WORLD HEALTH ORGANIZATION

ORGANISATION MONDIALE DE LA SANTÉ

MALARIA CONFERENCE FOR THE WESTERN PACIFIC AND SOUTH EAST ASIA REGIONS

Baguio, P.I., 15-27 November 1954

WHO/Mal/118
Baguio Conf./17
2 December 1954

ORIGINAL: ENGLISH

The Chief of the Malaria Section has the honour to communicate hereunder the following note:

ANOPHELES SUNDAICUS AND ITS CONTROL BY DDT RESIDUAL HOUSE SPRAYING IN INDONESIA

by

H.T. SOEPARMO, Chief Malaria Institute
Ministry of Health, Indonesia
and
R.L. LAIRD, Malaria Adviser,
Division of Public Health, FOA to Indonesia

INTRODUCTION

The archipelago of Indonesia is composed of about 2000 islands extending over 3000 miles from west to east. The total land area is about 735 000 square miles with a total population of about 80 million. Certain parts of Indonesia, for example Java and Madura, are heavily populated, averaging 950-1000 people per square mile. Other large areas such as Sumatra and Kalimantan have a sparse population and thus offer great potentialities for resettlement of people from Java on virgin lands.

Indonesia's economy is predominantly agricultural although there are rich deposits of oil, tin and other minerals. The principal exportable agricultural products are rubber, copra, tea, tobacco and palm oil. Other agricultural products raised principally for internal consumption are rice, cassava, sugar, maize, coffee, yams, peanuts, soy beans, and potatoes.

The indigenous population is made up of about 15 major ethnic and linguistic groups of Malay origin. These people are mostly occupied in smallholder agriculture, general labour and performance of personal services of negligible social utility. In addition there are about 80 000 Europeans, mostly Dutch, and about two and a half million Chinese. The Chinese practically monopolize the internal retail trade, rice and rubber milling, and small industry. They also provide much of the labour for the tin mines of Bangka and Billiton and the tobacco and rubber estates of the east coast of North Sumatra.

Generally speaking, the standard of living is relatively low and there are many public-health problems of which malaria is number one. It has been conservatively estimated that 30 million people are under malaria risk, a great proportion of whom suffer from the disease regularly.

Malaria is endemic in practically all of the inhabited islands of Indonesia and in many areas affects 100 per cent. of the population. The importance of malaria can be shown by its influence on the general mortality rates. In the rural districts of Java the average mortality rate is 20 per 1000 population per year. When endemic malaria is present the rate varies from 20 to 50 per 1000 per year and during epidemics it sometimes reaches 400 per 1000 per year.

There have been approximately 80 species of anophelines identified in Indonesia and at least 15 are proven malaria vectors.

The malarious areas of Indonesia can be divided roughly into coastal areas, rice-growing areas and hill regions up to about 4000 feet. Most of the coastal malaria is transmitted by the brackish water breeding Anopheles sundaicus. There are some areas in Sumatra, however, where A. sundaicus regularly breeds in fresh water. This mosquito is a well known malaria vector. There are many highly endemic areas in Indonesia for which A. sundaicus is entirely responsible for transmission. This mosquito seems to be a true house mosquito, feeds on human blood and is highly susceptible to infection. W. G. Stoker found, for instance, an oocyst index of 39.2 per cent. in East Java. There are also a number of other species of anophelines involved in the transmission of malaria in the interior of the principal islands.

Since the brackish water breeding A. sundaicus is the principal malaria vector in Indonesia, we shall limit our discussion primarily to this species. A. sundaicus breeds mainly in fishponds, lagoons, swamps and marshes along the coastal areas. Because these breeding areas are socially and economically important in Indonesia, we would like to describe them briefly before discussing control methods.

FISHPONDS

There are several types of fishponds in Indonesia such as

1. the ricefield fishponds where the farmers alternate a crop of rice with a crop of fish;

2. permanent fresh-water fishponds, and

3. brackish water fishponds.

Although the first two types are important A. aconitis breeding places, it is the brackish water type that we are most concerned with in this discussion. Since brackish water ponds are formed by a mixture of fresh water and sea water, they naturally will be found along the coastal areas.

The Chanos-chanos or "Bandeng" fish are cultured in these ponds and grow rapidly enough for two crops a year to be produced. Crabs and a few other less important fish are also sometimes harvested from these ponds. The Chanos-chanos are a sea breeding fish, so naturally grow well in brackish water ponds. Because most people like this kind of fish, it is eaten regularly and is an important source of protein in the daily diet. The popularity of the Chanos-chanos is responsible for the extremely widespread culture of this fish. Nearly the whole coast of North Java and a large part of the south coast as well as some coastal areas of other islands are covered with this type of fishpond. Although they are beneficial both economically and from a dietary point of view, these ponds present a hazard as far as malaria is concerned because of the potential breeding of A. sundaicus. There are other factors in this picture of fishpond-sundaicus-malaria. As you know, A. sundaicus thrive best in cultures of certain algae which give them protection for their development. The two kinds of algae preferred by the sundaicus of Indonesia are Chaetomorpha and Heteromorpha. These are green floating algae found almost everywhere, including the fishponds.

