

Field operations for eradication of Aedes aegypti from the United States were begun in 1964 and expanded in 1965. Significant reductions have been achieved. Research for the development of new or improved methods is being continued. The results indicate the feasibility of eradication.

AEDES AEGYPTI ERADICATION PROGRAM OF THE UNITED STATES—PROGRESS REPORT 1965

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FIELD operations for the eradication of *Aedes aegypti* in the United States, Hawaii, Puerto Rico, and the Virgin Islands were begun in June, 1964, as an outgrowth of the collaborative effort by nations of the Americas to eradicate urban yellow fever from the Western Hemisphere. When the operations were initiated, this vector of urban yellow fever and dengue had been eradicated from all mainland countries of the Western Hemisphere between the United States and Cape Horn except Venezuela, Colombia, and French Guiana¹ where activities are still in progress.

In accordance with international quarantine regulations, that portion of the United States from South Carolina to Texas, including Puerto Rico and the Virgin Islands, was designated in 1960 by the World Health Organization as the country's yellow fever receptive area (Figure 1). This area was so designated because of the prevalence of *Aedes aegypti* and in essence establishes the geographic limits of the eradication program. Hawaii, with limited infestations on three islands, was also included in the plan of operations because of increasing prevalence of hemorrhagic fever in the Western Pacific.

Ecologically, *Aedes aegypti* is a semi-tropical mosquito characterized in the

United States as an urban or domestic mosquito with human preferential biting habits, and having a limited flight range. In proximity to human habitations, eggs are deposited slightly above the water surface on the sides of artificial containers holding clear or unpolluted water with little organic content. Eggs may hatch within a few days or, under certain conditions, can remain viable for several months. Prolonged freezing destroys the egg, thus establishing the areas of continuous infestations in the United States. Preferred breeding sites are discarded automobile tires, automobile bodies, refrigerators; tin cans; buckets; jars; flower pots; and containers used for storage of potable water in areas lacking community water supplies. *Aedes aegypti* larvae are also occasionally found in tree holes and in the axils of leaves of traveler's palms and air plants or bromeliads.

Procedures in United States

The operational plan evolved from procedures utilized by countries of the Americas who had successfully achieved eradication, and from methods developed during the conduct of a pilot eradication project in Pensacola, Fla.² In those countries of the Americas where community water supplies are minimal or

nonexistent, eradication was accomplished ostensibly through control of interior household breeding occurring in containers used for collection and storage of water. In contrast, and as noted above, breeding habitats in the United States occur primarily outside the dwelling units and mainly in the litter accumulated by an affluent society that has failed to develop or apply procedures for sanitary storage, collection, and disposal of household and municipal refuse. Because of these differences, the United States program is being conducted as a generalized community vector control and sanitation program in cooperation with state and local departments of health, in contrast to categorized programs conducted by the central government in Central and South America. The evolved plan of operations consists briefly of: (1) entomological inspection to determine the prevalence of infestations in an area, (2) insecticidal spraying of *Aedes aegypti* larval breeding sites and of selected adult resting places,

(3) community environmental sanitation or source reduction activities to free the human environment of water-holding containers, and (4) periodic re-inspection and application of remedial measures until eradication is achieved.

The procedures are designed to achieve the maximum cooperation and utilization of existing local resources for attainment of the eradication objective, and concurrently to assist in obtaining improvement of premises and community sanitation deficiencies and alleviation of problems associated with the promiscuous dumping of refuse on premises, vacant lots, and along public roadways. To achieve this relationship and cooperation, the operations are being conducted under contractual arrangements with the departments of health of the states lying within the infested area. Under this arrangement, the Public Health Service develops and provides operational guidelines and evaluation criteria; furnishes virtually all major items of supplies and equipment;

