

## The Prospects for *Aedes aegypti* Eradication in Asia in the Light of its Eradication in Brazil

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It is surprising that the view has been put forward that the decision must be against eradication in Asia—that the beginning of eradication in Asia is many years in the future. That would surely be a premature decision. Eradication of *Aedes aegypti* in the Americas began in 1933 and is still far from complete; in the meantime, the programme has paid magnificent returns in reduced operating costs and in freedom for eradicated areas from all threat or urban yellow fever and dengue.

I have visited Asia several times and lived in East Pakistan for a year. I have watched the development of the *A. aegypti* programme—first control, later eradication—in the Americas; on the basis of that experience, I would recommend working towards local eradication from the beginning whenever serious anti-*Aedes aegypti* programmes are undertaken in Asia. Continuing *Aedes aegypti* control is difficult and expensive; in the absence of epidemics, it is not an easy task to get the money to keep this mosquito under control. I have never yet visited an effective old *A. aegypti* control programme. Under the immediate threat of an epidemic, one can get money, men and authority for effective temporary control of *A. aegypti*; long-term maintenance of control is another matter.

In 1923, the Rockefeller Foundation organized a programme in north Brazil for the eradication of yellow fever based on the control of *A. aegypti* breeding. The objective of this campaign was not to eradicate *A. aegypti* but to eradicate yellow fever through the reduction of *A. aegypti* breeding and the maintenance of low *A. aegypti* indices in the principal cities. In the sixth year of uninterrupted *A. aegypti* control measures in Recife, yellow fever appeared within 200 metres of the service headquarters. This was glibly attributed to the carelessness of a single inspector in a limited zone of the city. Inspection of the infected block revealed two *A. aegypti* breeding foci; reinspection by the service

doctors showed two more. Still these were claimed to be exceptions. But a check of 100 houses in 10 widely separated sections of the city revealed an *A. aegypti* breeding index of 26%; the reported breeding index was only 0.8%.

This Recife failure of 1929 contributed to the development of the programme for the eradication of *A. aegypti*, first in Brazil and later in the Americas. In 1930 I came to the Cooperative Yellow Fever Service in Brazil without previous direct experience in *A. aegypti* control. Facing the responsibility of preventing yellow fever, I was determined that the Recife fiasco should not be repeated. A great deal of money was being spent in this campaign, money of the Rockefeller Foundation and money of the Brazilian Government: all we had to show for it was the report on the *A. aegypti* indexes in the cities worked. I was determined that our *A. aegypti* indices should be just as certifiable as our bank statements. When equipment and supplies were purchased, we set up specifications and checked to see that we got what we were paying for; we decided to be equally careful in checking the use of such equipment and supplies!

There was then a deliberate attempt to develop a service with certifiable results. We established careful controls covering many details; working areas were mapped and itineraries were prepared; all work was recorded and checked by supervised supervisors.<sup>2</sup>

We did not plan to eradicate *A. aegypti*. From 1927 to 1929 Dr M. E. Connor, then director of the Service, had tried to eradicate *A. aegypti* in a single small city. The attempt was made in Paraiba (today João Pessoa), a city of 40 000 people. The local director was authorized to use as many men as needed to accomplish eradication. The index came down to a very low level but never to zero. Dr Connor eventually decided that the eradication of *A. aegypti* was impossible; he believed there were such things

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<sup>2</sup> See the papers by S. Camargo on pages 602 and 610 of this issue.

as an irreducible minimum, a law of diminishing returns, and the sanctity of the species, all operating to prevent eradication. We did not challenge this conclusion. We were not thinking of eradication, but only of a system whereby the work of the inspector could be certified. As part of this system, we began to check the larval index by an independent adult-capture index. We also determined to avoid *A. aegypti* breeding in the same foci week after week; a specially disagreeable mixture of fuel oil and kerosene was applied to all containers found breeding mosquitos, the fuel oil to gum up the container and the kerosene to let it spread. This particular mixture was most effective. The container had to be thoroughly cleaned before it could be used again, thus destroying the eggs and larvae and automatically preventing its being a continuing focus.

Itineraries were prepared for each inspector showing where he was to be at a given time in the week. Each block was numbered; this number was shown on the map and was painted on each corner of the block with indications of where to begin, how to proceed, and where to end. Each man carried a flag to be left at the entrance of the house where he was working; it was his responsibility to be found. These are just a few of the points built into the system.

Being fairly well satisfied by the end of 1932 that we were getting results, I went home on leave. When I returned in April 1933, I unexpectedly found that *A. aegypti* had been eradicated from eight or nine cities in north Brazil. I would like to be able to say that we planned this, but we did not. It happened.

Certain pressures now developed. With no *A. aegypti* to be found, none were missed; all inspectors automatically received the bonus for perfect work. This caused a budget problem which was solved by a move which also served to protect the area free of *A. aegypti* from reinfestation. The clean areas were put on a monthly cycle, and the three-fourths of the staff thus released were assigned to clean up the suburbs and surrounding villages. Eventually, eradicated areas were put on a 3-month, a 6-month, and even an annual cycle of checking.

Thus the eradication of *A. aegypti* in Brazil became a progressive development with expansion at the periphery of each clean area. There was no radical increase in the number of employees beyond the number previously required for *A. aegypti* control in the major cities of the country.

Eradication began in Brazil in 1933. In 1934, I proposed the eradication of *A. aegypti* from the

entire country to the staff. Some of our men had been working with *A. aegypti* for 25 years; knowing the problem, they considered the eradication of *A. aegypti* from Brazil at that time to be just as impossible as many consider it from Asia today.