LAGOONS

This type of breeding place is most dangerous during the change from the dry to the rainy season and vice-versa. Generally speaking these lagoons are formed at the mouths of streams. During the slack flow of the stream, the sea pushes sand into the river mouth so that fresh water cannot break through this barricade and a lagoon is formed. Usually at high tide some sea water spills over the sand barrier and the mixture of fresh water and salt water creates a brackish water lagoon. Soon green algae begins to grow, producing a suitable breeding place for A. sundaicus. If this happens at the beginning of the dry season and the stream eventually dries up, the salt content of the lagoon, through evaporation, becomes so concentrated that sundaicus breeding is prevented. However, at the beginning of the next rainy season when the fresh water returns to the stream, the salt content of the lagoon is reduced and favourable conditions for breeding are again present. Although there are some large rivers in Indonesia which have sufficient flow to prevent this condition, there are a great many small streams which regularly form lagoons where they empty into the sea. Coastal lagoons therefore are another important source of A. sundaicus.

SWAMPS AND MARSHES

Much of the coastal area of Indonesia is composed of wide flat plains having an elevation at, or only slightly above, sea level and consequently the tide often affects water level some distance inland. Because of the action of the tides, sea water often becomes trapped by sand congestion and other barricades and so forms swamps and marshy areas. These are diluted with fresh water from streams and rain and become brackish. The rise and fall of the tide will prevent these areas from becoming breeding places if a good connexion to the sea can be maintained. In many places the presence of mangrove forests prevents the building of barriers and so maintains outlets for the tide to flow back and forth, thus preventing the establishment of breeding areas. However, when these mangrove trees are cut down, as they sometimes are for the wood or to clear areas for fishponds, breeding places are soon formed and sundaicus makes its appearance.

These are some of the more important A. sundaicus breeding places and since these conditions exist in many areas of Indonesia the control of A. sundaicus is a very complex problem.

CONTROL MEASURES

Malaria control in Indonesia before World War II was directed toward specie sanitation. This was carried out by constructing drains, operation of tide gates, keeping fishponds clean, larviciding, etc. Because of the tremendous expense, this type of control was limited. Only a few of the fishpond owners could afford to pay for the construction and maintenance of such engineering facilities and the government was unable to maintain sufficient supervisory staff to inspect the ponds to see that they were kept clean and the tide gates and drains were in proper working condition. In a small area these methods would work well but in 1952 there were 108 000 hectares of brackish water fishponds in Indonesia so the task of checking alone was formidable.

Mosquito breeding in the lagoons could be prevented by keeping the mouths of the rivers open by constructing a pier or putting a tunnel through the sand barrier or simply keeping the sand dug out of the channel. Again this could be done in the case of a few streams, but in Indonesia there are thousands of rivers and it would be practically impossible to keep them open to the sea.

It is also difficult to maintain the mangrove forests in some areas, especially where communities are growing. The people need additional land for agriculture and fishponds so it is difficult to prevent the cutting of these forests.

The best control, of course, is the establishing and maintaining of a good drainage system and in areas where this has been done malaria control is good. The expense of these measures, however, is prohibitive on a nation-wide scale.

The introduction and world distribution of residual insecticides stimulated a great deal of optimism concerning malaria control in Indonesia. Encouraged by results obtained in other countries, Indonesia began her first trials of malaria control with residual insecticides in 1951. The success of these trials resulted in the adoption of this method of control to a nation-wide malaria control programme.

In the formulation and execution of a national programme Indonesia is receiving aid from two outside sources. The World Health Organization furnishes a malaria control demonstration team which is composed of three technicians and in co-operation with the Malaria Institute is demonstrating malaria control methods to an Indonesian staff. The Foreign Operations Administration is also furnishing three technicians in addition to helping the Indonesian Government with supplies for the execution of the national programme.

The present programme is based mostly on residual house spraying once a year with DDT using a dosage of two grammes per square meter. Generally speaking the results so far have been encouraging. In most areas the transmission indices have dropped significantly after one application of DDT. There is, however, one striking exception to the above, as is shown in Table I.

Table I

RESULTS OF DDT RESIDUAL HOUSE SPRAYING AS INDICATED BY THE TRANSMISSION INDEX*

Area	Before spraying	After 1st spraying	After 2nd spraying	After 3rd spraying	Vector
Banten	16.0	1.6	0.9		Anopheles sundaicus
Tanggerang	3.45	0.0			" "
Tjenghareng	4.9	0.0	1.3		" "
Djakarta (Part)	10.0	3.6			" "
Tandjung Priok	20.4	20.0	18.0		" "
Marunda	18.0	0.0	0.0	0.5	" "
Tjiandjur	17.2	0.2	0.0		" aconitis
Semarang	7.0	0.7			" sundaicus
East Java	18.0	3.0			" "
Metro	20.4	1.5	0.55		" aconitis " nigerrimus
Singkawang	16.6	0.0			" sundaicus
Sulawesi	17.5	3.0			" "
Nusa Tenggara	59.0	48.0			" "

* WHO project not included. This will be covered in a separate report. Other areas not tabulated due to incomplete reports.

