



*executive committee of  
the directing council*

PAN AMERICAN  
HEALTH  
ORGANIZATION

*working party of  
the regional committee*

WORLD  
HEALTH  
ORGANIZATION



78th Meeting  
Washington, D.C.  
June 1977

Provisional Agenda Item 23

CE78/17 (Eng.)  
2 May 1977  
ORIGINAL: ENGLISH

PROPOSED PAHO POLICY FOR DENGUE, YELLOW FEVER, AND AEDES AEGYPTI

I. BACKGROUND

The present policy concerning Aedes aegypti was mandated to the Organization in 1947 by the Directing Council, as follows:

"To entrust to the Pan American Sanitary Bureau the solution of the continental problem of urban yellow fever, based fundamentally on the eradication of Aedes aegypti, without prejudice to other measures that regional circumstances may indicate."

In 1970 a PAHO study group on the prevention of Aedes aegypti-borne diseases recommended that "until such time as eradication may be achieved in the Hemisphere, consideration should be given to other procedures for the control and prevention of aegypti-borne diseases."

The Directing Council at its XXIII Meeting in October 1976 adopted Resolution XXIII, which resolved:

1. To request the Director to entrust the Scientific Advisory Committee with a study of the present Aedes aegypti situation in the Americas and with a review of the present PAHO policy in the light of recent scientific advances in the control of yellow fever and dengue and the reinfestation with Aedes reported by several countries which had previously achieved eradication.
2. To recommend to the Director that he circulate the report and recommendations of the Scientific Advisory Committee to Member Governments for their comments in advance of the XXIV Meeting of the Directing Council in 1976.

3. To ask the Director to prepare for the consideration of the XXV Meeting of the Directing Council an updated policy statement on Aedes aegypti, dengue, and yellow fever, incorporating the comments of the Member Governments and the recommendations of the Scientific Advisory Committee.

## II. RESUME OF THE REPORT OF THE SCIENTIFIC ADVISORY COMMITTEE (March 1976)

The First Meeting of the PAHO Scientific Advisory Committee on Dengue, Yellow Fever and Aedes aegypti was held in Panamá City, Panama from 22 to 26 March 1976. The Committee considered the present epidemiological situation, recent scientific advances in vector control and immunization, and reviewed the existing policy of the Organization on Aedes aegypti eradication. They then examined three alternative policies:

### Alternative I

Abandon eradication and control programs, maintain surveillance for yellow fever and dengue, institute yellow fever vaccination and emergency vector control when necessary.

### Alternative II

Abandon eradication policy and attempt to maintain Hemisphere-wide control of Aedes aegypti at levels sufficiently low to make disease transmission unlikely, maintain disease surveillance and yellow fever vaccination in critical regions.

### Alternative III

Adopt a flexible policy which recognizes subregional differences, continue eradication wherever it has been achieved and extend eradication to new areas wherever possible, utilize vector control, disease surveillance and yellow fever vaccination as required on a subregional basis to provide maximum protection of population.

The Committee reviewed the advantages and disadvantages of the three alternatives and adopted the following supplemental report as the recommendation of the Scientific Advisory Committee in response to operative paragraph 3 of Resolution XXIII of the XXIII Meeting of the Directing Council in 1975:

SUPPLEMENTAL REPORT

Adopted by the PAHO Scientific Advisory Committee on Dengue, Yellow Fever  
and Aedes aegypti

Plenary Session, 26 March 1976

Panama City, Panama

The Scientific Advisory Committee on Dengue, Yellow Fever, and Aedes aegypti, together with temporary advisors from several countries, having prepared the first report of the Committee, wishes to emphasize the following salient points to the PAHO Directing Council.

There is total agreement that eradication of Aedes aegypti is the most effective measure to prevent urban yellow fever and dengue. In addition, eradication is technologically possible provided sufficient financial resources are available, as well as concurrence of all Hemispheric countries. However, since resources are limited and costs are increasing, some nations may not consider eradication as a justifiable program. Therefore, the group favors the adoption of a more flexible policy for the control of the aforementioned diseases.

Such a policy would, on one hand, encourage maintenance and extension of eradication, and on the other hand, would endorse a number of measures which provide protection in the absence of eradication, including vector control, surveillance and vaccination against yellow fever. This policy takes into consideration the recent and significant advances in the technologies of mosquito control and eradication procedures.

For these reasons, the Committee wishes to bring the following to the attention of the Directing Council:

First: PAHO should encourage Member States to endorse a regional policy for the control of Aedes aegypti transmitted dengue and yellow fever which recognizes subregional differences and which utilizes eradication, vector control, disease surveillance and yellow fever vaccination as required, to provide protection of populations against yellow fever and dengue. Those nations or territories which have achieved eradication of A. aegypti should be encouraged to maintain this status, and any other nation or territory which is engaged in, or plans to undertake, eradication should likewise be encouraged and assisted in this endeavor.

Second: PAHO should encourage Member States to increase the vaccination of populations exposed to sylvatic yellow fever. PAHO should assure the availability of high quality YF vaccine to member

nations including provision for rapid increase in vaccine production in the event of a large scale emergency requirement.

- Third: PAHO should promote the necessary steps to be taken to ensure the availability of insecticides and application equipment, ready access to air-spray services, and rapid response to urgent requests for assistance.
- Fourth: PAHO should assist in the development of clinical, field and laboratory training programs which will strengthen coordinated surveillance activities for the recognition of cases of yellow fever, dengue fever and dengue hemorrhagic fever, outbreaks of these diseases, and the introduction of dengue serotypes new to the Region.
- Fifth: PAHO should encourage Member States to enter into such bilateral or multilateral agreements as may be necessary to protect eradicated nations or territories from reinfestation.
- Sixth: A study should be made in depth of the possible means of preventing automobile tires from harboring the A. aegypti and of impeding the unrestricted transport of infested tires, since they are believed to be the main source of reinfestation.

### III. RESPONSES OF THE COUNTRIES TO THE SCIENTIFIC ADVISORY COMMITTEE REPORT

The Report of the Scientific Advisory Committee was circulated to all Member Countries and their response requested. The following is a summary of those received as of 25 March 1977:

There was no reply from eight countries or territories (Argentina, Barbados, Canada, Ecuador, Haiti, Paraguay, French Territories, and Netherlands Antilles).

There was a reply but no comment from two countries (Cuba, Belize).

Eighteen of the countries replying generally favored Alternative III recommended by the Scientific Advisory Committee (Anguilla, Bahamas, Bolivia, Chile, Costa Rica, Colombia, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Surinam, Trinidad and United States of America). The choice of the 18 Member Countries in the subregional areas of the Hemisphere for Alternative III indicated the varying attitudes of these countries to their present Aedes aegypti problem. Each country admitted the serious nature of the problem and the need for constructive action to solve it. The approach to the problem was clearly identified with the epidemiological situation, political climate, and most of all the capacity of each

country in terms of its resources. The vector problem was properly equated by each Member Country in relation to other health priorities before considering the action to be taken under Alternative III. From the general comments of the Member Countries, there is an immediate need for training, financial and technical assistance from the Organization, especially in the less-developed countries in the Hemisphere, for combating Aedes aegypti and protecting the population from yellow fever and dengue.

Responses were received from three countries which differed from any of the alternatives given by the Scientific Advisory Committee:

The Dominican Republic stated that neither yellow fever nor dengue are considered public health problems and therefore the Government has no Aedes aegypti eradication or control program.

Venezuela considers eradication of Aedes aegypti to prevent yellow fever as not justified since urban yellow fever disappeared in Venezuela several years before Aedes aegypti eradication campaigns began on the Continent. Venezuela has a surveillance program for yellow fever based on deaths in monkeys. Whenever these are observed, immediate human vaccination campaigns are instituted in those areas where the population is at risk. This policy of vaccinating human populations is said to produce an immune barrier against the extension of the disease into urban areas.

The Government of Brazil, having suffered two recent reinfestations of Aedes aegypti (1967, Belém, and 1976, Salvador), is absolutely against any modification of the present policy of the Organization for eradication. The countries of the Americas are now subject to the risk of urban yellow fever, or dengue hemorrhagic fever and possibly other arboviruses. Complete protection against these diseases is possible only with eradication of the vector, in the opinion of the Government. To achieve this, the Government of Brazil believes that the Organization should stimulate eradication programs with the following indispensable assistance:

1. All Member Governments should be mutually convinced of the need to assure maximum priority for eradication programs.

2. The Organization should assure full and complete cooperation of those countries and territories still infested in order to execute their programs.

3. The Organization should continue the programs of eradication in order to resolve the problems of reinfestation which are presently being observed in the Hemisphere.

The Brazilian Government observes that, of those countries favoring Alternative III, several are maintaining a national eradication program (Bolivia, Chile, Colombia, Costa Rica, Honduras, Guatemala, Nicaragua, Peru, and Panama). The Authorities consider inappropriate the Scientific Advisory Committee's recommendation of stimulating eradication in some countries while others remain infested with the vector.

Annex



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ON DENGUE, YELLOW FEVER AND AEDES AEGYPTI

GORGAS MEMORIAL LABORATORY, PANAMA CITY, PANAMA

22 - 26 MARCH 1976

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## INTRODUCTION

On behalf of Dr. Hector R. Acuña, Director of the Organization, Dr. Pedro N. Acha, Chief of the Division of Disease Control welcomed the group and gave a brief resume of the background for reorganization of the Committee with its new terms of reference.

The previous Scientific Advisory Committee on Dengue, meeting in Bogotá, Colombia in May 1974 recommended that it be reconstituted to include experts in yellow fever and A. aegypti. Such a new Committee could then advise the Director of the Pan American Health Organization on the entire problem of A. aegypti-borne diseases, their prevention, control and surveillance. Accordingly, the new Committee was appointed by Dr. Acuña during 1975 and given its initial assignment of responsibilities.

At the XXIII Directing Council Meeting, in October 1975, Resolution XXIII was adopted requesting the Director to review the current policies of the Organization on A. aegypti eradication and prepare a preliminary report for the XXV Directing Council. The newly constituted Advisory Committee was charged with this responsibility which became the major agenda item for the First Meeting.

