period, and applications must be made more frequently than with DDT.

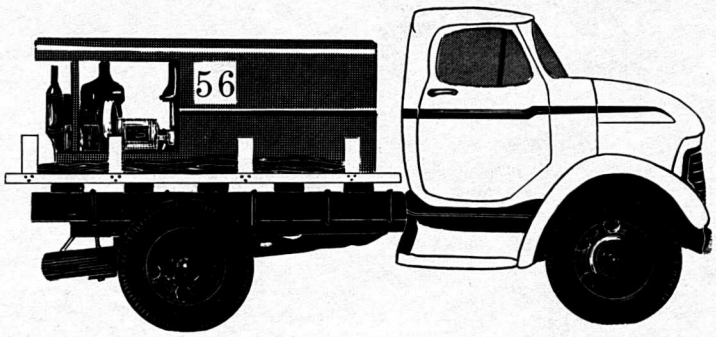


Figure 14. *Aedes aegypti* Power Sprayer

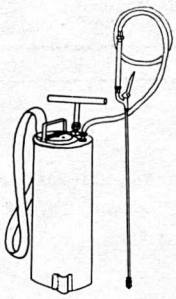


Figure 15. Compressed Air Sprayer

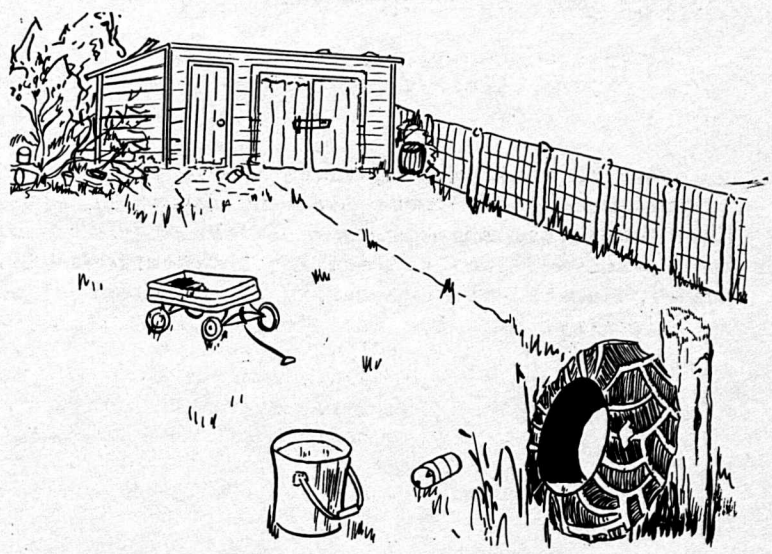
Hand sprayers (Figure 15) are used in well sanitated areas where the scarcity of tires, junk, old appliances and other water containers does not justify the use of power sprayers. The hand-pumped compressed-air sprayers are similar to those used by individuals for spraying small gardens and ornamentals.

DDT wettable powder, rather than the emulsion, is used for application to tree holes and vases containing flowers or cuttings. This material causes no damage to plants.

Source Reduction

Source reduction is the removal of water-holding containers (Figure 16) from the environment and the proper management of water-holding articles that have value and cannot be removed from premises. Source reduction requires the interest and participation of the individual resident in placing rubbish and trash* at the curb for collection. In the case of automobiles and large plumbing fixtures, or appliances such as refrigerators, special arrangements must be made for collection and disposal. Although inspections and a public motivational program are carried on by Aedes aegypti Eradication Program personnel, source reduction is chiefly a local activity involving the health department, other local departments, and every citizen in a community (Figures 17-20).

Figure 16. Backyard with many water-holding containers, the breeding places of *Aedes aegypti*.



*Trash includes such items as leaves, lawn clippings, and shrub trimmings.

