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RESULTS OF FILARIASIS CONTROL PROGRAMME IN THE FEDERATION OF MALAYA

By Professor A. A. SANDOSHAM,*
Senior Malaria and Filariasis Research Officer,
Institute for Medical Research,
Federation of Malaya.

Filariasis in man in the Federation of Malaya is due to two species — **Wuchereria bancrofti** (Cobbold, 1877) and **Brugia malayi** (Brug, 1927).

Wuchereria Bancrofti

Infection by **W.bancrofti** has long been regarded as rare in Malaya. Small endemic foci of low grade infection have been recorded from Penang and Singapore. More recent work (Polunin 1951, 1953; Wharton, 1960; Laing and Wharton, 1960; Wharton *et al.*, 1963; Warren *et al.*, 1963) has shown that this infection is more widely distributed than was originally suspected, especially in the rural areas affecting the Malays and the aborigines (Fig. 1). The chief vector of **W.bancrofti** in urban Malaya is **Culex pipiens fatigans;** in the rural areas of Pahang Wharton (1960) has shown that it is transmitted by **A.whartoni** while Warren *et al.*, (personal communication) found **A.maculatus** the vector in Pulau Aur, an island some 50 miles off the East Coast of Johore. Wharton found experimentally that **C.p.fatigans** was twenty times more efficient as a vector of the urban than of the rural strains of **W.bancrofti.**

Brugia Malayi

B. malayi is mainly associated with the swamp forests bordering the big rivers as they run into the sea, and the rice fields to the North-west of the Peninsula. It is also widely distributed in scattered areas in the country, including hilly districts, among the Malays and aborigines, though the people here are not infected so heavily. The vectors in the hilly country are not definitely known but it is felt that **Mansonia dives, Anopheles donaldi** and **Aedes chrysolineatus** may be involved in some of the areas. **B.malayi** occurs in two forms, one referred to as the periodic, because the microfilariæ exhibit noctural periodicity, and the other semi or sub-periodic, in which the microfilariæ are found by day as well. This was first noticed by Turner and Edeson (1957). These two forms are transmitted by different vectors.

B.MALAYI; PERIODIC FORM — The periodic form is characteristic of the coastal settled rice fields (Fig. 2) and open swamp country of South Kedah, Province Wellesley, Penang and N. Perak. The houses (Fig. 3) are found on either side of roads running through this area. Filariasis here is transmitted by **Anopheles campestris** Reid, 1962 (formerly known as the dark-winged **A.barbirostris)** and to a lesser extent by **Mansonia uniformis, M.indiana** and **M.annulifera.** This type of terrain has no reservoir of animal infection which could prove a zoonosis.

B.MALAYI; SEMI-PERIODIC FORM — The semi- or sub-periodic form which is characteristic of swamp forest areas (Fig. 4) such as occurs in East Pahang has animal reservoirs of infection particularly the dusky leaf-monkey **Presbytis obscurus** (Fig. 5) which has a natural infection rate of 70 per cent. This type of **B.malayi** is transmitted by various species of **Mansonia** particularly **M.bonneæ, M.dives, M.annulata** and **M.uniformis.** The **Mansonia** larvæ and pupæ obtain their oxygen supply from the submerged portions of water plants (Fig. 6).

Clinical Features in Malaya

W.bancrofti infection in Malaya is not heavy and clinical features attributable to this species are relatively rare. Occasional cases of lymphangitis, hydrocœle and chyluria have been noted in association with microfilariæmia.

Turner (1959) gave an account of filariasis in Malaya and showed there was no signifi-

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Fig. 1. Map of Malaya showing distribution of filariasis.

Fig. 2. Rice fields of the coastal plains in N.W. Malaya (a breeding place of **Anopheles campestris)** where the periodic type of **B.malayi** occurs.