The Committee was welcomed to Panama by Dr. Abraham Saied, Minister of Health of Panama, who reviewed the history and importance of yellow fever in Panama, since 1905. He emphasized the geographic and strategic importance of Panama as a focal point for international travel with the accompanying risks of re-introduction of yellow fever, dengue, and the problem of controlling reinfestations with A. aegypti. He called attention to the need for international cooperation in these endeavours and the pleasure of his Government in hosting this important Meeting.

The full Committee was in attendance for the first Meeting. In addition, temporary advisors were present from Panama, Brazil, Trinidad, Colombia, Venezuela, United States of America and Thailand. The group elected Col. Philip K. Russell as its Chairman who then guided the Committee through the agenda and the plenary sessions which adopted the accompanying report.

## I. CURRENT STATUS OF YELLOW FEVER AND DENGUE

### A. Yellow fever

#### 1. Epidemiological considerations

Sylvatic yellow fever continues to be observed in South American forests, the Amazonian forest being the most important focus of the disease. From these enzootic areas the infection may extend into other forested areas, as it was the case in Central America in the fifties, and on repeated occasions towards central and western Brazil, Paraguay and northern Argentina. The known wave phenomenon of the number of human cases increasing every five or six years continues to be observed.

Urban yellow fever, once common in Aedes aegypti infested cities has not been registered recently. The last outbreaks happened in Rio de Janeiro in 1928, in Bucaramanga in 1923, and in Socorro in 1929. In addition, five cases of urban yellow fever occurred in Trinidad of which one case possibly occurred in Port of Spain during the 1954 outbreak.

Sylvatic yellow fever continues to be a disease of forest workers, and cases are usually sporadic. However, on certain occasions, particularly in colonization areas, if unvaccinated people come in contact with the enzootic viral cycle, outbreaks of the disease occur.

It is believed that the enzootic situation is a complex one, not yet fully understood. Although the monkey-mosquito cycle is the basic component of the enzootic situation, dynamics and movement trends of monkey populations as well as consideration of certain vectors such as Sabethes chloropterus and possibly mammals other than monkeys, such as marsupials, deserve further study. At present, the enzootic situation appears to be composed mainly of a chain of small wandering epidemics in monkey bands, the transmitting vector being species of the genus Haemagogus.

There has been a decrease in the incidence of the reported cases in most countries. The decline seems to result mainly from the increased use of the 17-D vaccine. Nevertheless, it should be kept in mind that many unrecognized infections might occur, especially in the remote areas, due to the lack of surveillance.

Sizeable epidemics, however, have been recorded in the past 10 years in Argentina, Bolivia, Brazil, Colombia, Peru and in Venezuela (Table 1.) These outbreaks have occurred in the Amazon region and outside of it. In countries like Brazil more cases have been diagnosed outside of the Amazon region. Undoubtedly this is due to the low population density in this region.

Although the number of cases proven by histopathology or by virus isolation recorded during these outbreaks is usually small, retrospective epidemiological investigations often suggest that the evidence of infection is much higher. This impression is usually supported by serology. Thus yellow fever complement fixing antibody in high titer was found in 18 (1.4%) out of the 1201 persons living in the area of Goiás State, Brazil, during the 1972-73 epidemic of yellow fever which occurred in that State. This finding suggests that some 21,000 people out of the 1,5 million rural inhabitants of the epidemic area might have been infected. Nevertheless, only 71 cases were laboratory proven, 44 of these by histopathology.

Tropical rain forests where adequate densities of Haemagogus vectors are found and which for long periods of time have not been exposed to yellow fever virus, may harbor large monkey populations, thus becoming receptive areas for the infection. If the virus were introduced there, epizootics and epidemics are likely to occur. At present, there are receptive areas in western Panama and Central America, as well as in southern Brazil.

Haemagogus mosquitoes seem to be the main vectors during these epidemics. Although most infections seem to occur within the forests, it is possible that outside forest transmission might occur. This could have been the case in past outbreaks in Central America, where Haemagogus anastasionis, a good yellow fever vector, can breed in secondary growth forest, as well as in artificial containers. Other mosquitos such as Aedes leucocelaenus and Sabathes species play a role as yellow fever virus vectors.

Surveillance of yellow fever cases should be increased, especially by histopathology of liver section of fatal suspected cases. This should be undertaken particularly in the enzootic areas and in the known epidemic areas. These include areas of central and southern Brazil, eastern sections of Paraguay, the Magdalena river valley of Colombia, Bolivia, Venezuela, Peru and Ecuador.

Also surveillance should be increased in urban centers infested by Aedes aegypti, especially those located near the enzootic and epidemic areas. In addition, yellow fever vaccination should be routinely carried out, primarily in these areas, as well as in the new areas of colonization of the Amazon basin. Priority should also be considered for road workers and other groups of people engaged in forest clearing.

## 2. Current risk of epidemic urban yellow fever

Because yellow fever virus is in certain forests of tropical America and Aedes aegypti occur in some urban regions, the danger of epidemic urban yellow fever persists. On the basis of sylvan human cases reported during the past decade, or on the occurrence of infection in monkeys, and the presence of Aedes aegypti in adjacent urbanized areas, Colombia, Venezuela, Panama,

Trinidad, Surinam and Guyana are at greatest risk of urban yellow fever. In addition, Bolivia, Brazil, Ecuador, Peru and Argentina are at risk, if re-infestation with Aedes aegypti should occur (see map.)

The recent reappearance of dengue virus disease in central Colombia during 1975 and 1976 in regions near sylvan activity of yellow fever virus provides a historically unique opportunity to compare the ecology and epidemiology of yellow fever and dengue viruses in one region. Although current information indicates that yellow fever virus antibodies do not protect against dengue virus disease, it is unknown whether dengue immunity will affect human susceptibility to yellow fever virus infection and disease.

## B. Dengue

### 1. Epidemiological considerations

Epidemics of dengue and dengue-like diseases have recurred at frequent intervals in the Western Hemisphere. In this century, major outbreaks occurred in 1904, 1915, 1922, 1934, 1941, 1949-50, 1953-64, 1968-69, 1971-72 and 1975-1976. Those since 1960 have been limited to the Caribbean region (see Figure 3 and Table 2). Attack rates were high, sometimes exceeding 70 or 80 percent.

Only serotypes 2 and 3 are currently recognized in the Americas. Serotype 2 virus was first isolated in Trinidad in 1952 and serotype 3 was first recovered in Puerto Rico during the 1963-64 epidemic. Both serotypes caused epidemic disease in the Caribbean region during 1968 and serotype 2 predominated in 1969. Sporadic dengue transmission has been detected in Puerto Rico during 1970 through mid 1975. An island-wide epidemic began



in September 1975, during which approximately 1300 cases of dengue-like illness were detected by an intensive surveillance system. Early institution of control measures probably interrupted the epidemic.

In Colombia, where dengue was endemic in the 20th Century until 1952, Aedes aegypti was virtually eliminated between 1952 and 1960 (the city of Cucuta excepted). However, after the country became reinfested with the mosquito in 1969, two serious outbreaks of dengue fever have been observed: one, in the northern region during 1971 and 1972 producing at least 450,000 cases, and, the second, in the Magdalena valley, during 1975 and 1976. The etiologic agent of the former was dengue 2; from the latter two isolates have been identified as dengue 3, other isolates are still under study. Moreover, after the outbreak in northern Colombia, the disease continued to appear there under endemic fashion.

Dengue's high attack rate, associated morbidity and long periods of convalescence lead to suffering, absenteeism, impaired efficiency at work and a burden on health facilities which can result in wasteful health care. The importance of suspected cases of DHF described in Puerto Rico should not be underestimated, nor should the risk of DHF appearing in the Americas under epidemic form. Yet to be fully explored are the possibilities of congenital abnormalities, abortions and recrudescence of underlying diseases. The toll of an outbreak includes both the direct costs of patient treatment and the indirect costs of emergency vector control measures, lower work productivity and decreased tourist revenue. The costs of continuing A. aegypti control must also be taken into account.

In regions where the vector has been eradicated, dengue outbreaks may develop if reinfestation of A. aegypti occurs from other areas.

This can occur with remarkable rapidity (Table 3.) Moreover, the geographic extent of the disease may also increase as reinfestation continues into areas once free from A. aegypti.

## 2. Hemorrhagic manifestations in America

The clinical pictures of dengue with hemorrhagic manifestations described in two adult Puerto Rican cases are not exactly the same as dengue hemorrhagic fever (DHF) observed in southeast Asia. In Asian DHF, the patterns of bleeding are different, gross hematuria and jaundice are not observed, profound ecchymoses and large purpuric spots are unusual, even in cases with marked thrombocytopenia. In addition, massive hemorrhage, if present, usually follows the onset of shock.

Two cases from Puerto Rico in 1975 may represent dengue fever with unusual hemorrhages or atypical DHF with a different pathogenesis from that observed in southeast Asia. However, a third case, a 14 year old male with dengue-like illness, positive tourniquet test, thrombocytopenia ( $88,000/\text{mm}^3$ ) and hemoconcentration (46% to 37% during recovery or about 25% hematocrit increase during illness) fulfill the criteria for diagnosis of DHF (WHO criteria grade II.) Since this is only one case among some 1300 recognized cases and an unknown number of unrecognized cases in Puerto Rico during 1975, caution should be exercised in interpreting the significance of hemoconcentration to rule out dehydration due to other processes than plasma leakage.

## 3. Risk of DHF

There is a risk of DHF in the Americas for the following reasons: the presence of dengue 2 and dengue 3, even in the same country, the growth

of urban populations and their crowding, the high levels of Aedes aegypti infestation, the increasing human traffic between towns and between countries, the proven observation that hemorrhagic manifestations have occurred in Puerto Rico and the possible introduction into the area of dengue 1 and 4 serotypes.

C. Other Arboviruses

In the Americas, the possibility of arboviruses other than those of dengue and yellow fever being transmitted by Aedes aegypti is to be considered, particularly Venezuelan equine encephalitis.

