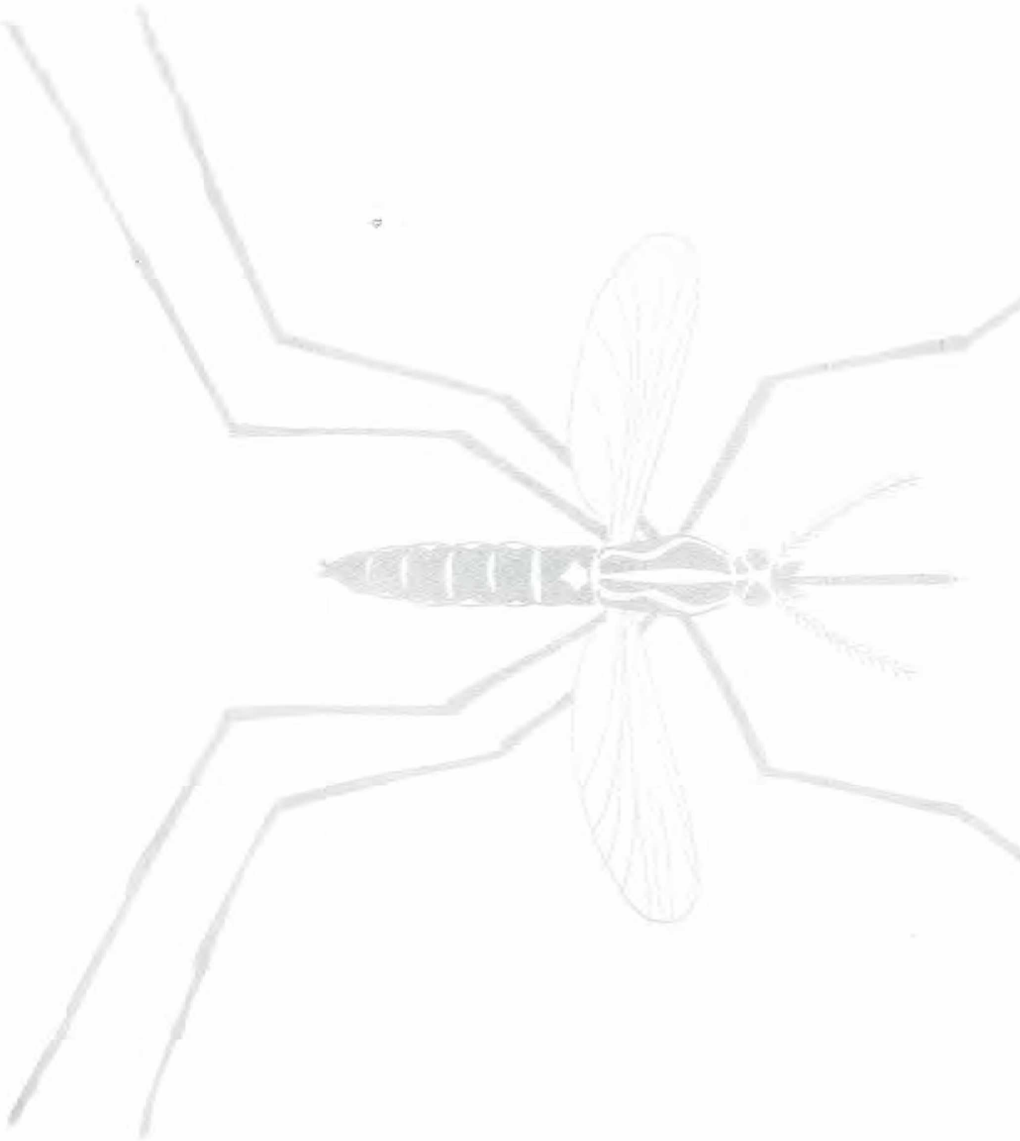


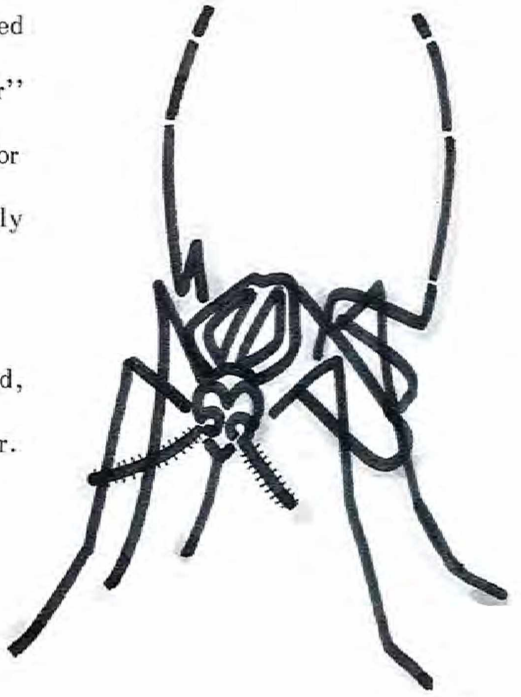
THE AEDES AEGYPTI ERADICATION PROGRAM

1966

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
Communicable Disease Center
Aedes aegypti Eradication Branch
Atlanta, Georgia 30333

Two years ago the Public Health Service began a program to eradicate *Aedes aegypti* (the yellow fever mosquito) from all the still-infested areas under United States responsibility. This mosquito is notorious as a vector of human diseases: of yellow fever, historically one of the most dreaded pestilential diseases; of dengue fever, often called "breakbone fever" because of the pain its victims suffer; and of other hemorrhagic fevers, for example, a severe new type now epidemic in the Orient and moving slowly westward.

Here is the story, briefly, of why this mosquito must be eradicated, of how the eradication program works, and of what has been done thus far.