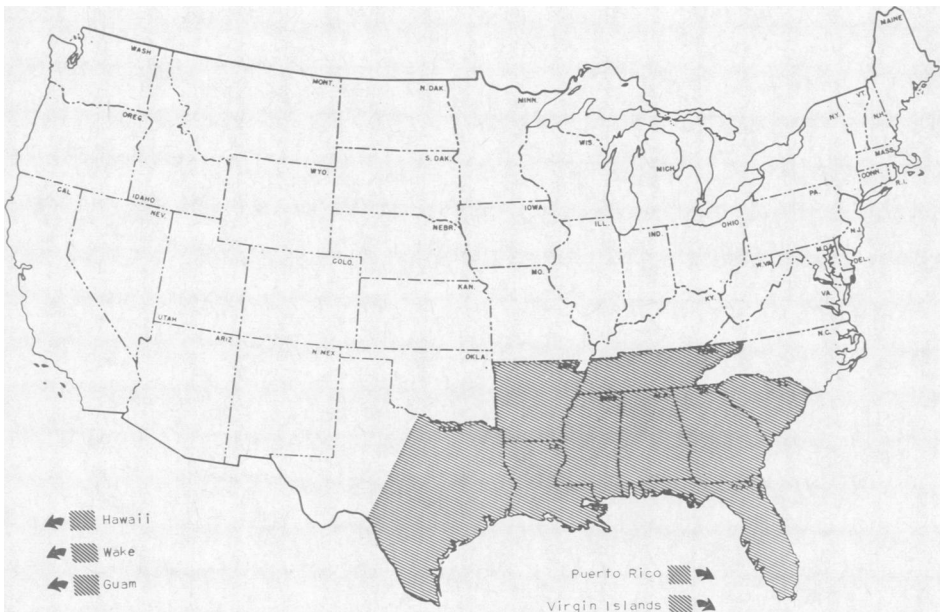


Figure 1—Yellow fever receptive area in the United States, revised September, 1960.

assigns technical staff to state and local areas; trains personnel; develops public informational materials; and conducts investigations for evaluating and improving eradication technics. The states assign a senior staff member who arranges for office and warehousing facilities; develops and reviews operational plans to assure that the eradication effort is being conducted in conformity with state policies; establishes and maintains liaison with other state and local governmental agencies for attainment of their maximum cooperation and participation in the eradication program; and employs the labor force and ancillary personnel required in operations. Aside from these contributions by the cooperating agencies, the program is totally financed by the federal government.

The initial plan provided for the initiation of concurrent state programs throughout the infested area, with field operations in all major urban areas. Limited funds precluded such extensive activities, and in the spring of 1964 field operations were begun in the Virgin Islands, in ten selected urban portions of Puerto Rico, in seven southern counties in Florida, and in four counties in southern Texas. Considerations prompting selection of these areas were knowledge of their heavy infestation, continuous breeding throughout the year, or their high potential for infesting neighboring countries. Operations were expanded in the late summer of 1965 to include coverage of virtually all heavily infested areas in Puerto Rico, Florida, and Texas, and a contract was negotiated with Hawaii. Preliminary negotiations are currently under way which will permit expansion of activities into heavily infested counties of Alabama, Georgia, and South Carolina. Operations are currently being conducted by approximately 160 federal and 1,200 state contract employees.

The usual pattern of operations, fol-

lowing a public information campaign and recruitment and training of personnel, consists of premises inspections and insecticidal treatment of all existing and potential breeding containers and adjacent adult resting habitats within a one-block radius of observed infestations. DDT, because of its long residual action and economy, is the insecticide of choice on the mainland where the mosquito species is susceptible. Malathion is utilized in Puerto Rico and the Virgin Islands where the species is resistant to the chlorinated hydrocarbons. Both insecticides were initially applied as a 2.5 per cent water emulsion. The concentration of DDT was reduced to 1.25 per cent following field investigations that confirmed its effectiveness. Reinspections and any required insecticidal treatments of areas are conducted on a three-month cycle where DDT is used and on a one-month cycle where malathion is used. Major used-tire lots and other primary foci are inspected and treated monthly. Extensive efforts are made to involve the community in extensive community premises sanitation activities following initial knock-down of heavy infestations.