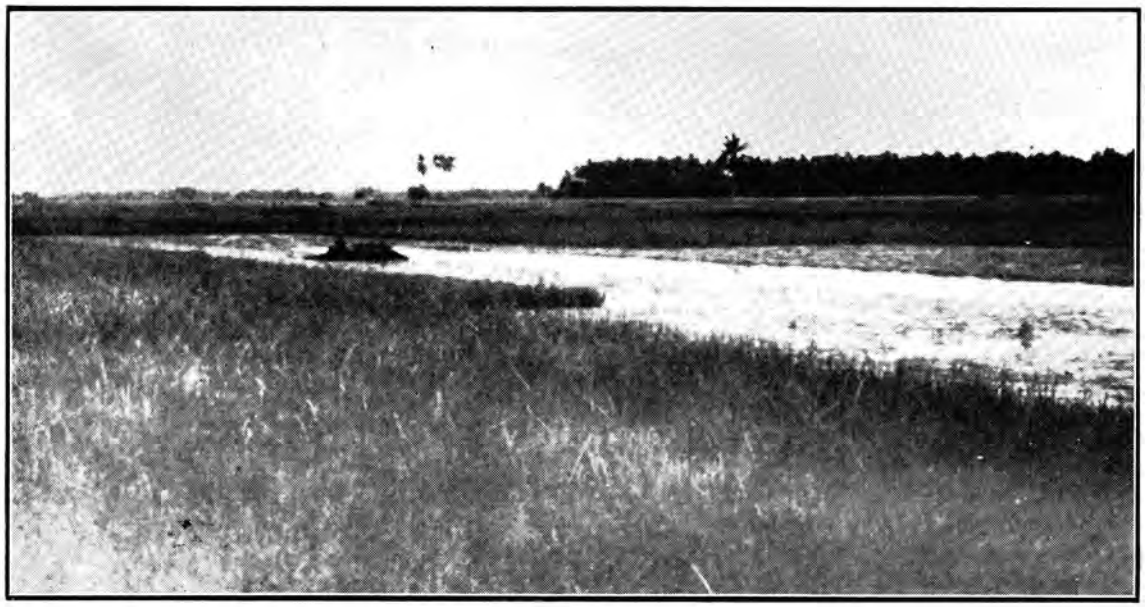


Fig. 3. A typical Malay house raised on stilts, with wooden floors and walls, and attap roof.

Fig.. 4. The edge of a typical swamp forest in East Pahang (a breeding place of **Mansonia** spp.) where the semi-periodic type of **B.malayi** occurs.

cant difference in clinical manifestations between the two forms of **B.malayi** infection. Experimentally infected human volunteers developed enlargement of lymph glands, a retrograde lymphangitis and transient swelling of the affected limb with a slight eosinophilia (Edeson *et al.*, 1960), or a marked leucocytosis and eosinophilia associated with preliminary changes (Buckley, 1958). These early stages probably pass unnoticed by the rural population. Attacks of adeno-lymphangitis lasting 3 to 5 days often with associated fever occur at irregular intervals. The affected limbs, nearly always the legs below the knee in **B.malayi** infection, may show transient swelling during these attacks ultimately leading to elephantiasis (Fig. 7 and Fig. 8). Sometimes abscesses are associated with these attacks. Recent work by Beaver *et al.*, (personal communication) suggests that eosinophilic lung or tropical eosinophilia in Malaya may have a filarial etiology.

Prevalence of Filariasis in Malaya

It was estimated in 1960 that about 5 per cent of the total population of Malaya had filariasis, mainly due to **B.malayi,** about half of them living in the more heavily infected areas on the banks of the large rivers as they run into the sea. In such areas 45 per cent of the people may have microfilariæmia and 5 to 6 per cent elephantiasis of the legs.

Filariasis Control in Malaya

As the result of researches carried out by the staff of the Institute for Medical Research a programme of control was drawn up for the whole country. The aim of the campaign was not to set out to eradicate the infection but to bring it down and keep it at a level at which no clinical symptoms would occur. Wilson (1961) has reviewed the preliminary work and the field work in Kedah and Pahang which led to the final adoption of the regime for mass control in Malaya which was to give 5 mg. diethylcarbamazine citrate per kg. body weight once a week for six doses.