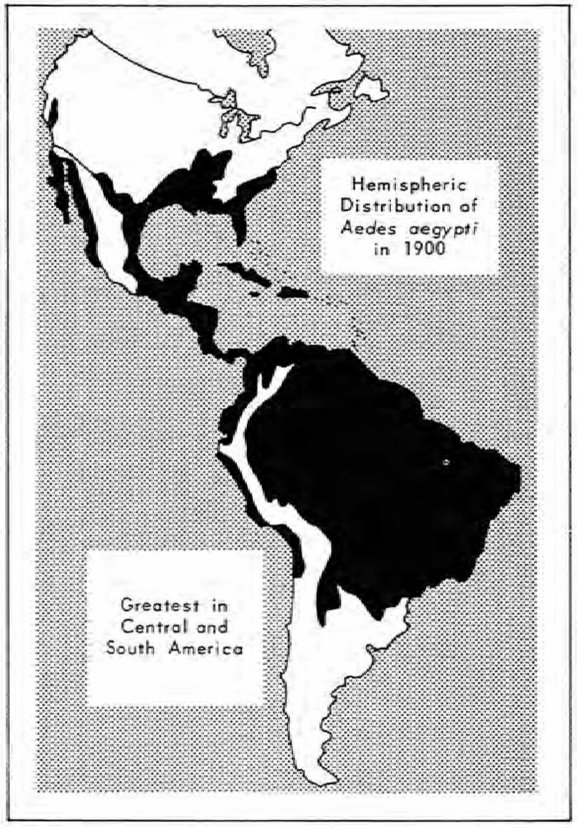


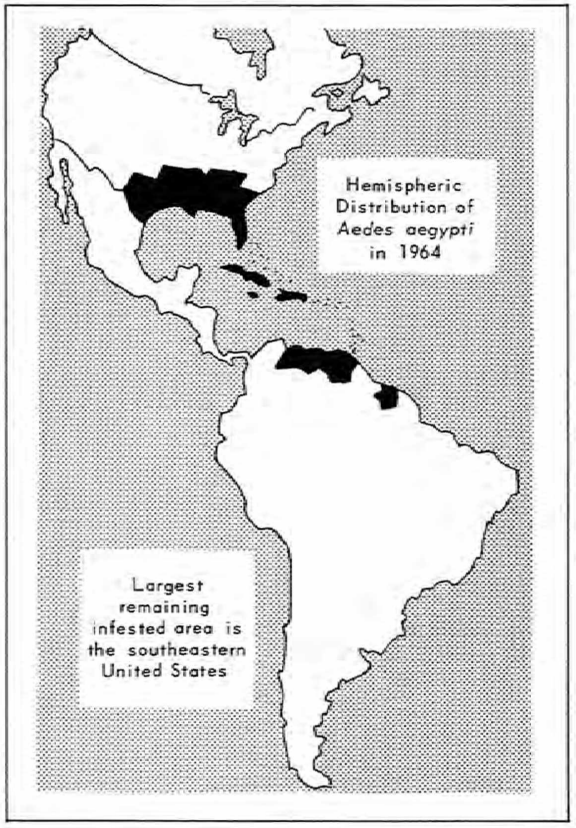
HISTORY

Programs to control Aedes aegypti, the yellow fever mosquito, date back to the turn of the century, when it was first learned that this insect spreads yellow fever from person to person. For centuries yellow fever was rampant in tropical regions of Africa and America, often extending to temperate areas in violent epidemics during the summers. In the New World, these epidemics struck port cities all the way from Buenos Aires on the south to Boston and Philadelphia on the north, occasionally even reaching to inland cities. In one great epidemic — in New Orleans in 1878 — 27,000 people came down with the disease and more than four thousand died.

Proof that Aedes aegypti spreads yellow fever was announced in 1900, and the knowledge was put to immediate use. In Havana, Cuba, in 1901, a campaign against Aedes aegypti was successful and the city was completely rid of yellow fever. In the city of Panama, which was plagued with yellow fever, an Aedes aegypti control program in 1904–1905 resulted in eradication of the disease. The results of these drives and of early work in various countries of the Americas led to the belief that yellow fever could be ERADICATED by temporarily reducing Aedes aegypti breeding in key cities of endemic areas.

Early Aedes aegypti control programs, together with a complex of pressures, did indeed result in a dramatic decrease in yellow fever, which continued almost through the 1920's. In late 1927 and early 1928 almost a year passed with no cases reported anywhere in the hemisphere.





The United States experienced its last epidemic in 1905; and until the advent of air travel, this country's protection against epidemic yellow fever seemed assured. However, other American countries were not so fortunate. In 1928 there was an explosive epidemic in Rio de Janeiro, which had been free of yellow fever for 20 years. Following this, there were a number of small, widely separated outbreaks in Colombia and Venezuela. These epidemics could not be traced to any urban

source, which was a part of the classical epidemiologic picture.

Over the next few years, yellow fever WITHOUT Aedes aegypti was seen on numerous occasions, primarily in rural areas. Where had the seeds of the unexplained cases and outbreaks come from?

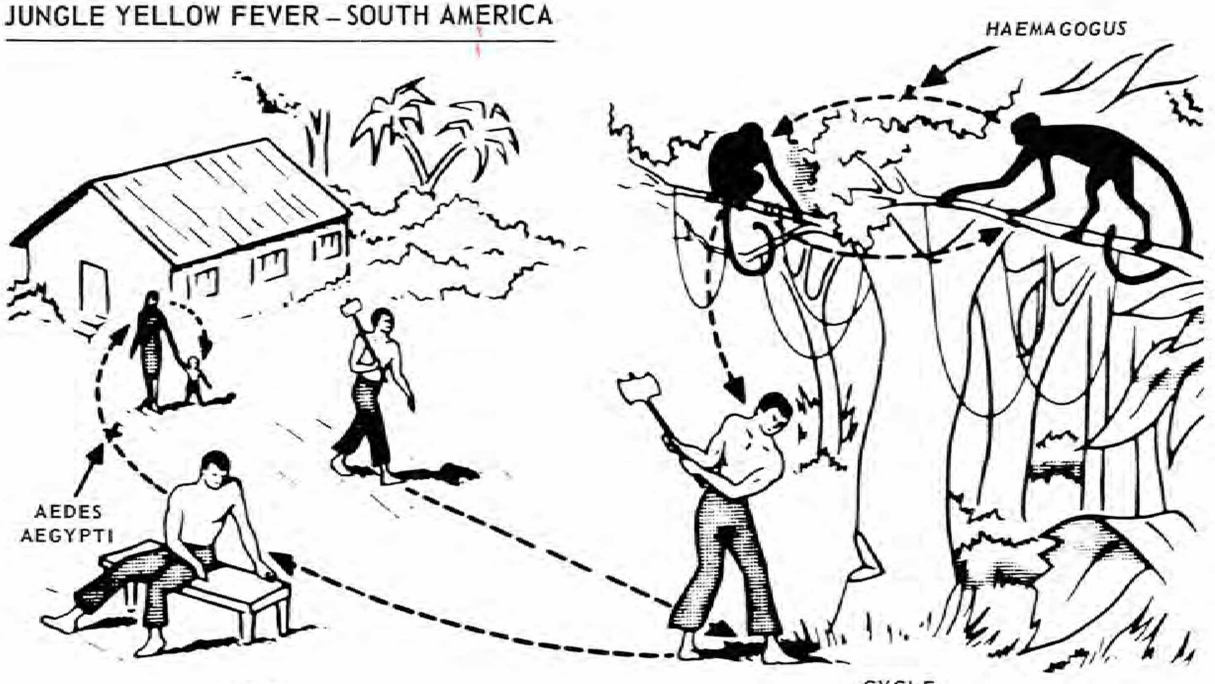
Investigations using ever-improving techniques led to recognition of a wild cycle of yellow fever that exists completely apart from the urban cycle. In this sylvan cycle, the yellow fever virus is transmitted among monkeys and possibly other wild vertebrates by forest mosquitoes that breed in tree holes and other wild sites. They seldom find their way into human habitations, and this only when a village or home is adjacent to forest or jungle. However, people who go into the tropical forests or work near them can become infected by these wild mosquitoes, then unwittingly carry yellow fever back to their home community. There, if Aedes aegypti are present, a new urban cycle of the disease may begin.