Progress of work in the operational areas has been hampered by technical considerations and logistical problems associated with the procurement of equipment and recruitment of personnel. Pre-program survey data implied that rural infestations were confined to a relatively limited geographical area, and that primary problems of infestations were associated with lower socio-economic areas of urban communities—areas generally characterized by poor housing and accumulations of refuse on premises and vacant lots.

Results

Operational results in problem areas have disclosed in excess of 80 per cent of the premises infested in Puerto Rico and the Virgin Islands, and 70 per cent

block-infestation rates on the mainland. Rural infestations have also proved to be much heavier and more widespread than previously anticipated. Used automobile tires represent the most frequent source of larval development and reinfestations have been associated with intra- and interstate commerce of used tires. To add to the complexity of the problem, larvae have also been recovered with considerable frequency in tree holes and bromeliads and, contrary to common belief, at distances in excess of three-eighths of a mile from human habitations.

Significant reductions in infestations have been achieved in all operational areas, and portions of many areas appear to be free of infestations. No positives have been found on successive inspections in Coamo, Puerto Rico and several counties along the United States-Mexico border. The cities of Key West, St. Petersburg, and Bradenton, Fla., and the island of St. John in the Virgin Islands, and Vieques off the coast of Puerto Rico are rapidly approaching negativity. These results are highly encouraging and tend to confirm the validity of the operational procedures. In addition, results have demonstrated the mutual benefits that can accrue by coordinating the eradication effort with local vector control and community sanitation programs. Premises sanitation has been improved, concerted efforts have been made by several public works departments to collect and dispose of accumulations of community refuse and litter, and local ordinances permitting pick-up and disposal of abandoned automobiles have been passed. The net effect of such cooperative activity in premises sanitation lies not only in the elimination of many conditions contributing to persistent infestation, rodent-harborage, and presence of other vectors, but also in improvement of the environmental health and esthetic appearance of communities.

During the past two summers, surveys were conducted in 5,257 communities in 639 counties in ten southeastern states to provide more precise information on the scope of the problem. The surveys reaffirmed extensiveness of rural and urban infestations as disclosed by the operational programs and revealed widespread infestations throughout Florida; southern Alabama and Georgia; and portions of Mississippi, South Carolina, and Texas. In contrast Louisiana, Arkansas, Tennessee, and western Mississippi were characterized by scattered areas of infestations. The six known positive cities in these latter states (Alexandria, La.; Vicksburg, Miss.; El Dorado and Texarkana, Ark.; and Chattanooga and Memphis, Tenn.) were subjected to reinspections and insecticidal treatments by mobile crews. Surveillance data would suggest that, with the exception of the Tennessee communities having large used-tire reprocessing centers, which are subject to continuous reinfestations, the area of the Mississippi River Valley comprising Arkansas, Louisiana, Tennessee, and western Mississippi is free of *Aedes aegypti* or, if the species is present, infestations are nominal (Figure 2). While similar conditions were observed in portions of Texas, Mississippi, Alabama, South Carolina, and Georgia, no conclusive hypothesis for the apparent lack of infestations in the Mississippi Valley has been advanced. It should be noted that limited infestations have been found in North Carolina but these may prove to be of a transitory nature.

As essential supportive elements in the operation, laboratory and field research represents a continuing aspect of the program. Field collections of *Aedes aegypti* are obtained at periodic intervals and tested to determine any change in susceptibility to insecticides. In a collaborative study undertaken to evaluate the hazard to wildlife resulting from the use of pesticides on this program,

