SOME ASPECTS OF MOSQUITO CONTROL ACTIVITIES IN SOUTH AMERICA

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In this brief comment on mosquito control work in South America I shall only be able to touch upon activities in a few countries. There are eight independent republics and five dependencies of European powers in the area, ranging in size from tiny Tobago with 116 sq. miles to huge Brazil which is larger than the continental United States. Conditions vary widely over this vast territory, but all countries except Uruguay lie wholly or partly within the tropics, and all are confronted with the necessity for combating one or more arthropod-borne diseases, of which malaria is the most widespread. Hence nearly all countries which have organized mosquito control campaigns have done so primarily with the idea of malaria control. These campaigns have expanded rapidly within the past six years. The expansion and extension of control programs have been due principally to the availability and efficacy of the residual insecticides.

Most of the countries have very limited financial resources. The amount of money available for mosquito control is therefore relatively small, so that until recently the control programs were largely limited to the use of larvicides and minor drainage, with a small amount of major drainage if there were any funds left over. These campaigns were conducted almost entirely around the more important centers of population, progress was slow, and while results in small areas were good, on the whole the outlook was anything but encouraging.

All this has now been changed. Pessimism has given way to optimism. With the dramatic results being obtained, more money is being appropriated for the programs, and more work is being done. Control programs are being extended to entire countries, and if the present rate of progress is maintained, malaria will soon become a rarity.

The expansion of control programs has been aided by international and by United States governmental agencies. The Pan American Sanitary Bureau, an organization of the American States themselves, is actively supporting a continental *Aedes aegypti* eradication program, and is interested in the control of various arthropod-borne diseases in a number of countries. In addition the World Health Organization, of which the Pan American Sanitary Bureau is the regional office, is directly interested in campaigns in certain countries. An affiliated organization, UNICEF, furnishes residual insecticides to some countries, which would otherwise have difficulty in obtaining them in sufficient quantities. The IIAA, a U. S. Government organization which administers the Point Four program, gives financial aid and expert assistance in various countries. The Rockefeller Foundation, one of whose principal interests used to be in malaria, still gives a small amount of aid to two or three countries.

However, the countries themselves are directing their programs and are doing a good job of it. Over the years they have developed a strong body of administrators and technical men, many of whom are known to members of this Association.

Their task has not been easy. It is perhaps difficult for most of us to visualize their problems, political, geographical, financial and social. In a few instances, politics may dictate the hiring of personnel and the places where campaigns shall be conducted. In most, communications are difficult, roads few or non-existent in the malarious areas, and the centers of population small and often isolated. More serious, perhaps, is the fact that—with a few exceptions—the educational standards

are low, with a high rate of illiteracy, so that not only is it difficult to reach the people by the usual educational methods, but what is worse, it is difficult to find subordinate employees who can accept responsibility and who can understand the importance of the work they are called upon to perform.

The professional classes are well educated, however, and the general principles upon which control work is conducted are the same throughout the hemisphere, thanks to the free exchange of information which we enjoy. This exchange has gone both ways, for each continent has profited by the experience gained in the other.

I shall now take up briefly a few of the accomplishments in mosquito control in three countries, while emphasizing that equally good work is being done elsewhere.

Brazil. Under Doctor Mario Pinotti, Brazil has developed the largest control organization in this hemisphere, covering as it does the entire country with the exception of the State of São Paulo. They work from the vast and difficult Amazonian region in the north to the extensive and difficult forest areas of the State of Santa Catarina in the south.

This latter region is unique. It is the only place in the world outside of a small area in Trinidad, where severe endemic malaria is known to be caused by *Anopheles* breeding in bromeliads. The area covers some 40,000 sq. km., or more than 15,000 sq. miles, in a wide strip along the mountainous coast. Important as an agricultural and industrial region, it is inhabited by almost a million people. Bromeliads are epiphytic plants somewhat similar to and related to the common pineapple. Most species hold water in their leaf bracts, varying in quantity from a teaspoonful to a quart or even more. It is in this water that certain species of mosquitoes breed, among them *Anopheles* of the sub-genus *Kertezia*. The bromeliads may be either terrestrial or arboreal, depending upon the species.

Thus the malaria in the city of Florianopolis, a city of 35,000, was carried by *Kertezias* breeding mainly in ground bromeliads. Hand removal of these plants was begun in 1943 and in 6 years all the 15 million plants had been destroyed over an area of 33 sq. km. Malaria has been wiped out. The cost was close to 7 cents per plant.

This was a fairly simple operation, but the problem in the heavily forested areas just back of the coast is much more difficult. This is mostly virgin rain forest, with the larger trees reaching a height of over 100 feet. The trees bear a heavy population of bromeliads, often with hundreds of plants per tree, or as Pinotti puts it, an average of 5 plants per sq. meter.

There are only two ways to prevent mosquito breeding—either destroy the trees and with them the bromeliads, or destroy the bromeliads only. Neither can be done over the whole area by the Malaria Service, but a good deal is being done to control the malaria. As the region is settled and the resources utilized, the people themselves are cutting down the trees either for lumber, or to clear the land for their farms. The Malaria Service has cut down the forest around the more important cities such as Blumenau, Brusque and Joinville, and the famous baths of Caldas da Emperatriz, and is reforesting with smooth bark trees which are less susceptible to infestation with bromeliads. In other areas, they have carried out the difficult feat of removing the plants by hand, a task which must be seen to be believed. I have seen some of their operators climbing around in the large trees with complete disregard for their safety. Unfortunately, a few serious accidents have happened. These operations have eliminated malaria as a real problem in the principal centers.

The remainder of the population lives in small villages or in isolated rural houses, principally the latter. These houses are regularly sprayed with a residual insecticide, which operation alone has considerably reduced malaria incidence.