Recognition of sylvan yellow fever and of the mechanism that converts it to urban yellow fever gave urgency to Aedes aegypti control efforts. In the endemic region of the New World, the number of Aedes aegypti control programs burgeoned.

The countries that pioneered control found that they could eradicate this mosquito from large land areas, but could not stay rid of the species unless their neighbors likewise were free of it. Thus the idea emerged that hemisphere-wide eradication would be necessary if the gains made by any single country were to last.

Formal proposals for hemisphere-wide eradication of Aedes aegypti date back to the early 1940's. Bolivia, the first country

JUNGLE YELLOW FEVER – SOUTH AMERICA



JUNGLE TO URBAN

MAN GOES INTO JUNGLE, BECOMES INFECTED, RETURNS HOME, AND IF *AEDES AEGYPTI* ARE PRESENT MAY INITIATE THE URBAN OR MAN-MOSQUITO-MAN CYCLE

to eradicate the species, proposed to the conference of the Pan American Sanitary Bureau in 1942 that member nations undertake eradication of this vector.

Activities were limited during World War II, but at the PASB Conference in 1947, a formal resolution for programs to be conducted by all infested countries and territories of the hemisphere was signed by the member nations, including the United States. Within the next ten years, a total of 42 eradication programs were in some stage of progress.

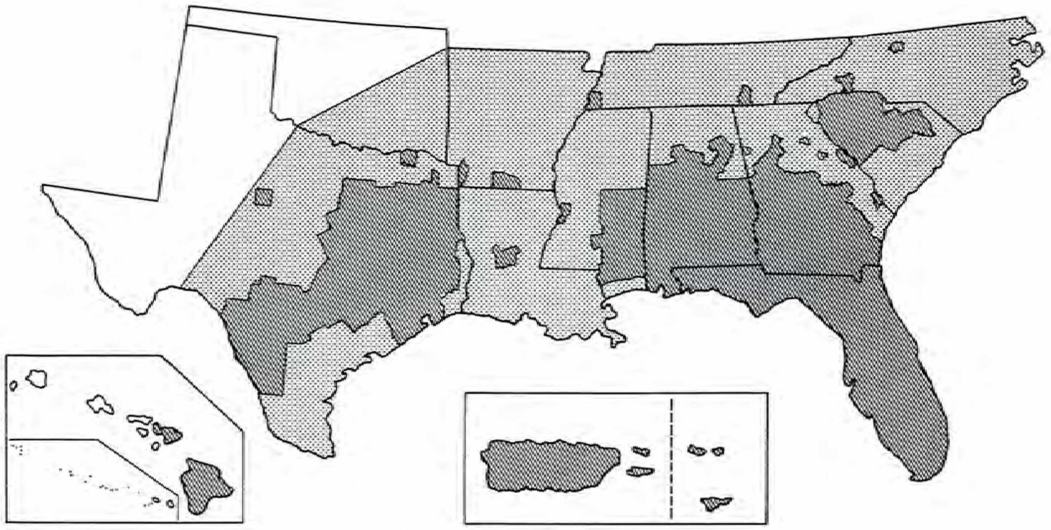
Although the United States was among the nations signing, no program was started here at that time. As a result of strict enforcement of international quarantine regulations and of constant surveillance, coupled with the safety to us inherent in the eradication programs in Latin America,

the United States remained free of yellow fever.

While this country did not feel the urgency for Aedes aegypti eradication that was felt by countries near the jungle reservoir of yellow fever, U.S. officials were not indifferent to the problem. On two more occasions — 1961 and 1962 — this country committed itself to conduct a program of eradication. Also, between 1957 and 1961, the Communicable Disease Center of the Public Health Service conducted a pilot eradication project at Pensacola, Florida, to determine the feasibility of an eradication program here, to devise methods of eradication based on the use of modern materials and equipment, and to develop cost figures as the basis for program planning.

The first positive move toward activating an eradication program for this country came in 1963. At the specific request of the President, the 87th Congress appropriated funds to begin limited operations. Late that year national headquarters for the program was established in Atlanta, Georgia, with the activation of an Aedes aegypti Eradication Branch in the Communicable Disease Center. Field operations were begun the next year, 1964.