The experience in the Americas shows that eradication must grow. We attempted before 1942 to get eradication programmes started in Paraguay, Bolivia, Peru, Ecuador, Venezuela, and Cuba. Men were chosen, sent to Brazil for training in eradication techniques, and returned to their own countries to begin eradication programmes. The programme was successful only in Bolivia, where the Rockefeller Foundation maintained a staff and directed it; the programmes failed wherever outside support was not given.

The Rockefeller Foundation never sponsored the *A. aegypti* eradication programme. The Foundation had worked on hookworm disease eradication and had not succeeded; it had discovered that yellow fever could not be eradicated; now it was unwilling to undertake *A. aegypti* eradication. "Eradication" was a dirty word in those days. It became respectable with the eradication of *Anopheles gambiae*; when the eradication of *Anopheles gambiae* in Brazil was proposed, the Foundation gave US \$100 000 in 1939 to undertake its control but refused to be committed to its eradication. The success of the *Anopheles gambiae* eradication programme in Brazil made the effort to eradicate *A. aegypti* respectable. There was no publicity on *A. aegypti* eradication until 1941, after *Anopheles gambiae* had been eradicated.

How did international eradication come about? It came through growth within Brazil. In 1946, *A. aegypti* eradication in Brazil had progressed so far that reinfestation from neighbouring countries had become a serious problem. The director of Brazil's Yellow Fever Service proposed the eradication of *A. aegypti* in Paraguay as a defence measure for his country. He proposed that the Rockefeller Foundation negotiate a working agreement with the Paraguayan Government to eradicate *A. aegypti* from that country, that the Foundation pay one-third of the operating expenses, and that the Brazilian Government pay the other two-thirds and furnish the technical staff, supplies, and equipment for the programme. Thus Brazil disclosed that its interest in *A. aegypti* eradication was much broader than its own national territory.

The point was made, however, that Brazil's problem was merely being transferred to another frontier, that between Paraguay and Argentina.

This resulted in the Brazilian Government's proposal in 1947 that the nations of the Americas join in an effort to eradicate *A. aegypti* from the entire Western Hemisphere.

The reaction in the United States of America was a natural one. With a suitable vaccine and DDT, why spend money to eradicate *A. aegypti*? As shown in another paper,<sup>1</sup> the USA did not begin its *A. aegypti* eradication programme until 1964, after Mexico had eradicated *A. aegypti* and then in response to requests made at the PAHO Directing Council in 1961. A resolution was passed at that meeting calling for completion of the job within five years. This type of pressure promises to be an important factor in the eradication of other diseases in the future.

Eradication often begins and spreads to protect free areas rather than to free infested areas. The roots of the eradication of *A. aegypti* in the Americas are in Asia. In 1914, the director of the International Health Division of the then newly created Rockefeller Foundation went around the world to learn how the Foundation could be useful. In India, in Singapore, and elsewhere in Asia, he found fear of the possible importation of yellow fever to Asia through the newly opened Panama Canal. With Gorgas's collaboration, he committed the Foundation to the eradication of yellow fever from the Americas and West Africa—the infected half of the world—to protect the other half of the world.

In 1963, when the US Congress approved financing for *A. aegypti* eradication, the USA accepted a new principle in international health, the principle that a country without a disease or disease vector is entitled to protection from reinfection or reinfestation. Today every eradication programme is a potential world problem. Brazil's eradication of *A. aegypti*, which began in 1933 in a few cities along the coast, has grown into a hemispherical programme; its shadow is already falling on Africa and Asia.

As pointed out in other papers, the Western Hemisphere has had 65 years' cumulative experience in the struggle against *A. aegypti*. Gorgas started in Havana in 1901, Oswaldo Cruz in Rio de Janeiro in 1903. At the time the Rockefeller Foundation began a hemisphere-wide attack on yellow fever in 1918, the Brazilian Government also undertook the national eradication of yellow fever on a similar plan. This effort lasted until 1921 when, with yellow fever apparently conquered, the Yellow Fever Service became a service against rural endemic diseases. Yellow fever reappeared, and in 1923 the Foundation was invited to collaborate in the Government's programme.

The Foundation's effort also failed; during its period of responsibility, yellow fever occurred in Rio de Janeiro. The Brazilian Government again developed its own service under experienced men in Rio de Janeiro and in other cities. In 1929, the Government and the Foundation united in a joint project; at the end of 1931, their services were amalgamated. Thus, three decades of North American and three decades of Brazilian experience were united in the same organization to plan measures against *A. aegypti*. The resultant standards came from this accumulated experience.

One of my first steps, in 1930, was to prepare a manual of operations. It was the basis of uniformity and was indispensable for teaching and administration. The first edition in 1934 represented the best of North American and of Brazilian techniques. In 1938, Sir Malcolm Watson, the pioneer of malaria control in Malaya, requested the Rockefeller Foundation to publish a description of the anti-*A. aegypti* work in Brazil.<sup>2</sup> This volume has the answers, as known in 1940, to many of the problems encountered today in anti-*A. aegypti* work. It gives the picture before residual insecticides were known. The basic things that we learned then, when eradication was done the hard way, are still important today.

<sup>1</sup> See the paper by D. J. Schliessmann on page 604 of this issue.

<sup>2</sup> Soper, F. L., Wilson, D. B., Lima, S. & Sá Antunes, W. (1943) *The organization of permanent nation-wide anti-Aedes aegypti measures in Brazil*, New York, Rockefeller Foundation.