## II. THE AEDFS AEGYPTI ERADICATION PROGRAM

### A. Current Status

The overall picture of the progress made in Aedes aegypti eradication as of early 1976 is as follows: 17 countries or territories have now been freed from Aedes aegypti, 10 of which (with eradication certified by PAHO) are engaged in vigilance activities: Argentina, Aruba, Belize, Bermuda, Bolivia, Bonaire, Brazil, Canal Zone, Cayman Isles, Chile, Costa Rica, Ecuador, Paraguay, Peru, Saba and St. Eustatius, and Uruguay (see Map.) Of the remaining countries and territories 34 are still infested, 20 have active campaigns and 14 are engaged in limited activities or have no eradication program (see Table 4.) The situation existing in the countries still infested is described in detail in Appendix I. Amongst the efforts made in 1975 to provide safeguards against diseases transmitted by A. aegypti, special mention should be made of the decisions of the governments of Jamaica and of Trinidad and Tobago to expand their control activities into organized national eradication programs with effective financial support.

The fact that eradication operations are taking longer than expected to achieve their objective is not due to technical problems, the target Aedes aegypti having remained susceptible to the insecticides now used against them. The standard insecticides and methods employed are at present Abate (for which the common names biothion and temephos have been under consideration) for focal treatment of infested water at 2 ppm, and a 2.5% suspension of fenitrothion (Baytex) or 5% malathion suspension for perifocal treatment of the immediate surroundings on which the mosquitoes rest. Area sprays, applied from the air or from the ground, by the ULV method have been

used in some countries as supplementary measures. Despite a steadily increasing accumulation of outside breeding sites (e.g. tyres, tins, etc.), these operations have always succeeded in bringing the infestation indices down. In the past 2 years eradication has been achieved in the islands of Bonaire, Aruba, Saba, St. Eustatius and Grand Cayman.

That operations have not produced results as fast as expected is in fact due to the working plan having been unrealistically optimistic. Since they did not contain a contingency allowance to guard against inevitable losses or erosion of working time, it usually takes 11 weeks for the crew assigned to a specific area to complete a cycle set for 8 weeks. The net result is that only 4-5 cycles (and sometimes fewer) are completed in a year instead of the expected 6 cycles.

As in any large-scale operation, national programs have often been delayed by certain deficiencies. At the operational level there may be inefficient personnel or inadequate supervision, and at the administrative level the inability of governments (inevitably frequent in an operation of this size) to live up to their commitments with respect to implementation and funding. It is more common for governments to overestimate their ability to fulfill the program in the long run than for the technical problems to have been underestimated at the outset.

The general inflationary trend in personnel and operating costs has severely handicapped programs as they proceed from one year to the next. This trend has been aggravated in recent years by the marked increase in cost and decrease in availability of insecticides and compression sprayers. Such negative influences have resulted in some cases of abandonment of a program previously undertaken in good faith.

At the present time the program against A. aegypti is centered in the countries and territories in the Caribbean area, most of which are participating, with the exception of Antigua, Dominica, Grenada, Haiti, Dominican Republic, St. Kitts-Nevis, Turks and Caicos, Puerto Rico and American Virgin Islands. Important mainland areas which are not participating at the present time are the United States and parts of Venezuela.

The danger of reinfestation resides principally in the export trade (e.g. new and old automobile tyres and steel drums, also heavy machinery) of these mainland countries. Sea and air traffic throughout the Caribbean and with infested areas in the Americas and other regions also constitute a reinfestation risk requiring continuous surveillance.

The newer approaches to A. aegypti control, such as genetic manipulation and the employment of pathogens, are interesting and deserving of support, even though they do not appear to offer any immediate prospect of routine employment. Several genetic control mechanisms have received limited field trials and have not as yet proved to be feasible in reduction of aegypti populations. None of the pathogens of aegypti examined in the laboratory has as yet proceeded to field trial against the species.

Under certain limited conditions Gambusia fish have been employed for A. aegypti control, but the breeding habitats where this is possible, usually constitute only a small fraction of the total larval habitats. Proposals for the employment of the predatory mosquito Toxorhynchites are still in the early developmental stages. Earlier attempts to establish these mosquitoes for Stegomyia control have not been markedly successful and the newer proposal is to release these predators at frequent intervals, as a sort of "living pesticide."

## B. Surveillance of the Vector

As an integral part of eradication operations, to guide the progress of the country program, a wealth of information is obtained. This can be used to serve a wider range of purposes than are at present exploited. The present practice of showing only presence or absence of the vector on maps of the overall program could be supplemented by maps which show either the current degree of infestation (house index) itself, or the categorization of the country with respect to infestation level (e.g. 15%, 2%, etc.)

In addition, the progress of vector population reduction in each country could be displayed, showing each year the current index existing as compared to the initial densities when the program was commenced. The contraction of the geographical extent of the infestation could also be indicated by a comparison of the number of localities infested. This would serve to indicate the present status of dengue and yellow fever transmission in that country, and would also display to governments the extent of the very real progress of the operations that they are funding and performing. The ensemble of the density figures for each country as mapped would give a clear and comprehensive picture of the entire Aedes aegypti program and provide an indication of the hazard of Aedes-borne disease in that part of the world. Categorization of the density levels can lead to tabulation showing concisely the current situation, as compared to that prevailing at the time when each country program was initiated (Table 4.)

A surveillance activity essential in an eradication program is the regular determination of the insecticide susceptibility levels of the vector. Early detection of the development of resistance will permit the timely changing to an effective insecticide, thus conserving the progress achieved. The monitoring service provided by the PAHO insecticide testing unit in El Salvador is useful in this program.

As an aid to general coordination, it would be advisable to deposit the data in the computer-based system, centered at WHO Geneva, of world-wide surveillance of Stegomyia vector of arboviruses. Use may be made of the deposited data at any time on demand, because the system includes a rapid map printout facility. The body of information accumulated by PAHO for Aedes aegypti and related vectors affords a potential for valuable comparison between the situation in the Americas and that in the Old World with respect to the transmission of yellow fever and dengue. The insecticide-susceptibility data will also be deposited with WHO Geneva as part of the world-wide computer survey of resistance. The surveillance and susceptibility data deposited each year into the computer system should be processed in Geneva, as rapidly as possible, and returned as map print-outs for publication in the Dengue and Yellow Fever Newsletter, or other appropriate PAHO publications.

At the stage when plans are being formulated for an eradication or control program, it is essential to know certain ecological and distributional facts about the local Aedes aegypti population, such as the major breeding habitats and unusual breeding habitats. This information can best be obtained with a stratified random sample of the possible ecological situations. Such a survey can be done in a short time with a minimum amount of resources.

For countries which have not undertaken an eradication program, a system of Aedes aegypti surveillance may be instituted similar to that being employed in Puerto Rico. Its objectives are to (i) determine seasonal fluctuations of population indices and to correlate the indices with rainfall, (ii) determine the relative contribution of various container types to A. aegypti breeding, and (iii) correlate larval population indices with



observed dengue virus activity. It is based on a systematic sampling of the incidence of A. aegypti larvae in 100 households in each of a number of strategically selected communities. The results are expressed in terms not only of the house index, but also the container index (percent of container infested); in addition the Dreteau index (number of infested containers per 100 houses or premises) is obtained as a more inclusive measure of the larval infestation level. Periodic measurement of the population density of adults, preferably by means of taking the biting (landing) rate, is especially desirable since it is the best basis on which a correlation with dengue transmission may be investigated.

The results of the two types of survey mentioned in the two above paragraphs may also be deposited in the WHO computer-based facility at Geneva.

Another type of surveillance concerns the vigilance activities in a country once eradication has been achieved. Its purpose is to ensure the detection of reinfestations as soon as they occur, so that appropriate remedial measures can be applied immediately before the infestation has spread. As methods for detection, the exposure of ovitraps is an especially useful adjunct to searches for larvae or adults; ports of entrance into the country especially demand examination. Experience has shown that the first half-year of the reintroduction is critical with respect to the cost and success of the eliminative operation. It is therefore clear that this type of surveillance requires a well organized system, failure to establish such a system has been conducive of serious reinfestations. (see Table 4.)

### C. Training

There is a need for a basic training program followed by refresher training, for the subprofessional personnel to be engaged in eradication programs who are concerned with the application of insecticides, the surveillance activities, and the supervision of field operations. These can be an integral part of the country program itself, or can be arranged to be available in other countries.

Since many of the countries involved in the overall program are relatively small, it often happens that an entomologist, engineer or epidemiologist is called to perform all the three functions mentioned. In these cases a program of professional training would appear necessary to broaden his expertise. Programs in larger countries would call for greater specialization in training.

### III. EMERGENCY VECTOR CONTROL

When urban outbreaks of Aedes aegypti-borne disease occur, immediate suppression of the adult vector population to the lowest possible level is essential. Control of mosquito populations for this purpose must be carried out by the use of space sprays; they may be applied by either aircraft or ground equipment, depending on the size of the area to be treated and resources available with which to do so.

#### A. Thermal Fogs

Formerly the most commonly utilized method of applying space treatment was the use of thermal fogging applying low concentrations of insecticides, usually no more than 5% in an oil carrier. While providing a reasonable degree of immediate knockdown and kill of adult mosquitoes, populations in the treated areas usually recover within a brief period of time. Furthermore, thermal fogging is highly dependent upon satisfactory meteorological conditions. Transporting large quantities of expensive diluents is uneconomical.

#### B. Non-Thermal ULV Sprays

During the last decade the development of highly effective techniques for the application of ultra-low volume (ULV) quantities of insecticide concentrates as non-thermal fogs has greatly altered and improved the ability to achieve effective, rapid and more economic control of adult mosquito populations. The equipment utilized in this technique may be mounted on an aircraft or on a vehicle, carried as a motorized knapsack sprayer or as a hand-carried sprayer. Inasmuch as concentrates as high as 96% technical grade are applied at target dosages ranging from 220 to

to 600 ml/ha, little or no diluent or carrier is required with a concomitant saving on the cost of inactive materials and their transport.