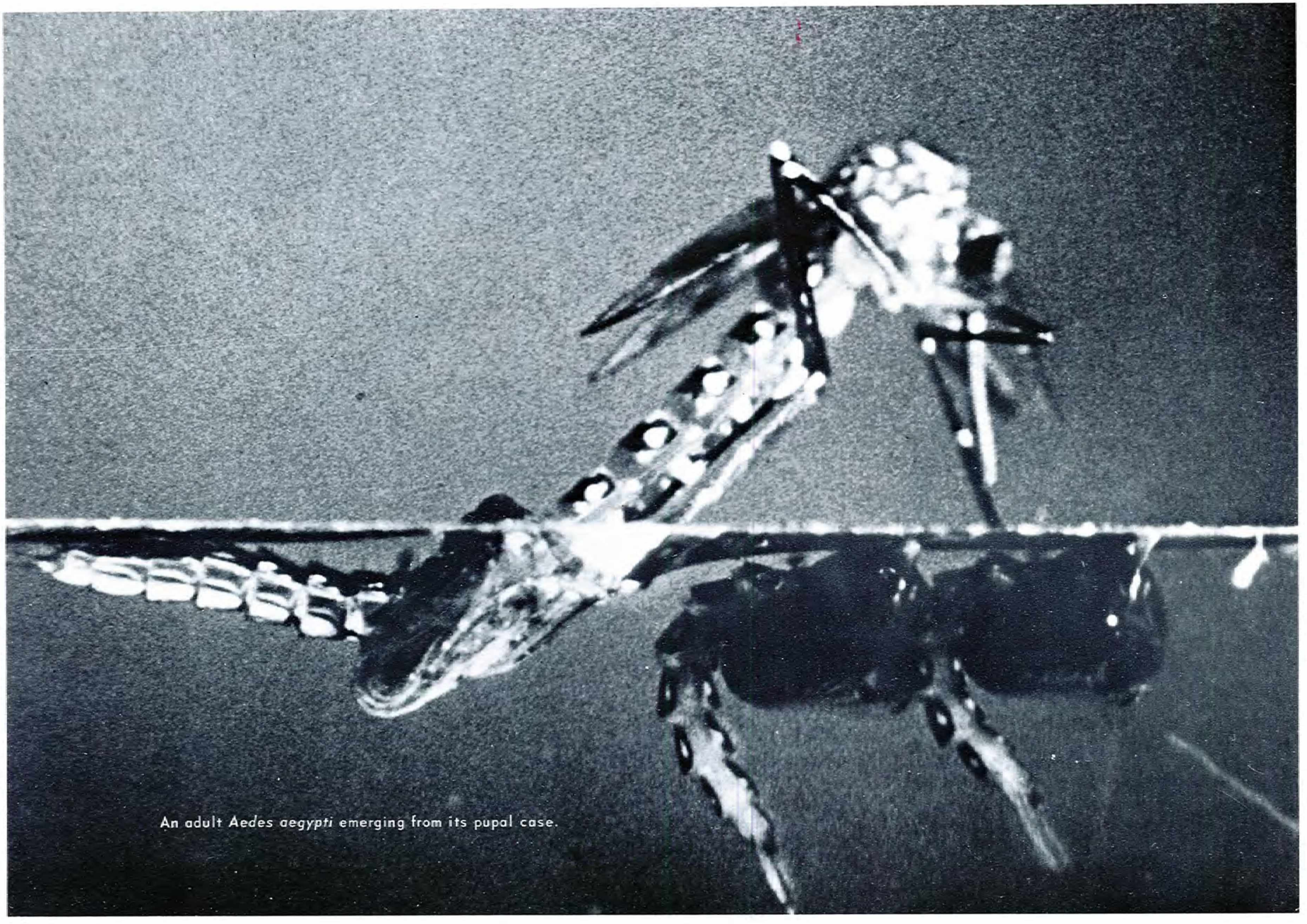
The area of infestation that our program will deal with includes ten southeastern States, Puerto Rico, the Virgin Islands, and the island State of Hawaii. The accompanying maps show (1) the presumed status of infestation in the total program area, (2) the area where operations were conducted in 1964, and (3) the total area operational at the end of 1965.



The area of infestation that our program deals with includes 10 southeastern States, Puerto Rico, the Virgin Islands, and the island State of Hawaii. Resources initially available were used to activate projects in Florida, Texas, Puerto Rico, and the Virgin Islands.

Initial operations were concentrated in areas where *Aedes aegypti* infestations were high and climatic conditions permitted continuous breeding. Activation of the program in southern Texas minimized chances of *Aedes aegypti* from the United States reinfesting neighboring Mexico.

Expansion of the program in 1965 continued concentration of resources in areas most favorable to mosquito breeding.



An adult *Aedes aegypti* emerging from its pupal case.

HOW THE PROGRAM WORKS

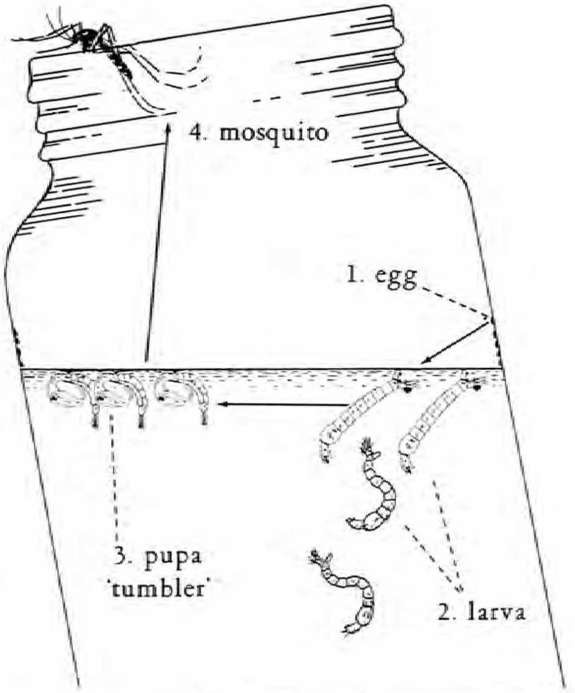
Eradication of any insect from a large geographical area is most difficult. In the case of Aedes aegypti, all infestations must be found, and all breeding sources must be treated with insecticides or removed. During the attack phase of the program initial reductions in Aedes aegypti populations may be dramatic. But as the species becomes scarcer and therefore harder to find, and as it becomes increasingly tolerant to the insecticides used, a much greater effort will be required. Once the species seems to be absent, a considerable period of diligent inspection and reinspection will be required to confirm this status. If during this verification period the species is not found again, eradication can be formally declared.

Aedes aegypti is generally found in cities and towns, though rural infestations are not uncommon. In an infested community, breeding is apt to be heaviest in neighborhoods with poor environmental sanitation and a profusion of suitable containers near human habitations. A quick look at the biology of this mosquito will show why this is true and will provide an understanding of the method of attack against the species.

Aedes aegypti is not a strong flier, hence spends its lifetime near the place where it hatches. The female lays her eggs at the surface of the water in a container with firm sides, cementing them there with a substance from her body. She never deposits them in a dry container, and never in water confined by earthen walls or banks. If the eggs remain wet, most of them hatch within a few days. If the water evaporates — or is otherwise lost from the container without disturbing the eggs — the adhering eggs dry out but remain alive and ready to hatch when the container again receives water. The dry eggs can remain alive for long periods, some for a year or more, then hatch when immersed in water.

After a brief period as larvae, or wigglers, and then as pupae, the adult insects emerge and soon are able to fly. They mate within a day or two, and the females remain fertile for life. Shortly after mating, the female seeks a blood meal, human blood, is possible, and soon is ready to find water in a suitable container and start the life cycle all over again.

The list of discarded and infrequently used items that serve for Aedes aegypti breeding is seemingly endless: used tires; old wrappers and containers made of plastic, glass, cellophane, waterproofed paper and other materials that weather away slowly or not at all; old appliances and parts; toys; junk automobiles; tubs, buckets, and other seldom-used vessels left upright in the open; pet watering dishes and bird baths; ornamental urns and other decorative items; containers for rooting or growing plants in water; and so on at length. In addition, the species will breed in tree holes, in water cupped by palm fronds, and in other suitable natural receptacles.