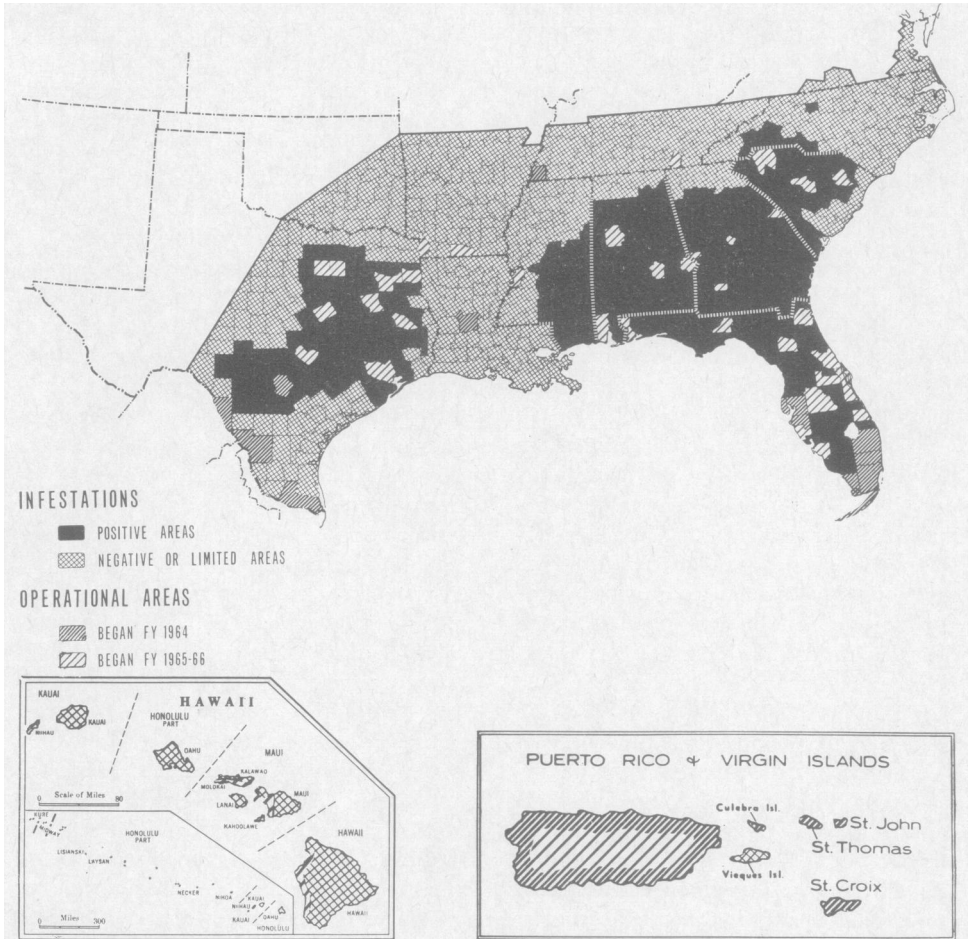


Figure 2—Status of *Aedes aegypti* eradication program, FY 1966.

it was found that no significant damage has been induced in the populations of birds in the treated areas of south Florida. Studies are in progress to develop more effective and economical procedures and include evaluations of alternate insecticides, chemosterilants, and various types of dispersal equipment. Plans are being finalized for an extensive field trial for the larvicidal treatment of potable water stored in containers in areas not served by community water supplies. In addition studies are continuing for the development or

improvement of oviposition and adult traps for detection of the mosquito in areas of low infestations.

Conclusion

Field operations for the eradication of *Aedes aegypti* from the United States were begun in 26 locations in 1964 and were greatly expanded in 1965. Significant reductions have been achieved, with a few areas rapidly approaching negativity. In infested areas, the mosquito breeding has been found to be more abundant and more widely dis-

tributed throughout both urban and rural areas than was anticipated. An analysis of field operations and surveys conducted throughout the yellow fever receptive area has permitted a more precise definition of the scope of the problem and has more clearly defined the technical and logistical complexities of the operations. The surveys throughout the Mississippi River Basin, supplemented by limited field operations, indicate that a large geographical segment of the yellow fever receptive area is either free of infestations or that the mosquito is present in exceedingly small numbers. Research for the development of new or improved methodology is being continued and field programs will be under way in all

heavily infested states by the end of FY 1966. Despite technical and logistical problems which have tended to delay the anticipated rate of progress, the results clearly indicate the feasibility of eradication. With continued budgetary support, eradication will be accomplished, the threat of yellow fever eliminated, and concurrent environmental improvements affecting some 40,000,000 people will be achieved.

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