ULV applications of insecticide concentrate can be carried out over entire cities by aircraft, as has been done with malathion, or by vehicle mounted equipment which can treat areas of around 225 ha/day. Operational field trials in Southeast Asia, Africa, and the Americas have shown that rapid reductions of population levels of A. aegypti or related Stegomyia can be achieved by the use of ULV application equipment and suitable insecticides in appropriate formulations. A sequence of several properly timed applications can virtually eliminate the vector for a period of months from the geographical areas covered. Several sequential ULV treatment with fenitrothion insecticide applied to the interior of house may provide more than six months of effective control of A. aegypti populations especially when entire neighborhoods are treated.

The committee was aware that while the environmental impact of ULV applications of malathion over urban areas was very small, care should be taken with the application of other insecticides. Equipment must be carefully adjusted to ensure optimum droplet sizes to avoid spotting of automobiles.

Trials comparing thermal fogs and non-thermal ULV insecticide applications have shown that the latter provides more effective control. Current information clearly indicates that in the immediate future, appropriate insecticides properly applied by ULV, should be used in attempts to stop epidemics of dengue, dengue hemorrhagic fever and yellow fever transmitted by Aedes aegypti, and that the effectiveness of these ULV applications of insecticide on the disease and vector mosquito population be evaluated as conclusively as possible.

#### IV. VACCINATION

##### A. Yellow Fever

Present yellow fever vaccines manufactured according to WHO requirements are safe and effective. They provide long lasting immunity and are essential tools for prevention of VF in a variety of epidemiologic situations. Vaccination under emergency and field conditions raises several problems relating to supplies, delivery systems, vaccine stability and efficacy.

Yellow fever vaccine is produced by a limited number of WHO approved manufactures with only 3 in the Americas. Current annual production is approximately 5 to 7 million doses and available stores are estimated at approximately 5 million doses. If an emergency situation occurred and production would have to be rapidly increased, a limiting factor would be the small quantity of secondary seed-lot at present available. The best present estimate of the additional secondary seed-lot which might be needed is estimated at 4000 ampoules. Furthermore, the increasing cost of the production of vaccines makes it no longer possible for the vaccine producing centers in Rio de Janeiro and Bogota to provide the vaccine free of charge. This may considerably limit the implementation of vaccination programs in countries which cannot afford the resulting additional expense.

An additional factor limiting a vaccination campaign may be the shortage of available operational mechanical injection equipment.

The efficacy of vaccination programs depend on appropriate manufacture, storage, transport and delivery of the vaccine. Variation in one or more of these factors has adversely affected seroconversion rates in vaccinees. Repeated monitoring of vaccine efficacy is a requirement for assuring successful vaccination programs.

Current vaccination programs are limited by the requirement for subcutaneous injection of yellow fever vaccine and by the instability of vaccine potency under tropical field conditions.

The duration of immunity has not yet been fully evaluated; this could greatly influence the design of vaccination campaigns. Immunologic interference by other flaviviruses has been implicated as a factor in reducing vaccine effectiveness. This phenomenon has not been adequately tested in a dengue-immune population.

B. Dengue fever

Research on dengue vaccines is in progress in three U.S. laboratories. Eventual development of a multivalent vaccine utilizing live attenuated dengue viruses appears feasible and offers promise of an alternative method for prevention of dengue at some future time, possibly within 10 years.

## V. DISEASE SURVEILLANCE

### A. Objectives

The committee believes that the following should be the principal objectives of a surveillance system for dengue and yellow fever:

1. Identify and confirm cases of dengue and yellow fever.
2. Recognize outbreaks of dengue and yellow fever, including disease and epizootics in monkeys.
3. Identify dengue serotypes, both autochthonous and imported.
4. Detect cases of dengue hemorrhagic fever.
5. Coordinate disease surveillance activities with vector programs.

In the absence of vector eradication, the committee emphasizes the crucial role of surveillance in providing the first line of defense against epidemics of dengue and yellow fever, and in detecting endemic transmission. Meaningful epidemiologic intelligence is essential to provide a rational basis for control related decisions.

### B. Integration with other programs

Surveillance for dengue and yellow fever should be part of the existing or developing national surveillance systems or organizations. Within these systems it will be necessary to develop the reporting of symptom complexes suggestive of dengue and yellow fever, especially acute febrile illnesses associated with rash, jaundice and/or hemorrhagic manifestations of any type. Special efforts will be required to identify and include in the surveillance system population groups at high risk, e.g. forest workers and persons living in or near areas with known or potential sylvatic yellow fever.

For the optimal effectiveness in reporting, analysis, and useful intervention, surveillance for dengue, yellow fever and Aedes aegypti should be integrated or very closely coordinated at a national level with vector control or eradication programs.

### C. Laboratory support

The value of surveillance depends largely upon the availability and utilization of appropriate laboratory support. Utilization in turn requires a simple and clearly defined system for specimen collection, storage, and transportation within and between countries.

For dengue, laboratory support is needed most in those areas historically at greatest risk of recurrent epidemics and/or endemic persistence of the virus. National laboratories in these areas should, at a minimal level, be capable of routine serologic diagnosis. In selected laboratories, higher levels of competence should be available, in the following ascending order:

- (i) production of HA or CF antigen,
- (ii) mosquito inoculation technique for presumptive virus isolation demonstrated by immunofluorescence.
- (iii) virus identification by complement fixation using antigen from mosquitoes or mice.
- (iv) mice and/or cell culture for virus isolation, and
- (v) cell culture for plaque reduction neutralization test and additional virus identification.

Further confirmation of dengue virus isolates would be provided by the WRAIR, previously designated as the PAHO Central Dengue Reference Laboratory.

### D. Serological Surveillance

Serological surveys are valuable in assessing the transmission and epidemiology of dengue and yellow fever. In addition to specific surveys for these viruses, serum specimens obtained for other purposes from high



risk groups can provide useful information. Serum collected from young children and recent arrivals in high risk areas would be especially valuable. Appropriate specimens from non-human primates and other wild animals, such as marsupials, should also be utilized.

F. Special surveillance for yellow fever and dengue hemorrhagic fever

Post mortem viscerotomy in suspected cases of yellow fever is a valuable diagnostic tool but in many countries viscerotomy services are inactive or do not exist.

Epidemiological surveillance for dengue hemorrhagic fever is hampered by the lack of a clear, clinical definition. To assess the possible emergence of DHF in the Americas, clinical and laboratory observations of suspected cases must be standardized so that they can be compared with the disease as it was observed in Southeast Asia and the Pacific. Routine clinical and laboratory observations should include at least tourniquet tests, search for petechiae, serial platelet counts and hematocrit determinations.

## VI. PREVENTION OF YELLOW FEVER AND DENGUE

### A. Introduction

In the Western Hemisphere the control or eradication of Aedes aegypti is obviously directed toward the protection of human populations, primarily in urbanized areas, against the viruses of yellow fever and dengue. The mosquito may serve as a pest to varying degrees, but this is not in itself usually regarded to be of sufficient importance to warrant a specific control program.

It was therefore in the interests of public health that a PAHO resolution (In Pub. 246, Doc. 3, Oct. 1947) and later supporting resolutions were issued. These made the eradication of Aedes aegypti from the Western Hemisphere a goal of the member nations.

Recent events in the epidemiological status of dengue and yellow fever, striking advances in pest control technology, fiscal constraints and other considerations have prompted PAHO to request a review of present PAHO policy.

The review of the present status of these diseases in the Hemisphere, and the status of eradication programs presented in the preceeding sections of this report have provided a framework on which this committee assessed the present policy; likewise a review of the current advances in mosquito control, immunology and epidemiology have provided additional insight into what recommendations may now be in order concerning the present PAHO policy on Aedes aegypti eradication.

In addition, advances in the state of the art of economic theory and the proper application of benefit cost analysis may permit a more accurate economic assessment than was heretofore possible.

B. Available alternative policies

The 1970 PAHO Study Group on the prevention of Aedes aegypti-borne disease recommended that "until such time as eradication may be achieved in the Hemisphere, consideration should be given to other procedures for control and prevention of aegypti-borne diseases." A cost-benefit analysis was then made on the alternatives of eradication and control and found that eradication was economical under most circumstances. The present policy concerning Aedes aegypti was mandated to the Organization by the 1947 Directing Council as follows:

"To entrust to the Organization the solution of the continental problem of urban yellow fever based fundamentally on the eradication of Aedes aegypti, without prejudice to other methods which may be indicated by regional circumstances."

It is this policy which the present Scientific Advisory Committee has been requested to review.

Therefore, the Committee has considered what are essentially three alternative policies, as follows:

Alternative 1

Abandon eradication and control programs. Maintain surveillance for yellow fever and dengue. Institute yellow fever vaccination and emergency vector control when necessary.

Alternative 2

Abandon eradication policy and attempt to maintain hemisphere-wide control of Aedes aegypti at levels sufficiently low to make disease transmission unlikely. Maintain disease surveillance and yellow fever vaccination in critical regions.

### Alternative 3

Adopt a flexible policy which recognizes subregional differences; continues eradication wherever it has been achieved and extend eradication to new areas wherever possible; utilizes vector control, disease surveillance and yellow fever vaccination as required on a subregional basis to provide maximal protection of population.

#### C. A recommended policy

After careful consideration of the present policy, including social and economic constraints within the Hemisphere and the alternatives listed above, the Scientific Advisory Committee believes that the third alternative offers certain advantages over the present policy and the other alternatives in the allowance for flexibility in approach.

It should also be clearly understood that those member states which have attained eradication or are engaged in a campaign should be supported or those considering undertaking eradication, should be encouraged if they intend to make this decision. Obviously, the ultimate solution to the problems of dengue and urban yellow fever lies in the eradication of Aedes aegypti. Alternative three, while certainly encouraging eradication wherever feasible, takes cognizance of the present situation in the Hemisphere, including economic and social constraints.

The present policy of hemisphere-wide eradication is technologically possible, given sufficient resources and concurrence of all Hemisphere nations. However, resources are limited, and the immense cost to some nations is not considered justifiable.