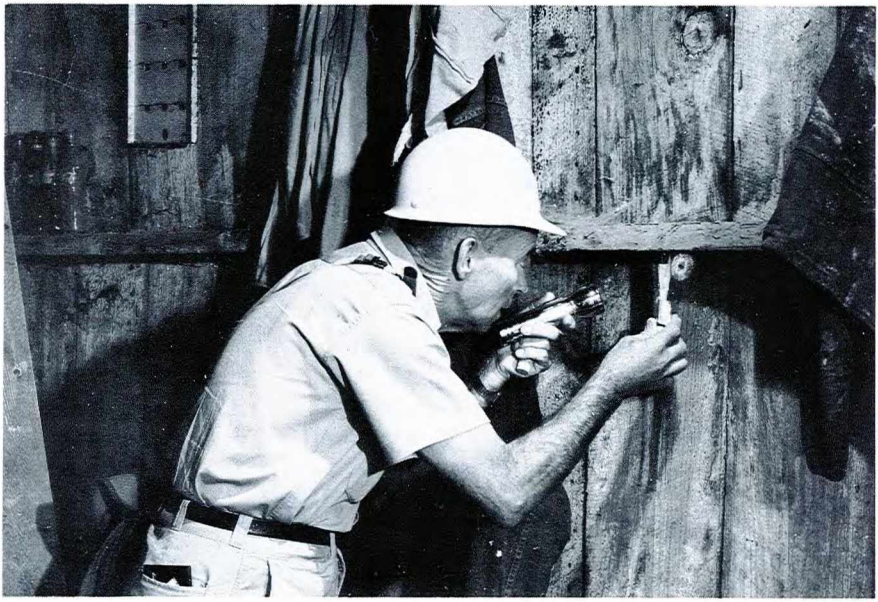
LIFE CYCLE OF THE *AEDES AEGYPTI* MOSQUITO
Mosquitoes need water in which to hatch. A mosquito begins as an egg (1), then hatches into a larva (2), then turns into a pupa (3), and the pupa turns into a mosquito (4). The mosquito then flies away from the water to find a meal of blood.

Childrens playthings, particularly when neglected, can collect enough water to allow *Aedes aegypti* breeding.

Junk such as this can produce prodigious numbers of *Aedes aegypti*.

Tires are a preferred breeding container for *Aedes aegypti*. Often they serve as a means of transport from infested to uninfested areas.

The inspector makes field identification of larvae and collects specimens.



As the species becomes harder to find, a search is made for adult *Aedes aegypti.*

The inspector uses a chloroform tube to capture and kill the adults.

Organization

Eradication operations must be pursued on private premises, since the grounds around homes and businesses are the site of most of the Aedes aegypti breeding. To get at this grass-roots problem most effectively, the eradication program is being conducted cooperatively by the Public Health Service and the health departments of the States involved. The program is financed with federal funds and is under the general direction of the Public Health Service; but each of the cooperating States contracts to eradicates Aedes aegypti from within its boundaries, using federal funds to pay its program costs.

For operational purposes each contracting State is a separate project in the total program. The Aedes aegypti Eradication Branch assumes responsibility for overall policy, planning, and guidance, provides training, research, and other supportive services, and procures and supplies the necessary equipment and materiel. The State health department carries on the day-to-day operations in a manner compatible with the overall eradication plan and with policies of both the Public Health Service and the State.

A project staff is headed jointly by a Project Director, representing the State health department, and a Project Officer, representing the Public Health Service. Below State headquarters level, the program is set up in operating areas of one or more counties, each headed by an area supervisor and one or more assistant area supervisors, who are federal employees, with sometimes a State representative as a counterpart for the area supervisor. At Branch headquarters and State and area levels in the projects, staff members are professional people, i.e., entomologists, engineers, vector-control specialists, sanitarians, health educators, and others as needed.

The largest segment of staff is made up of inspector-spraymen and their foremen, who are State employees. These are the men who work from door-to-door inspecting for Aedes aegypti, spraying as needed, and teaching the importance of container removal or proper management. They are in daily contact with the public and sometimes are the only contact between the program and the people.

Because of their critical position in eradication operations, these men are given intensive training in all aspects of the program before they are assigned to the field. This training includes the biology of Aedes aegypti as it applies to operations, the best approach in contacting householders and other premises occupants, the techniques of inspection and treatment, and the necessary records-keeping and reporting. The training courses stress the need for these men to explain the program at every opportunity, and to encourage the citizens to help by eliminating actual and potential breeding places from their premises.

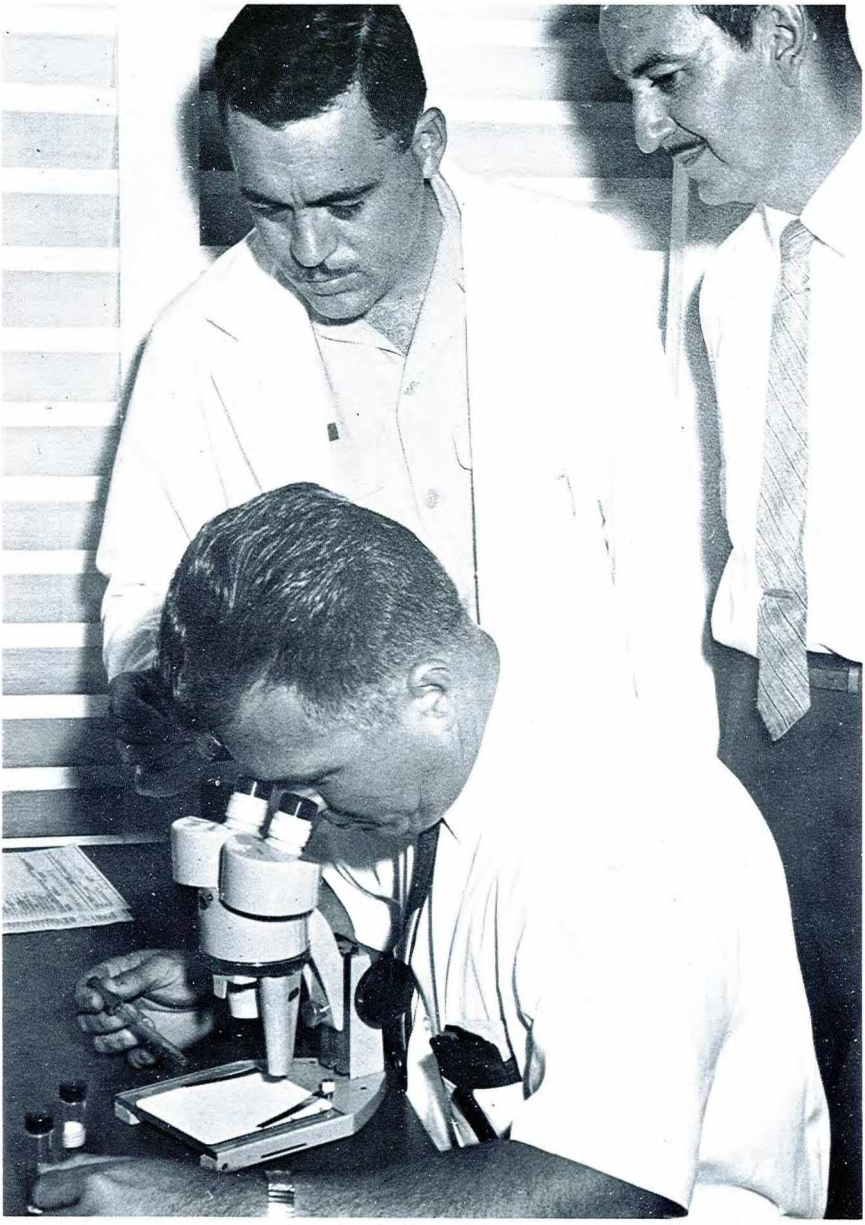
The inspector–sprayman must be tactful in dealing with the public. Here he shows the householder that a jar of plant cuttings in water has attracted *Aedes aegypti*.