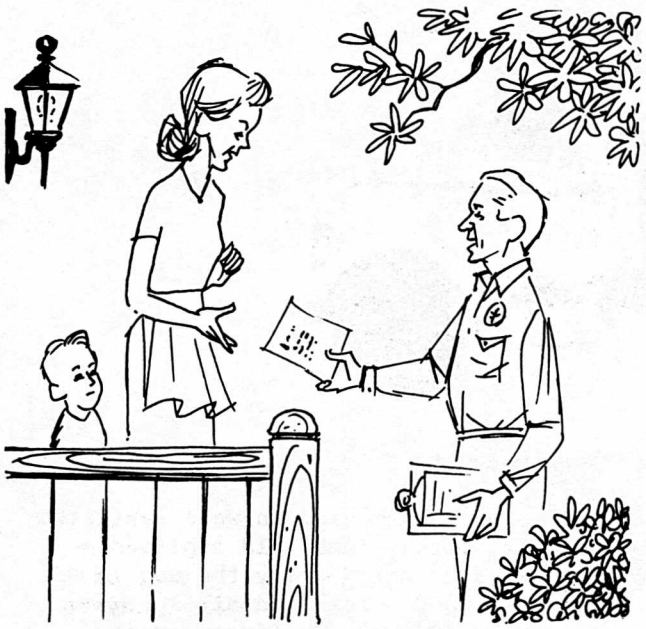


Figure 17. Inspector Discussing Removal of Water-holding Containers from Premises

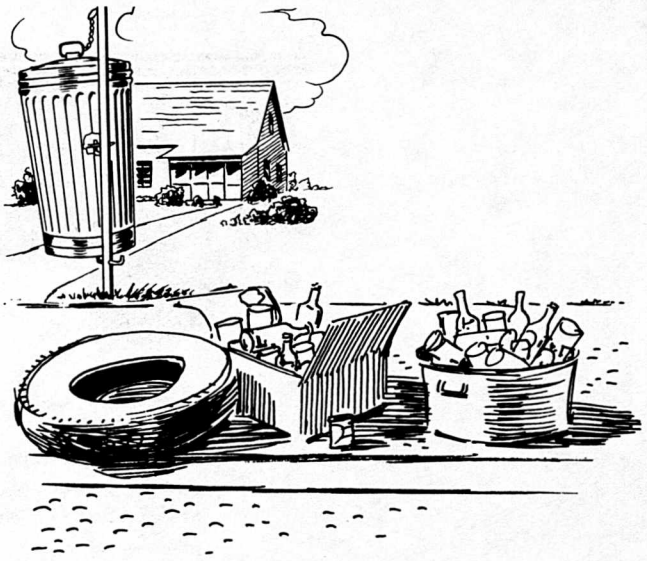


Figure 18. Placing of *Aedes aegypti* Breeding Containers at Curb for Collection

Figure 19. Collection Crew Loading Junk Piled at Curb

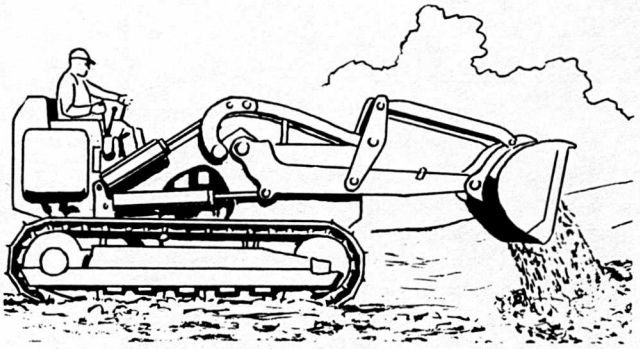


Figure 20. Complete Disposal and Burial of Junk in Sanitary Landfill

Source reduction produces a more beautiful community, better utilization of living space, and a more pleasant way of life. It reduces the breeding of mosquitoes other than *Aedes aegypti*, some of them being vectors of communicable diseases. It has positive values in reducing infestations of flies and rats, and prevents many home accidents. This activity is an essential supplement to intensive inspections and effective spraying in a well-rounded *Aedes aegypti* eradication program.