#### D. Basis for recommended policy

1. As noted earlier in this report, commendable progress has been made in A. aegypti eradication in many areas of the Hemisphere. There remain,

however, a number of member nations which have been unable or unwilling to proceed toward eradication at a satisfactory pace. Some nations have, in fact elected to postpone eradication for the foreseeable future. In some cases they have elected to follow alternative measures even though they face a present threat from yellow fever and/or dengue; in others, the threat of A. aegypti-borne disease appears to be so remote that they have elected to employ their available health resources elsewhere.

The danger of introduction of yellow fever into major A. aegypti infested urban areas of the Hemisphere now free of this disease, and where there are no nearby foci of jungle yellow fever is a theoretical possibility, but appears to be an unlikely event at present. Transport of infected jungle mosquitoes is extremely unlikely, and the enforcement of adequate immunization requirements for travelers to or from infested areas as mandated by international agreements, should offer adequate protection from transport of viremic persons. Furthermore, an effective surveillance system, and the provision of emergency vector control capabilities in areas now free of yellow fever should assure against any major outbreaks of the disease, or their quick suppression, should they occur. The possibility of mass immunization in such urban centers is also an obvious fact to be considered.

Where urban areas are infested with Aedes aegypti near centers of jungle yellow fever transmission, the risk of epidemics is considerably higher. If epidemics erupted in such areas, the most likely sites would be in northern South America. Continuous, adequate vaccination of persons in urban centers near jungle sources of infection will reduce the risk of an urban yellow fever epidemic, as will intensified efforts to bring Aedes aegypti populations below the level necessary to sustain an epidemic. As

noted above, the Committee deems it very unlikely that the yellow fever virus will be transported long distances either by infected mosquitoes, or man, or monkeys.

There are also urban centers where Aedes aegypti has been eradicated near jungle yellow fever foci. Barring re-introduction of the mosquitoes, the risk of urban yellow fever is obviously non-existent.

2. The emergency vector control measures described earlier in this report represent a significant increase in the speed at which A. aegypti population may be brought to very low levels. The availability of this technology, together with a high level of surveillance may serve the interests of many member states and areas for protection against urban yellow fever. However, it is essential that such mosquito control technology be available on a national or regional basis, backed up by adequately trained staff.

Experience has shown that it is possible to suppress A. aegypti populations to an extremely low level, and to maintain this control. Such programs must be directed by well trained professional staff, utilizing the most appropriate measures, applied by the best available technology. The failure of many existing programs may not be due to technical faults or lack of resources, but to administrative problems, and inadequate supervision and training of the staff.

3. Necessarily, and to an increasing degree, allocation of resources in the health field must involve economic, as well as humanitarian considerations. Prevention of yellow fever and dengue is no exception to this situation.

Because of the special individual circumstances of each country, a single hemispheric cost benefit approach to the situation would be erroneous. Each country or region should make its own decision based on its individual epidemiologic, economic, political situation, both as it is, and as to what is feasible for itself in the future, but with due consideration of its international health and trade responsibilities. Whether a country should maintain its position or change should be a considered choice and not occur through default. However, it must be pointed out that all countries have a continuous vector control commitment which with surveillance will continue whatever the future level of disease prevalence and Aedes infestation. The efficacy of these continuing programs is a function not just of money spent but also of departmental efficiency. The maintenance of a low risk situation through the proper use of such programs should be more economic than budgets for recurrent emergencies in addition to the ongoing costs of a less efficient vector control program. The acceptance of a stop-go laissez-faire response to emergencies puts excessive management and economic strains on the health and environment services. It is better to have proper professional staff in charge, modern stock control of the necessary chemicals and equipment, stock-piles of adequate volumes of material to deal with emergencies in the country or shared in the region, and an annual or biannual economic assessment of the situation in parallel with the epidemiologic surveillance.

E. Requirements for protection against yellow fever and dengue

The adoption of a flexible approach to the protection of human populations from yellow fever and dengue would require a strengthening and improvement of some elements of the various existing programs.

1. Disease surveillance

Physicians and public health officials in areas with vector mosquitoes must be alert to the possible occurrence of yellow fever and dengue and be trained to identify cases should they occur. Access to adequate backstop laboratory facilities should be insured.

2. Surveillance of Aedes aegypti populations

It is obvious that those countries which have achieved eradication must maintain a high level of surveillance for the re-introduction of the vector. Even were it possible to eradicate A. aegypti from the Hemisphere, it should be recognized that surveillance against reinfestation from Africa or Asia would have to be maintained indefinitely, at currently unknown expense.

Where populations of A. aegypti still occur in the Hemisphere, it is obviously essential for human protection that as accurate information as possible be maintained on population levels, and on the insecticide susceptibility of such populations.

3. Vaccination for yellow fever should continue to be a major component of the strategy of prevention of yellow fever not only where jungle cycles are identified but also immediately and on a large scale should urban yellow fever be identified in other areas. Vaccination of persons entering or leaving areas of jungle yellow fever should also be carried out in order to reduce the risk of urbanization of yellow fever.

4. Where outbreaks of dengue or yellow fever occur, a quick-response capability must be readily available with which to obtain immediate suppression of Aedes aegypti populations.



5. While it is clear for reasons stated earlier in this report that some member state may not choose to enter upon A. aegypti eradication programs, PAHO should urge and assist member states to organize Aedes aegypti control programs. These may either be part of a regularly organized mosquito abatement program, or a separately organized operation.

While we cannot assess with complete accuracy the level of Aedes aegypti populations below which dengue transmission will not occur, it has been widely held that with a house index below 5% urban yellow fever transmission will not occur and this may be a reasonable target for general purposes.

For the foreseeable future primary reliance will have to be placed on insecticides for A. aegypti control. In all cases the use of pesticides in routine operations should be supplemented and supported by active, vigorous campaigns of sanitation and public education.

The provision of dependable piped water supplies may be very important in many areas in reducing the storage of water, and thus the level of A. aegypti breeding. The elimination of all unneeded containers, and the provision of A. aegypti-proof water holding covers for those which cannot be disposed of, should also reduce vector populations. Community cooperation to achieve this is essential.

The development of resistance to chlorinated hydrocarbon pesticides and the indications of some tolerance to the organophosphates indicates more strongly than ever the need for continuous monitoring of the resistance status of A. aegypti in all areas of the Hemisphere. There do appear, however, to be adequate effective materials still available, although the situation is not one to engender a feeling of complacency.

Most populations of A. aegypti remain reasonably susceptible to organophosphates, and several carbamates and synthetic pyrethroids as adulticides. The more novel insect growth regulators are effective as larvicides. Nevertheless there remains a need to encourage the search for new, improved and environmentally acceptable insecticides by whatever means possible.

In summary, the employment of larvicides, or the use of ULV techniques to obtain adult (and some larval) control offer by far the best prospects for routine Aedes aegypti control at present, supplemented by as much environmental sanitation as possible.

6. Nations or other geographical entities which have achieved Aedes aegypti eradication rightly expect cooperation in maintaining this status. Nations deciding not to eradicate must accept responsibility for minimizing the possibility of exportation of A. aegypti to eradicated areas. Bilateral and multi-lateral arrangements among member states will be needed to achieve such goals. This could include adequate inspection of materials at ports of exit, or their treatment, to assure against the importation or Aedes aegypti into areas free of the mosquito.

Reinfestation of Aedes aegypti into countries where it had previously been eradicated has sometimes been traced to the importation of used tires contaminated with the eggs of this mosquito. There is also a considerable commerce in used tires in tropical countries involving their movement from one part of the country to another. A considerable part of the effort involved in a control or eradication campaign based on larvicides is consumed in locating and treating discarded tires, tire dumps or used tire stores. There are published investigations on ovicidal chemicals to

destroy these eggs. There are also means of destroying old and useless tires in the form of mechanical shredders. These approaches offer the possibility of either preventing these infestations of used tires or of converting them into a form which will not hold water but will still allow the tire to be used for fuel (e.g. for the protection of orchards and other crops on frosty nights).

F. Review and evaluation of policies

Inherent in adoption of a policy of flexible strategy is the need for frequent periodic review both locally and hemisphere-wide. It is not possible on the basis of the present evidence of hemorrhagic dengue in the Caribbean to predict whether or not dengue hemorrhagic fever will become an epidemic problem in the area. Should this happen or should the ecology of the mosquito change, eradication in some areas where Aedes aegypti control and disease surveillance as previously practiced, might become the strategy of choice. In addition, it is anticipated that pest control technology will evolve with consequent marketing of new classes of insecticides. These advances might necessitate a change in basic strategy for Aedes aegypti control or eradication.

R E C O M M E N D A T I O N S

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I. CURRENT STATUS OF YELLOW FEVER AND DENGUE

The Committee recommends that the Organization should:

- a. assist the Government of Colombia to investigate the epidemiological interrelationships of yellow fever and dengue viruses and possible effects on human infection and disease in the Magdalena river valley of central Colombia (where the two viruses now seem to be present in neighboring areas). (1) By assigning and/or training of additional personnel with expertise in dengue virus isolation and identification, (2) assisting in importing laboratory supplies;
- b. assist the Government of Panama in surveillance of forests in eastern Panama for activity of yellow fever virus, and provide emergency aid if required to interrupt progression of jungle yellow fever into Central America;
- c. promote research to determine the relative vector competence of different geographic populations of Aedes aegypti for dengue and yellow fever viruses and to assess the role of this factor in the epidemiology and control of disease.

II. STATUS OF AEDES AEGYPTI ERADICATION PROGRAM

The Committee recommends that the Organization should:

- a. assist Governments to make the initial plan of operations for a national program for Aedes aegypti eradication more realistic by (1) making a greater allowance for contingencies which reduce the output of manpower with respect to the magnitude of the operation, (2) subjecting this plan to periodic review and possible adjustments;
- b. make greater use of the detailed surveillance data obtained in the course of Aedes aegypti programs, especially the house index and the Breteau index, by (1) depositing the data in the computer-based retrieval

system maintained at WHO, Geneva for retrieval and map print-out, (2) communicating the results in printed or map form in appropriate publications, i.e. the Dengue, Yellow Fever Newsletter.