Sampling the water in an old tire.

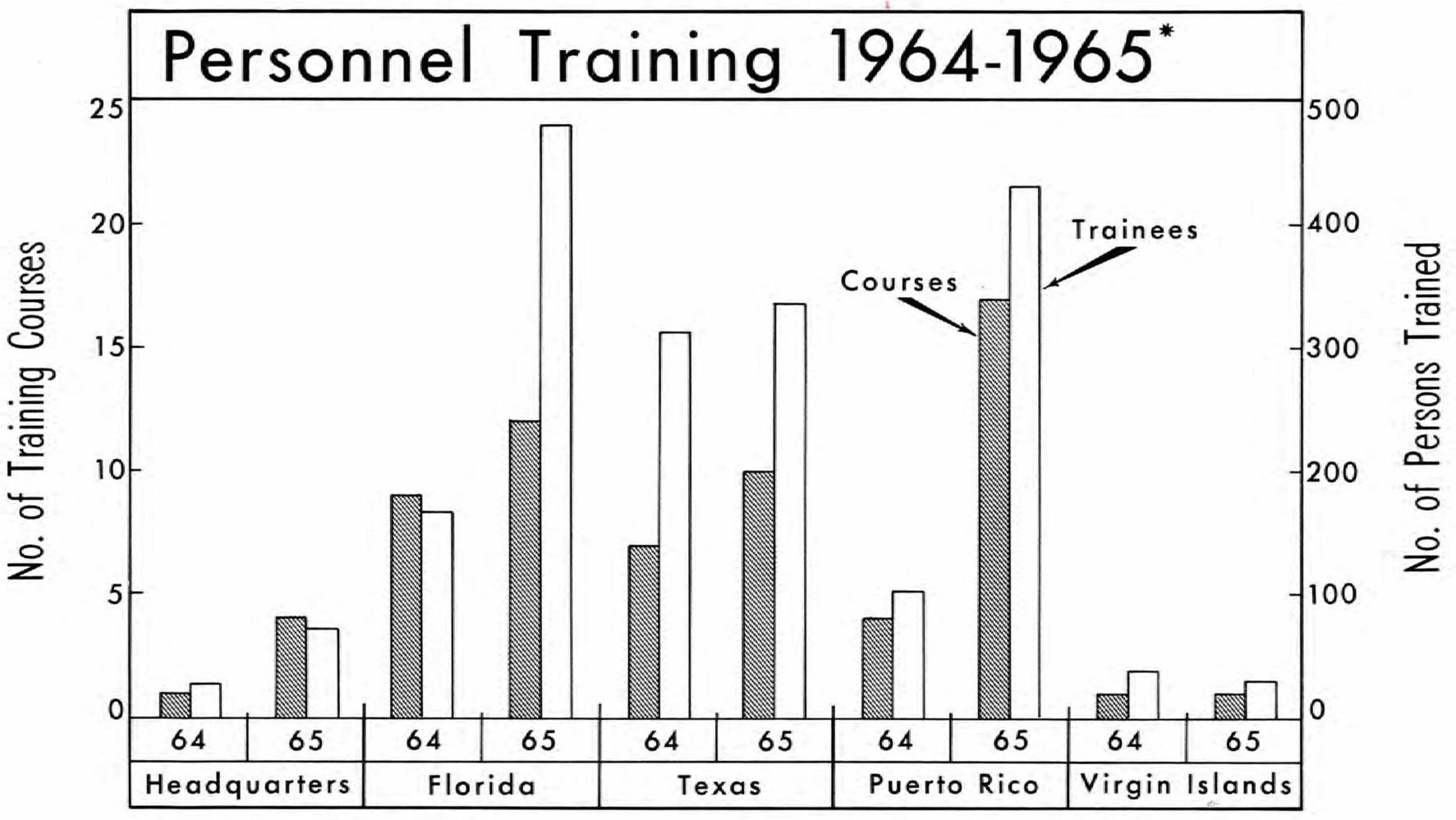
Using the power sprayer.

Workers recruited for operations must be given essential training. Here a motion-picture crew on location is "shooting" a training film.

Operations personnel learn to make tentative identifications of mosquito larvae without the microscope . . .