Table I shows most of the malaria control activity in Indonesia and as mentioned above in general the results are encouraging not only in the A. sundaicus areas but also in areas of other vectors. In Tandjung Priok, however, the results were disappointing. After two years' spraying the transmission index was not reduced significantly.

Tandjung Priok, the seaport town of Djakarta, is located near this city. It is the largest seaport in Indonesia. The town is made up of a number of kampungs (villages) having a total population of about 70 000. It is spread out over a low flat plain bordering the coast and is a combination of urban and semi-urban areas. As a result of an inadequate drainage system, we have many brackish water areas suitable for breeding A. sundaicus. Many of the people have built private fishponds which further complicate the problem. This type of area is most difficult to spray.

In order to ascertain the reason for failure of DDT spraying to control malaria in this area, it was necessary to study several factors including:

(a) quality of DDT
(b) spraying techniques
(c) resistance of mosquitoes to DDT.

Before shipment the DDT is tested chemically and must meet WHO specifications. Each shipment of DDT on arrival and periodically while in storage is tested biologically and for suspensibility. From these tests and the results obtained in other parts of Indonesia we have concluded that the DDT is good.

It is always possible that an inadequate coverage with DDT spray may cause a failure in control. In an area such as Tandjung Priok where the community is growing there are many instances of so-called "wild occupation". This means that people build houses on available land without licence or authority and in some areas after a section has been sprayed many new houses will be constructed in a very short time. Because of this "wild occupation" and the difficulty of spray squads being informed concerning new construction, many houses do not get sprayed until the next spray occupation. Mr. Stone, sanitary engineer of FOA working in the Government Malaria Institute, investigated this situation and found that the average number of these new houses was approximately 15 per cent. Even though this seems a bit high, we do not believe that this could account for the complete failure of the programme.

Another possibility of failure due to spraying technique might be the fact that up to the present we have sprayed the wall only up to two and a half meters. This procedure was based on some earlier observations which indicated that A. sundaicus did not rest above this height. However, more recent investigations do not confirm this observation. Although we may be flirting with danger, this procedure in other areas has not caused failure and we do not believe that it was responsible in Tandjung Priok.

The third factor, that of DDT resistance in the mosquito, seems to be the most probable cause for the lack of control in this area. Dr. Crandell, FOA entomologist working in the Government Malaria Institute, started biological testing on wild caught mosquitos from the Tandjung Priok area. Table II gives the results of his first test. Many subsequent tests have confirmed the evidence obtained in the figures shown in this table.

Table II

BIOLOGICAL TEST FOR SUSCEPTIBILITY TO DDT AND DIELDRIN

Mosquito	Per cent. mortality					
	Dieldrin 0.625%	DDT 5%		DDT 10%		Control
	24 hrs	24 hrs	48 hrs	24 hrs	48 hrs	48 hrs
Anopheles sundaicus (from Antjol)*	100	0	0	0	0	0
A. sundaicus (from Padamangan)*	100	0	0	0	0	0
Aëdes aegypti	100	95	100	93	93	0
Culex fatigans	100	5	5	6	6	0

In Table II we can readily see that A. sundaicus caught in different parts of Tandjung Priok are resistant to DDT while it remains very susceptible to dieldrin. This resistance to DDT might be explained by the fact that during the revolution

* Kampungs in Tandjung Priok

Djakarta and surrounding area including Tandjung Priok was occupied by the Dutch Army and, during those days (about 1947) the malaria campaign consisted of intensive larvicidal work with DDT. This was also true of Tjirebon, a town about 250 km east of Tandjung Priok on the north coast of Java. Recent investigations by Dr. Crandell have shown a similar resistance to DDT by A. sundaicus in the Tjirebon area. Investigations in other areas have not demonstrated resistance in A. sundaicus or other species of anopheles.

In March of this year dieldrin was substituted for DDT in the programme in Tandjung Priok. The dosage is approximately 0.5 grammes per square meter and the entire walls plus the ceilings are being sprayed. This is being done to eliminate as much as possible the causes for failure and to try to effect control before the mosquito develops resistance to dieldrin. Early results of this campaign are shown in Table III.

Table III

INFANT PARASITE RATES IN THREE VILLAGES SPRAYED WITH DIELDRIN*

Date	No. exam.	No. positive	Per cent. positive
April	111	20	18
June	117	6	5.13
Sept.	161	0	0

INFANT PARASITE RATES IN THREE VILLAGES NOT SPRAYED WITH DIELDRIN**

Date	No. exam.	No. positive	Per cent. positive
Sept.	114	25	22

* These villages were sprayed in March and April 1954.

** These villages had previously been sprayed with DDT.

Although it is too early to draw definite conclusions concerning the success of this operation, we hope that by using dieldrin in the areas where the mosquitos are resistant to DDT we will be able to control malaria. We believe that DDT resistance is limited to certain definite areas and DDT will still be a useful tool in the control of malaria in much of Indonesia.