### III. EMERGENCY VECTOR CONTROL

The Committee recommends that the Organization should:

a. encourage and assist countries to (1) stockpile suitable ultra-low volume application equipment and ULV formulations of appropriate insecticides in any area where urban and peri-urban A. aegypti densities are high enough to allow for the possibility of epidemic transmission of disease; (2) to train personnel in maintenance and use of such equipment;

b. assure adequate supplies and equipment by appropriate means, such as stockpiling at centers where they can be quickly airlifted to any site of an outbreak of dengue or yellow fever.

c. ensure that information be readily available to countries on the location of aircraft fitted with ULV application equipment and qualified pilots to fly these planes;

d. assist and encourage member countries to carry out an inventory of the location of ground application equipment particularly ULV, stocks of appropriate insecticides and the availability of trained vector control operators. This information should also be readily available through PAHO to all the countries.

e. assist member countries to assess: (1) the effectiveness of the use of ULV application, (2) the adequacy of the equipment and its operation by trained personnel, (3) the efficiency of operating personnel.

#### IV. VACCINATION AGAINST YELLOW FEVER AND DENGUE

The Committee recommends that the Organization should:

- a. take steps to assure the immediate availability in the Western Hemisphere of 4000 ampoules of secondary seed-lot (meeting the WHO requirements) for increased yellow fever vaccine production to meet a possible emergency in the Americas;
- b. review its role in assuring adequate supplies of yellow fever vaccine to those countries which do not have their own production facilities;
- c. offer assistance to member countries undertaking vaccination programs to monitor populations receiving the yellow fever vaccine to assure detection of reduced immunogenicity, detection of reactogenicity of the vaccine;
- d. keep an inventory of available mechanical vaccination equipment and assure the availability of sufficient injection equipment to meet emergency mass vaccination requirements;
- e. encourage and assist research on the following subjects: (1) alternate yellow fever vaccine delivery methods, e.g., scarification, multiple puncture; (2) improved vaccine stability under tropical conditions; (3) duration of immunity following yellow fever vaccination; (4) effect of naturally acquired dengue immunity on seroconversion following YF vaccination, (5) development of dengue vaccine;
- f. encourage member states to increase the vaccination of populations at risk of sylvatic yellow fever.

#### V. SURVEILLANCE

The Committee recommends that the Organization should:

a. assist countries in strengthening surveillance for dengue and yellow fever by (1) encouraging the reporting of appropriate symptom complexes, (2) raising clinical awareness among physicians and auxiliary workers throughout the health system by suitable training and (3) by strengthening selected laboratory facilities by means of fellowships or consultants;

b. continue to provide manuals, guides, filmstrips and other appropriate educational materials to be used by professionals responsible for clinical diagnosis and care of patients. It should also provide fellowship training in clinical management of DHF when indicated;

c. promote research to assess the usefulness of currently available biopsy instruments or modifications thereof as alternatives to the viscerotome for obtaining sufficient post-mortem liver tissue for the post-mortem histopathological diagnosis of yellow fever;

d. encourage governments to establish or reactivate programs for obtaining post-mortem liver tissue for diagnosis of yellow fever.

e. continue to disseminate information on dengue, yellow fever and Aedes aegypti through the quarterly newsletter. Bearing in mind the new responsibilities of the Committee, the name of the Newsletter should be changed to "Dengue, Yellow Fever Newsletter for the Americas";

f. initiate or extend negotiation with International Air Transport Authorities to assure uninterrupted transportation of diagnostic reagents, specimens, or laboratory supplies which are essential for international surveillance of dengue and yellow fever. Member countries should be encouraged to approach national authorities, both public and private, to assure compliance with any negotiated international agreements.



VI. PROTECTION AGAINST YELLOW FEVER AND DENGUE

The Committee recommends that the Organization should:

a. encourage member states to endorse a regional policy for the control of Aedes aegypti transmitted yellow fever and dengue which recognizes subregional differences, and which utilizes eradication, vector control, disease surveillance, and yellow fever vaccination as required, to provide protection of populations against yellow fever and dengue.

Those nations or territories which have achieved eradication of Aedes aegypti should be encouraged to maintain this status and any other nation or territory which is engaged in or plans to undertake eradication should likewise be encouraged and assisted in this endeavor;

b. encourage member states to enter into such new bi-lateral or multi-lateral agreements as may be necessary to protect eradicated nations or territories from reinfestation;

c. assist member states to develop source reduction through community environmental programs as a method of achieving as low density as possible of this species;

d. arrange for a detailed study of possible solutions to the problem of transport of Aedes aegypti by unmounted tires. The study should accumulate all available information on the subject in the scientific and the commercial fields, and the study should address, not only the technical problem of preventing tires or tire material from harboring Aedes aegypti, but also the administrative problem of regulating the transport of tires from an infested to an uninfested area.

T A B L E S

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Table 1. Reported Cases of Jungle Yellow Fever, 1954-1975

Country or other political unit	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Argentina	-	-	-	-	-	-	-	-	-	-	-	2	51	1	-	-	-	-	-	-	-	-
Bolivia	-	4	6	19	2	1	14	2	-	81	13	19	69	-	27	8	2	8	9	86	12	147
Brazil	9	8	2	10	26	4	1	2	1	-	13	14	167	2	2	4	2	11	12	70	13	1
Colombia	12	22	16	35	21	21	11	9	30	10	10	2	3	5	11	7	7	9	3	16	35	12
Ecuador	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	3
Guatemala	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Guyana	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Honduras	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panama	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Paraguay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-
Peru	26	-	-	3	6	1	6	53	20	49	60	45	9	3	5	28	75	-	7	33	2	1
Surinam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	2	-	-	-
Trinidad and Tobago	18	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Venezuela	29	5	3	6	6	1	2	14	1	1	2	5	5	-	-	-	-	-	22	7	-	-
Total	95	39	28	80	61	30	34	82	52	141	98	87	304	12	47	48	86	28	55	212	75	164

Table 2.

## REPORTED CASES OR SUSPECTED OUTBREAKS OF DENGUE IN THE CARIBBEAN AREA, 1960-1975

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975 <sup>a</sup>
Antigua	-	-	-	-	264	8	-	-	179	...	...	-	-	-	...	...
Barbados	*...	*...	*...	*...	*...	*...	*...	*...	* P	*...	-	-	-	-	-	...
Colombia	*...	*...	*...	*...	*...	*...	*...	*...	*...	*...	*...	P	P	...	...	...
Dominica	...	...	-	2	43	-	...	-	41	-	-	-	-	-	-	-
Dominican Republic	494	821	822	350	407	527	...	...	-	16	-	3	-	-	...	-
French Guiana	...	...	...	...	...	...	...	...	...	...	P	P	...	-	-	...
Grenada	...	...	...	...	...	...	...	...	...	81	15	27	-	...	1	...
Guadeloupe	...	...	...	...	...	...	...	...	...	...	P	...	...	...	-	-
Guatemala	*...	*...	*...	*...	*...	*...	*...	...	...	-	-	-	...	-	-	6
Haiti	-	-	-	-	-	-	-	...	P	-	...	...	3	103	447	28
Jamaica	-	-	-	1578	156	36	6	6	367	545	31	14	4	3	2	1
Martinique	...	...	...	P	...	...	...	...	...	...	P	...	...	...	-	1
Mexico	-	-	1	2	-	-	-	-	1	-	-	2	-	-	...	...
Montserrat	-	-	-	-	-	-	-	...	P	...	...	...	...	...	...	...
Neth. Antilles	*...	*...	*...	* P	*...	*...	*...	*...	...	...	...	...	...	...	...	...
Puerto Rico	-	-	-	25737	2440	93	2	1	-	16665	136	15	85	710	44	1214
St. Kitts-Nevis- Anguilla (B)	-	-	-	-	721	-	-	-	P	-	-	-	-	-	-	...
St. Lucia	...	...	...	...	...	...	...	-	-	...	...	-	-	-	-	...
St. Vincent	-	-	-	-	-	-	-	...	P	-	-	-	-	-	...	...
Turks and Caicos Islands	-	-	-	-	-	-	-	-	...	...	...	...	...	30	P	...
Venezuela (C)	56	-	-	-	18306	4040	7750	1330	383	3917	403	5	25	5	-	-
Virgin Islands (UK)	-	-	-	-	-	-	-	-	-	-	-	2	2	-	...	...

\*Not notifiable

- Quantity zero

... Data not available

P Outbreak or presence of dengue-like illness reported

(a) Provisional or incomplete

(B) Excludes Anguilla 1969-1972

(C) Reporting area

TABLE 3

Reinfestation of Riohacha, Colombia with A. aegypti in 1970-1971  
Results of three entomological surveys covering all houses in the city.

<u>Date</u>	<u>Ratio *</u>	<u>House Index</u>
January 1970	0/3305	0
August 1970	99/3389	2.9
October 1971	1635/3759	43.5

- (\*) Numerator: Number of houses with larvae of A. aegypti.  
Denominator: Number of houses examined.

Table 4.