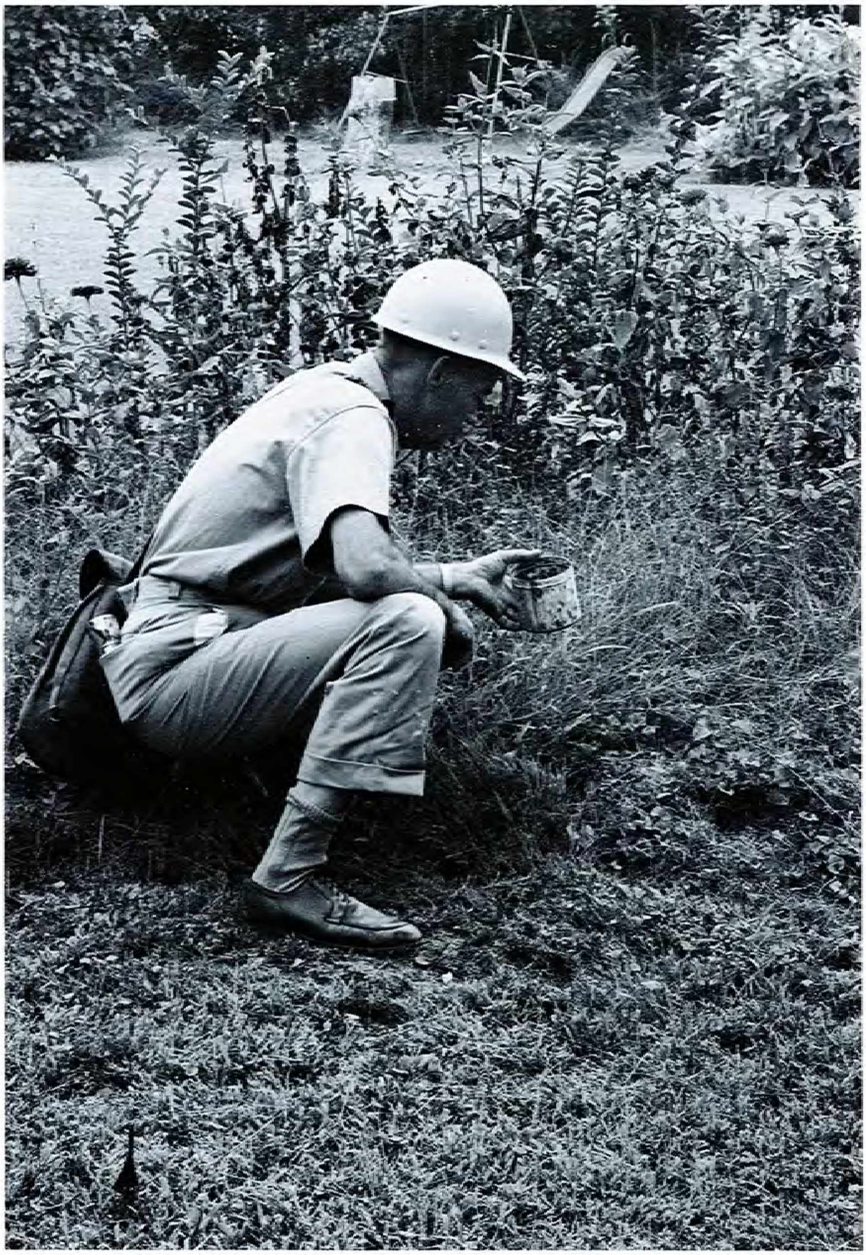
. . . and to use the microscope for positive identifications. They also learn to keep records on the source of larvae, the type of container collected from, and other pertinent information.



* March 1964—December 1965

A group of trainees on the Puerto Rico project receive classroom instruction.

The field men are taught the best approach in contacting householders.



The inspector learns the most likely places for hidden containers.

Field Operations

Unless prior surveys in the community have determined locations of Aedes aegypti infestations, inspections must be conducted on a house-by-house basis until infestations are found or the area is declared aegypti-free.

When infestations are found, actual and potential breeding sources at the infested premises and in the surrounding area are treated with insecticides. Treatment is repeated at intervals until Aedes aegypti is eradicated.

Insecticide is applied to artificial water-holding containers such as discarded tires, buckets, cans and bottles. The insecticide is directed at the mosquito larvae, although there is some coincidental control of adult mosquitoes. As a general rule, the men who serve as inspectors also carry out the spraying phase of the program.

The spray crews utilize a variety of equipment adaptable to either light or heavy infestations. The heavy power equipment is essential in areas of high infestations, such as used-tire lots, junkyards, and in some instances around houses in lower socio-economic areas where environmental sanitation may be poor. Hand sprayers or other light equipment serve admirably in clean neighborhoods where breeding is at a minimum.

Power sprayers mounted on trucks are used in heavily infested neighborhoods.

Hand sprayers are used in neighborhoods with few infestations.

Close-up of truck-mounted power sprayer.

Working With The Community

Public cooperation is essential in the eradication program. But it can be assured only if people are knowledgeable about Aedes aegypti and the method of attack in use against the species. To this end, pertinent knowledge is provided to the community through meetings with community leaders, through the newspapers, over radio and television, and by every other practical means. The people are encouraged...

To permit inspections, and insecticidal treatment when needed;

To remove all unnecessary containers and junk that can breed Aedes aegypti;

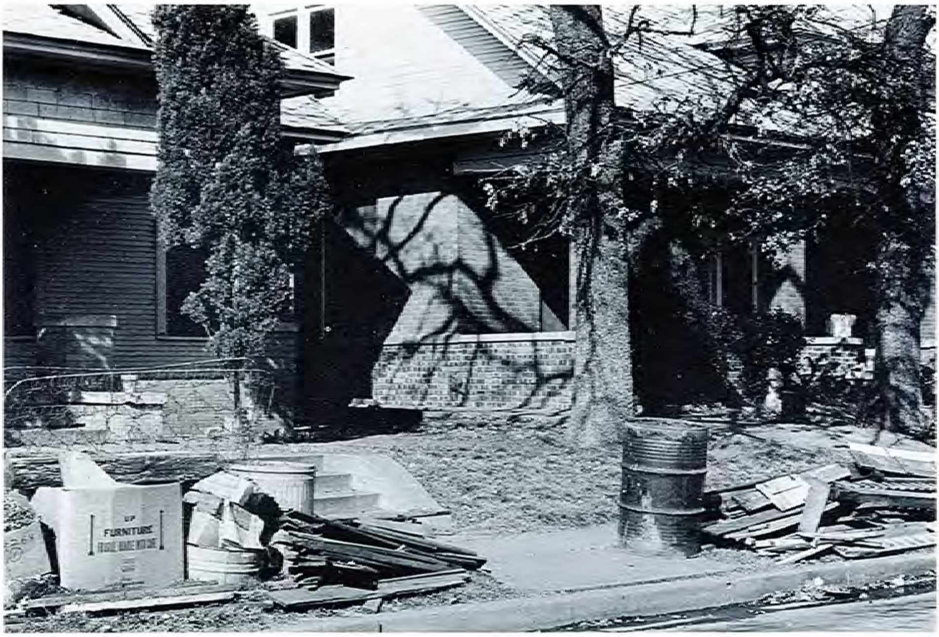
To care for needed water containers in a way that prevents aedes aegypti breeding.

Special community-sponsored cleanup campaigns are desirable. They may be limited to portions of a city with particularly heavy breeding, or they may be conducted city-wide. These cleanup activities are carried on by existing official and voluntary agencies of the community, working cooperatively with the program's area offices. Thus, improvements need not be restricted to elimination of Aedes aegypti breeding containers, but can also include the removal of breeding and feeding accommodations of other mosquitoes and of rodents and flies, as well as improved esthetic considerations in portions of the community where such values are often neglected.

Children collecting junk and placing it at the curb for pick-up.

Community-owned equipment and personnel removing junk.

Citizens participating in the clean-up drive.



Voluntary clean-up in a residential neighborhood.

A commercial premises participates in the community clean-up.

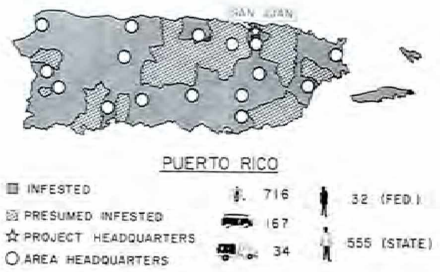
Citizens demonstrate care of the bird bath and container removal.