The Malaria Service is enlarging its activities to include control of other arthro-

pod-borne diseases, the most important of which is Chagas' disease. This disease is caused by the American trypanosome, *T. cruzi,* and is transmitted by blood-sucking *Triatoma* bugs which live in the house walls, sometimes in incredible numbers. Residual spraying is proving effective. In one campaign in Minas Gerais the Service is spraying some 100,000 houses with parathion.

Naturally, the consumption of insecticides is enormous. Until recently, all supplies were imported, but in 1950 in an effort to become at least partially self-sufficient, the Malaria Institute began the manufacture of gammexane in its own factory. The production goal for 1951 was 600 tons.

Venezuela. The accomplishments of the Malaria Division of the Ministry of Health of Venezuela are well known to most of you. Approximately 90 per cent of the 3 million people living in the malarious zones, which cover some 600,000 sq. km. (over 230,000 sq. mi., or slightly less than the state of Texas) are now protected by regular spraying of their houses with residual insecticides. The area includes the sparsely settled outlying territories, where the job has been really difficult. Trucks, boats, and horses are used for transportation, while a good part of the work must be done on foot. Malaria has been reduced to a very low level throughout the country, and has been wiped out over a large area. The Malaria Division is frankly aiming at malaria eradication.

However, malaria had been eliminated in most cities of over 10,000 population before the advent of DDT, by major drainage, and the Malaria Division continues to spend approximately 25 per cent of its budget on engineering works. One of the reasons, but not the only reason, for continuing permanent measures, is that in the extensive area where *Anopheles albimanus* is the principal vector, the number of *Anopheles* has been reduced little if at all by residual spraying of the houses. On the other hand, the dangerous vector, *A. darlingi,* which is more domestic, is eradicated by residual spraying.

Just as in the case of Brazil, the Malaria Division is being entrusted with additional responsibilities. These include the *Aedes aegypti* eradication campaign, control of rats in urban areas, and fly control as a means of reducing the incidence of gastro-intestinal disturbances. The transfer of other activities to the Division is also being considered.

Tobago. For the past four years a little-publicized campaign for the control and possible eradication of malaria and the responsible species of *Anopheles* has been in progress in the little island of Tobago, with most encouraging results. This work is being done on a very modest budget with funds almost entirely from local revenues.

Tobago lies near and is a ward of Trinidad. It has an area of 116 sq. miles, and a population of 30,000. Most of the island is mountainous, but the western fourth is flat, with several large tidal swamps comprising some hundreds of acres where *Anopheles* breed continuously and abundantly. These and smaller swamps, together with a hundred small streams the mouths of which are silted up by tidal action during the dry season, and thousands of small meadow pools formed during the rains, are the principal breeding places of *A. aquasalis,* the vector species.

With an annual budget of $40,000, or slightly over $1 per person, the Malaria Division of Trinidad and Tobago began its control program in 1948. Each of the 8,000 houses was sprayed with a residual insecticide, on a semi-annual basis. A continuous and intensive anti-larval program was begun, oil being used as a larvicide. These activities continue, but when at the end of the first year *Anopheles* were still being found, it was decided to drain the swamps and open new and protected mouths for the principal streams. By the end of 1951 all except two of the larger swamps had been drained and the rivers were no longer a serious problem.

The results have been dramatic. Malaria has disappeared, land values have

risen enormously, and the island has become a health resort. For almost a year no adult *Anopheles* have been found in the numerous traps or elsewhere, but an occasional larva is still found in the remaining water collections, the swamps and temporary small pools. Dr. Horace Gillette, the Director of the Malaria Division, believes that the species can be eradicated in another two years. Even should he prove too optimistic, the campaign has already more than justified itself.

These are only a few examples of the solid control work being done in South America, and Central America. If time had been available, I should have mentioned also the active and fruitful field and laboratory investigations being carried out in connection with the control activities. However, most of the published reports are abstracted in *Mosquito News* or in other journals.

As one result of the universal use of residual insecticides, the old malaria organizations are being given responsibility for the control of other arthropod-borne diseases, such as yellow fever, filariasis, typhus, plague, trypanosomiasis, bartonellosis, and fly-borne gastro-intestinal diseases. This is a logical step, and one to which I am sure the members of this Association are giving increasing attention.

While the enthusiasm for the residual insecticides is justified in spite of the rapid development of resistance by many species of insects—even including certain species of *Anopheles*—I believe it is significant that the use of "permanent" measures of control has not been abandoned, and in some instances is being increased. I need not go into the arguments for or against the exclusive use of residual insecticides, but I submit that they are to be considered as an additional powerful weapon in the continuing fight against pest insects and insects that transmit diseases to man, and not as the final and complete answer to the complex problem of their control.

FOREST MOSQUITO STUDIES IN AN ENDEMIC YELLOW FEVER AREA IN PANAMA

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Although sylvan yellow fever has been prevalent for many years in several countries in northern South America, particularly in adjacent Colombia, its presence in Panama was not generally known until January, 1949. Reports by Clark (1938) and Kumm and Crawford (1943) called attention to the fact that yellow fever had been active in relatively recent years east of the Canal Zone, but it required the actual recognition of several human deaths caused by yellow fever to cause this disease to be recognized as an important problem in Panama.

Entomologists had been active in the Canal Zone and adjacent Republic of Panama during most of the first half of this century, but they were concerned chiefly with the mosquito vectors of malaria. Thus, little was known of the composition of the mosquito fauna and its activity throughout the extensive forests covering much of the country. Following the recognition, in January 1949, of several deaths caused by sylvan yellow fever in the Pacora area, some twenty miles east of Panama City, the writers undertook a study of the composition and activities of the diurnal forest mosquitoes that relate to the possible vectorship by these insects of sylvan yellow fever in this area. At first,

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