STATUS OF AEDES AEGYPTI ERADICATION IN COUNTRIES AND TERRITORIES OF THE AMERICAS, JANUARY 1976

Country or Territory	Area in Km <sup>2</sup>			Stage of the campaign	Activities
	Total	Area initially infested	Percentage of total area		
Antigua, Barbuda and Redonda	442	280	63,3	Infested	Attack phase
Argentina	2.779.741	1.000.000	36,0	Eradication completed	Vigilance
Aruba	190	174	91,6	Negative	Consolidation phase
Bahamas	11.405	11.405	100,0	Infested	Attack phase (limited)
Barbados	430	171	39,8	Infested	Attack phase
Belize	22.965	22.965	100,0	Eradication completed	Vigilance
Bermuda	53	53	100,0	Eradication completed	Vigilance
Bolivia	1.098.581	100.000	9,1	Eradication completed	Vigilance (limited)
Bonaire	281	246	87,5	Negative	Consolidation phase
Brazil	8.511.965	5.358.822	63,0	Negative	Consolidation phase and vigilance
Cayman Islands	259	259	100,0	Negative	Consolidation phase
Chile	756.945	100.000	13,2	Eradication completed	Vigilance
Colombia	1.138.338	280.000	24,6	Infested	Attack phase (limited)
Costa Rica	50.700	20.000	39,4	Negative	Consolidation phase and vigilance
Cuba	114.524	100.000	87,3	Infested	Attack phase
Curaçao	472	448	94,9	Infested	Attack phase
Dominica	789	789	100,0	Infested	Attack phase (limited)
Dominican Republic	48.734	42.020	86,2	Infested	None
Ecuador	283.561	69.454	24,5	Eradication completed	Vigilance
El Salvador	21.393	18.675	87,3	Reinfested	Attack phase (limited)
French Guiana	91.000	91.000	100,0	Infested	Attack phase (limited)
Grenada-Grenadines (Carriacou, Petit Martinique and Union)	344	344	100,0	Infested	Campaign interrupted
Guadeloupe (and part of St. Martin)	1.779	1.619	91,0	Infested	Attack phase (limited)
Guatemala	108.889	36.423	33,4	Reinfested	Attack phase
Guyana	214.969	4.662	2,2	Infested	Attack phase
Haiti	27.750	27.750	100,0	Infested	None
Honduras	112.088	69.929	62,4	Reinfested	Attack phase
Jamaica	11.424	11.424	100,0	Infested	Attack phase
Martinique	1.102	1.000	90,7	Infested	Attack phase (limited)
Mexico	1.972.546	1.000.000	50,7	Reinfested	Attack phase and vigilance
Montserrat	103	103	100,0	Infested	Attack phase
Nicaragua	130.000	65.263	50,2	Reinfested	Attack phase and vigilance
Panama	75.650	56.246	74,3	Reinfested	Attack phase and vigilance
Canal Zone	1.432	1.432	100,0	Eradication completed	Vigilance
Paraguay	406.752	200.000	49,2	Eradication completed	Vigilance
Peru	1.285.215	638.000	49,6	Eradication completed	Vigilance
Puerto Rico	8.896	8.896	100,0	Infested	Campaign interrupted
Saba, St. Eustatius	29	29	100,0	Negative	Consolidation phase
St. Kitts, Nevis, Anguilla	396	396	100,0	Infested	Campaign being planned and attack phase
St. Lucia	616	259	42,0	Infested	Attack phase
St. Martin (Netherlands)	60	60	100,0	Infested	Attack phase
St. Vincent	388	332	85,6	Infested	Attack phase
Surinam	142.822	48.000	33,6	Infested	Attack phase
Trinidad and Tobago	5.128	3.108	60,6	Infested	Attack phase and vigilance
Turks and Caicos Islands	430	430	100,0	Infested	Attack phase and vigilance
United States of America	9.359.781	1.536.819	16,4	Infested	Campaign interrupted
Uruguay	186.926	186.926	100,0	Eradication completed	Vigilance
Venezuela	912.050	710.000	77,8	Infested	Attack phase (limited)
Virgin Islands (UK)	153	153	100,0	Infested	Attack phase
Virgin Islands (USA)	344	344	100,0	Infested	Campaign interrupted

(. ) Negative: free from A. aegypti(..) Erradication completed: certified negativity from A. aegypti

TABLE 5

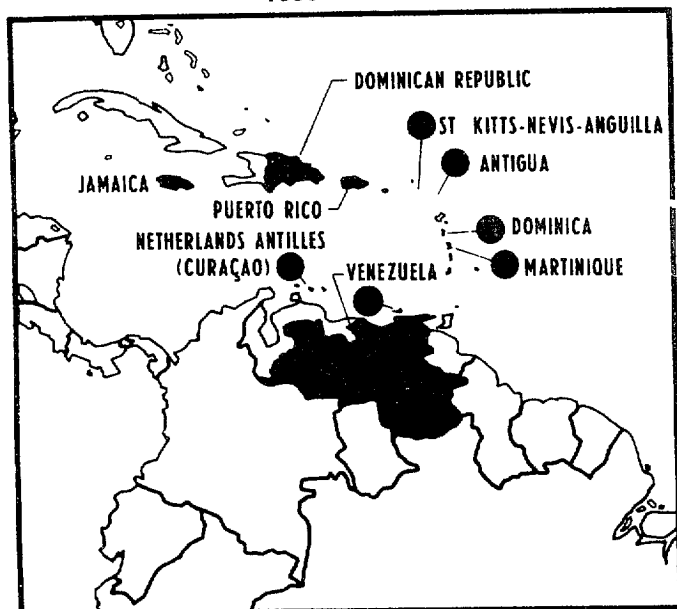
Progress in eradication programs:

Frequency distribution of the 34 presently-infested countries in the Americas with respect to degree of infestation a) at the time of initiation of the country program and b) at the present time.

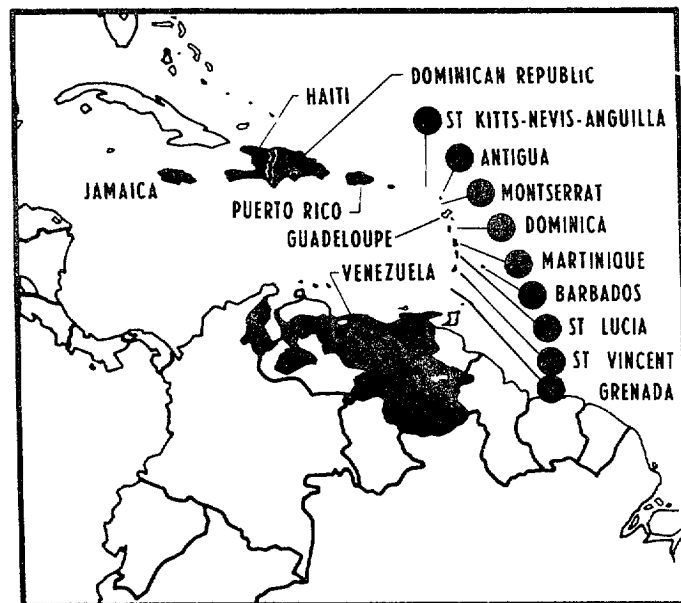
House-Index	Number of Countries	
	Initial	At end of 1975
15% and more	27	10
2 to 15%	7	10
less than 2%	0	14
TOTAL	34	34