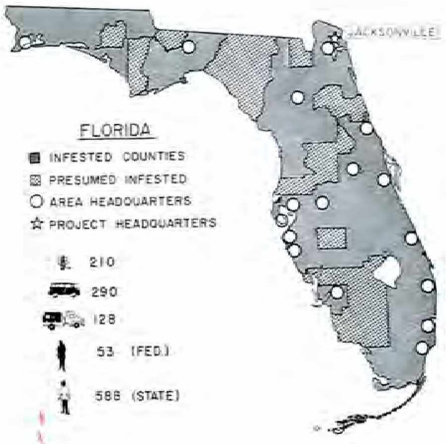
Boy scouts gather up junk on a vacant lot.

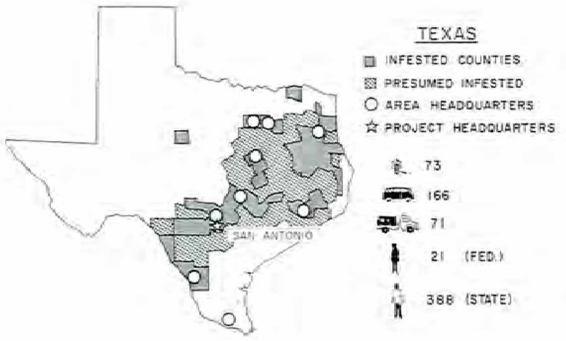
Six months after activation of the Aedes aegypti Eradication Program in the United States, a nucleus staff had been formed to initiate operations. Work was begun in four projects: Puerto Rico, the Virgin Islands, Florida, and Texas. In 1965 the program was extended to Hawaii, where three islands are known to be infested. At the present time (February 1966), operations are being extended to many new areas in Florida and Texas, and into Alabama, Georgia, and South Carolina. In subsequent years, there will be further program expansion until Aedes aegypti has been eradicated from all territory under United States responsibility.

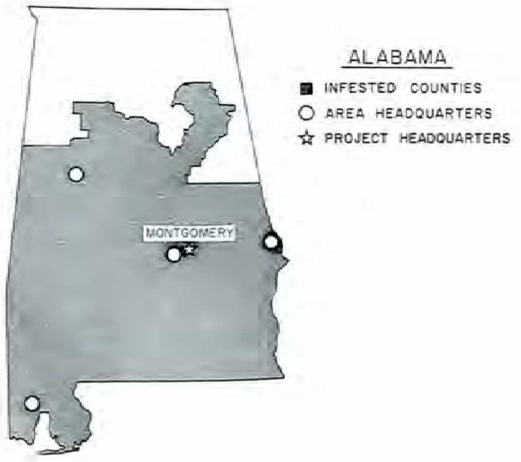
By the end of 1965 (see accompanying maps), 45 operational area offices had been set up in the four original projects. These projects had 1,587 State employees and 108 Federal employees working full time toward eradication. Equipment utilized included 1,064 hand sprayers, 241 power sprayers mounted on trucks, and 643 other vehicles.

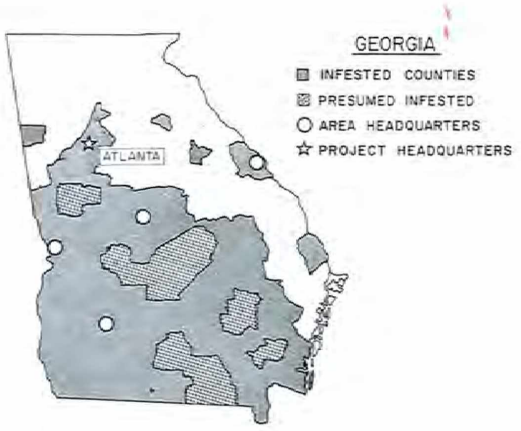
Although the major eradication effort through 1965 was centered in the four initial projects, activities of a less concerted type were carried on elsewhere. Early in the program rapid surveys were made throughout the infested region to indicate the extent of Aedes aegypti dispersion and to delimit more precisely the major areas of infestation. (See map page 3.) Also, mobile treatment operations were carried on in the areas where infestations appeared to be light or scattered. While close surveillance will be kept in these areas, it is not anticipated that a large force of people will be required until verification of eradication is necessary.

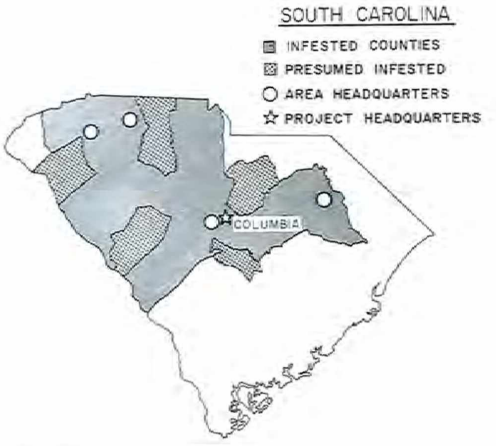












Area offices have been set up to begin operations in 1966 in Alabama, Georgia, and South Carolina.

During the first two years of operations many problems have come to light. For example:

The distribution of Aedes aegypti is much more widespread than originally anticipated. In some States the species is firmly established in most of the municipalities and surrounding rural areas.

Containers with unhatched eggs, particularly vehicle tires and jars of water containing plant cuttings, are continually being moved from place to place. This permits the introduction or reintroduction of the species into clean areas.

In a few mainland localities and in Puerto Rico and the Virgin Islands, Aedes aegypti shows resistance to DDT, the insecticide generally used in the program. This problem is being solved by the use of malathion, one of the organic phosphorus compounds. Other insecticides are presently being tested for possible use should they be needed later on. Methods to detect insecticide resistance are being refined and incorporated into all programs.

In some Program areas, Aedes aegypti breeds readily in natural containers such as tree holes and water-holding plants. To find these breeding sites and to treat them without damage to the plants requires the use of special equipment and methods.

The plan for program operations includes continuing research, both in the laboratory and in the field. Research activities now in progress include:

Testing the dispersal of insecticides by aircraft

The use of fogging machines to dispense insecticides against adult Aedes aegypti as a supplement to larviciding

The development of a safe insecticide for use in stored drinking water

Development of sensitive detection devices, such as the oviposition trap, which is particularly attractive for the Aedes aegypti females and thus gives an indication of the presence of the species

Aedes aegypti, carrier of one of man's most feared diseases, is marked for eradication from the Western Hemisphere. The largest remaining infestation—in the United States—is now under attack.