**Fig.3**  
**OCCURRENCE OF DENGUE IN THE CARIBBEAN**

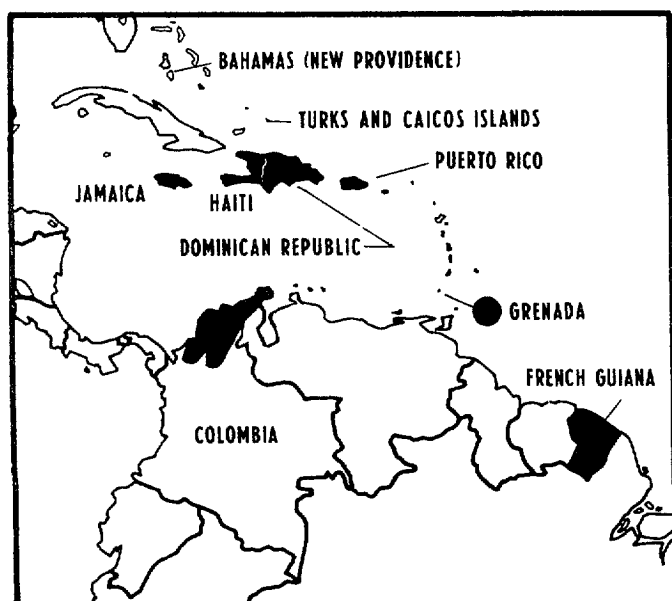
1963-1967



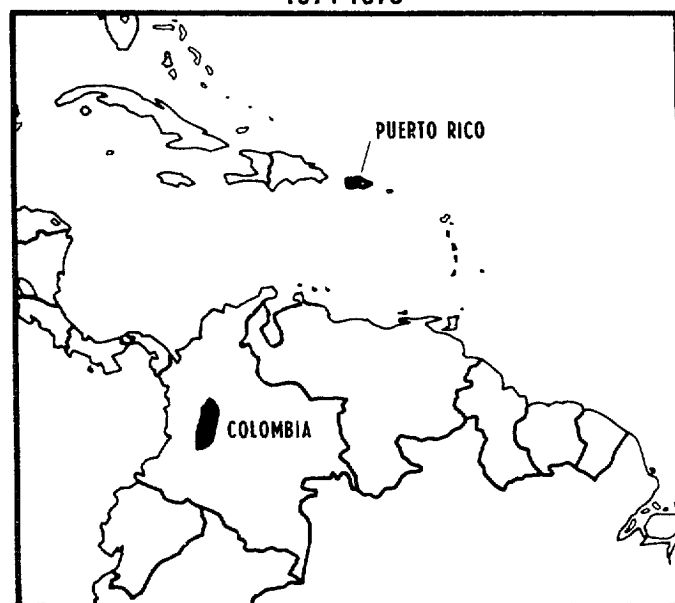
1968-1969



1970-1973

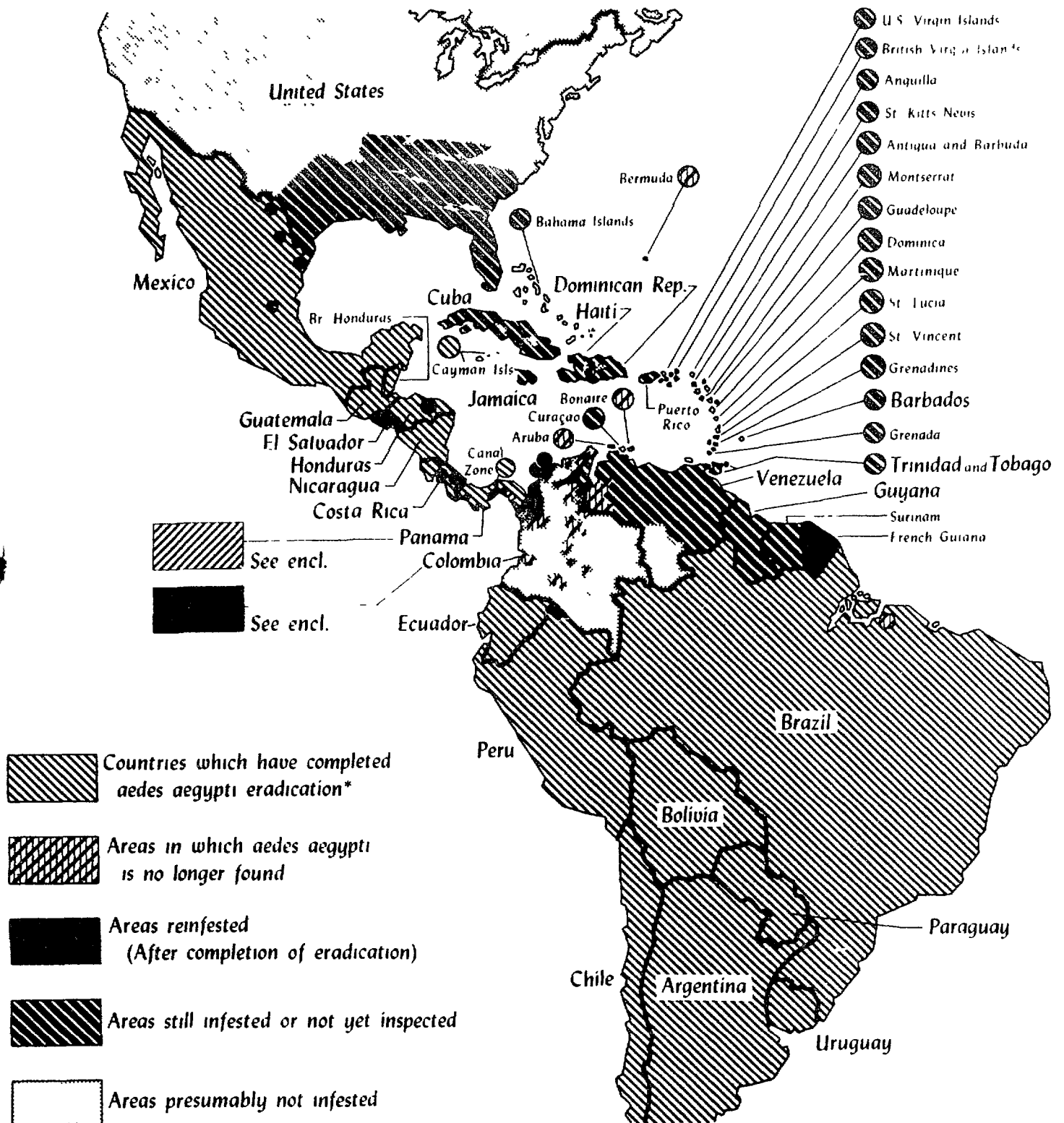


1974-1975





# Status of the *aedes aegypti* eradication campaign in the Americas, December 1975



\* Eradication carried out according to the standards established by the Pan American Health Organization

A P P E N D I X E S

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## APPENDIX I

SITUATION EXISTING IN COUNTRIES STILL INFESTED BY AEDES AEGYPTI, 19761. North America

United States of America, Puerto Rico, and the Virgin Islands (USA).

The campaign has been suspended since 1969. Control activities continue as part of a program of epidemiological surveillance only in Puerto Rico.

Mexico. Some foci of A. aegypti continue along the United States border in the states of Coahuila and Tamaulipas. Limited infestations have also been found in the states of San Luis Potosi, Veracruz and Quintana Roo and it is hoped that these will be eliminated by the surveillance services.

2. Central America

El Salvador. Because of financial limitations the campaign is limited to the city of San Salvador and the international airport at Ilopango with unsatisfactory results.

Guatemala. The campaign made marked progress in 1975 as a result of the efforts put into it. Among the 26 localities in the attack phase, only in the city of Santiago Escuintla were foci of A. aegypti found and these were localized in character with insignificant house indices, the latest reported being 0.01%.

Honduras. The program was continued with some budgetary limitations but, despite this, progress was made and of 323 positive localities treated and verified, 274 were rendered negative (84.8%).

Nicaragua. The program made notable progress by reducing to only two the eight localities found infested in 1973. The campaign received the necessary financing and technical assistance from the Organization.

Panama. Even though the reinfestation of Panama City has not been entirely eliminated, it is under control and has been reduced to minimal levels (house index of 0.17%) after seven treatment cycles and the supplementary application of insecticides at ULV together with environmental sanitation measures. In the course of the entomological survey of the rest of the country three further localities that were found positive have been treated appropriately.

3. South America

Colombia. The ground gained by the campaign since its reorganization in 1972 has, in effect, been lost as a result of problems in the financing of the eradication program and difficulties over the timely purchase of insecticides. The distribution of A. aegypti extends to almost all the areas of the country favoring its ecology and the program did not have sufficient funds to prevent or control an epidemic of dengue that occurred in Alto Magdalena during the second half of 1975. It is hoped that in 1976 the campaign will again receive priority and adequate financing.

Guyana. Operations continue in Area I, including the capital city of Georgetown, and in some 30 other localities. Considerable progress has been made in rendering 15 localities negative and, in 17 other positive localities, keeping the infestation house index below 0.5%. An Operational Plan for 1976 provides for the gradual expansion of the program to cover all infested areas.

French Guiana. Despite the deterioration in the campaign in the last quarter of 1974 and first half of 1975, it has succeeded in reducing infestation indices in Cayenne and its environs from the 10.7% reported in June to 4% in September.

Surinam. Since May of 1974 the program has been limited to coverage of most of the city of Paramaribo with the emphasis on the areas surrounding the four hospitals. The local authorities approved a pilot program for a combination of treatment by the perifocal method and the application of the insecticide fenitrothion at ULV to deal with the problem of the breeding places of Aedes aegypti in storm drains. The Organization is giving substantial support to this project.

Venezuela. The program continues in the west of the country but has made no progress towards eradication.

#### 4. Caribbean Islands

Bahamas. Limited control activities have continued in Nassau (the capital) and five other localities.

Barbados. Has maintained its favorable situation since 1972 with a 0.2% house index. Of the 61 localities in the country, 27 continue to be positive.

Cuba. The program has shown a tendency to recover its momentum since it has obtained new equipment for the application of insecticides at ultra-low volume (ULV), purchased with assistance from the Organization, as well as traditional spraying equipment and the insecticide Abate.

Haiti. Continues to be infested without activities.

Jamaica. After some delay caused by difficulties in obtaining the necessary materials and equipment, the national campaign launched attack operations in one of the regions included in the Plan, while going forward with the preparatory phase in others. This program is the largest one under way in the Caribbean region and its prospects of achieving the goal of A. aegypti eradication within the period set are very favorable. The

Organization awarded fellowships to observe programs in Brazil and Colombia to the Director of the program and to two other officials.

Dominican Republic. Continues to be infested without activities.

Trinidad and Tobago. After a significant increase, A. aegypti infestation has practically taken over the whole country. This situation led to the Government's decision to reorganize the campaign and convert it into an eradication program on a national scale. In the preparation of the operational plan and training of personnel, the Organization has furnished its support through Projects AMRO-0710 and AMRO-0210. A partial entomological survey in Tobago furnished negative results and it is planned to undertake a complete survey in 1976 in order to obtain a clear picture of the situation.

French Territories. The campaigns in Guadeloupe and Martinique continue to cover only part of the infested areas in both islands. In the French part of St. Martin a new campaign with properly trained local personnel began in October last.

Netherlands Territories. In the Dutch part of St. Martin the current campaign has had to face certain administrative difficulties, a shortage of insecticides and a high percentage of closed houses (20%). The infestation (house) index reported for the last cycle is 9.2%.

In Curaçao the Government approved funds to launch the campaign and the Organization has assigned a technical official to this island from where he will furnish technical assistance to the six Netherland Antilles. The campaign has initiated its activities and is training personnel and engaging in limited attack operations in the capital (Willemstad) and its environs, where the infestation (house) index is some 10%. A progressive expansion of the campaign over the forthcoming year is envisaged.

United Kingdom Territories

Antigua. The campaign showed increased regularity in its operations but without making significant progress. The infestation rate is below 5%.

Anguilla. The campaign has failed to progress as expected. The infestation index in the last cycle was 10.6%.

Dominica. As a result of a shortage of funds the campaign was suspended in early 1975 and replaced by limited control activities in selected areas of Roseau.

Grenada. From 1974 onwards the campaign has been experiencing serious financial problems. Organized eradication activities were suspended during 1975.

Turks and Caicos Islands. The Government has approved an appropriation of US \$14 thousand to organize the preparatory phase, which will be initiated in 1976.

Virgin Islands (United Kingdom). After successful attack operations commenced in 1973 and continued during 1974, serious problems were encountered in 1975, resulting in the suspension of operations throughout practically the entire year. It now appears that these problems have been solved and that regular operations will be recommenced.

Montserrat. The infestation of this island has been reduced to only three localities with an infestation (house) index of 0.4%.

St. Kitts and Nevis. Continue to be infested and to have no campaign.

St. Vincent. The results of the campaign have been favorable. The infestation index has fallen to below 2%.

St. Lucia. The campaign has made progress and 21 of the 27 localities in the country have been rendered negative and the infestation index maintained at a very low rate.

5. PARTICIPATION OF THE PAN AMERICAN SANITARY BUREAU

Since the outset of Aedes aegypti eradication programs in the Americas, the Pan American Sanitary Bureau has acted as the coordinating agency providing technical guidance on the execution of attack and surveillance activities to prevent the reintroduction of the vector.

It has also given its support to epidemiological research, the training of personnel and the supply of equipment and materials.

It maintains an Entomological Reference Laboratory, currently located in San Salvador, El Salvador, for research into the susceptibility of the various strains of A. aegypti to insecticides.

Finally the Pan American Sanitary Bureau participates jointly with interested governments in research into new insecticides, equipment and application techniques, seeking increasingly effective means of eradicating Aedes aegypti.