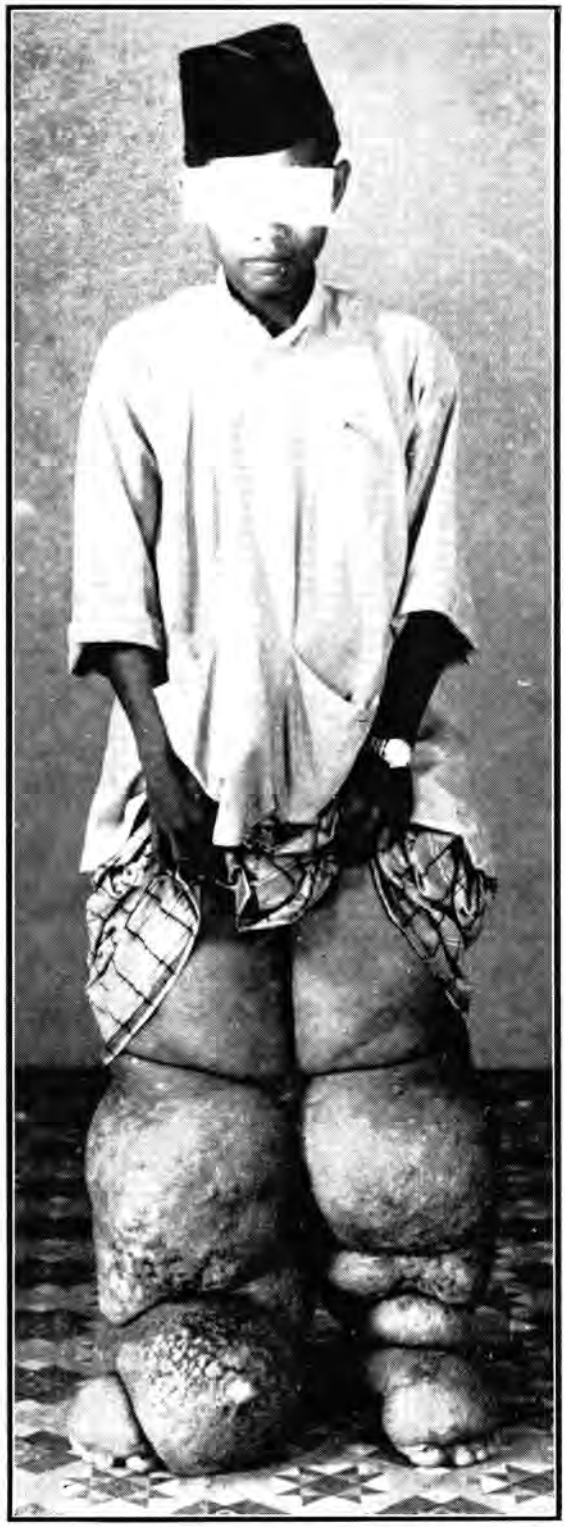
Outline of Method for Control

The method of control was outlined in an Institute for Medical Research Report No. 61 drawn up by Reid and Laing (1960). A team of four was to be trained at the Institute for Medical Research in the techniques of census taking, making blood surveys (Fig. 9), calculating and administring the drug (Fig. 10), following up cases and keeping accurate records. The team which is to work under the supervision of a Health Officer was to consist of (1) a Health Inspector or Hospital Assistant, (2) a Laboratory Assistant, (3) an Attendant and (4) a Driver (or Boatman). It was estimated that a team should be able to treat between 3,000 and 4,000 people a year at an all-in cost of M.$25,000 (about U.S.$8,300) per annum, i.e., about M.$6.50 (U.S.$2.15) per person treated. The control programme was to be divided into two phases. In the first one all persons (about 155,000) in the more heavily infected areas were to be treated; in the second phase the work was to be extended

Fig. 5. Dusky leaf monkeys **(Presbytis obscurus)** which live in swamp forests and which are found naturally infected with the semi-periodic type of **B.malayi.**

Fig. 6. The water hyacynth **(Eichornia crassipes)** is one of the many aquatic plants to the roots of which the larvæ and pupæ of **Mansonia** spp. are commonly found attached.

Fig. 7. A case of elephantiasis of both legs resulting from long-standing **B.malayi** infection.



to the less heavily infected areas at the same time carrying out resurveys in the areas covered by the first phase and retreating where necessary. It was expected that phase one should be completed by 1965 involving the use of 12 teams at an estimated cost for the five years (1961–1965) of M.$1,350,000 (U.S. $450,000).

CENSUS — Houses are visited first and given numbers which are painted on the front so that each house can be identified. A map (scale, 8 chains to the inch) is prepared and the distribution of the houses is indicated. During the house to house visits information is obtained with the aid of the penghulu or headman which is entered in a loose-leaf sheet to be filed in the binder kept in the base headquarters. House number, name, age, sex and details of clinical filariasis are entered straightaway. Subsequently this register is used to record blood survey results and details of treatment, including reactions to treatment. Although a person may have a negative blood film, a febrile or lymphatic reaction to treatment may denote infection. Details of births, deaths, new arrivals, etc., are entered as the information becomes available by a system of monthly returns provided by the headman.

BLOOD SURVEYS — These have to be carried out at night because of nocturnal periodicity of microfilariæmia. Before a blood survey is planned the penghulus have to be consulted as to the date and place where the people are to assemble — schools, shops and headmen's houses have been found the most convenient central spots. Thick blood films are taken from at least a third of the population to include both sexes of all age groups. The finger (or toe in the case of an infant) is pricked and a measured 20c.mm. of blood is drawn up a Sinton's pipette to make a thick film. About 200–300 films can be taken in an evening by one team. These films are stained by Giemsa stain subsequently in the base laboratory and examined. The microfilariæ are identified and all of them counted. The findings are recorded as (1) the microfilaria rate (the number of positive films expressed as a percentage of the total examined) and (2) the microfilarial density or load expressed as the mean number of microfilaria per 20c.mm. blood (i.e., the total num-

Fig. 8. Another case of elephantiasis due to **B.malayi** affecting both legs.

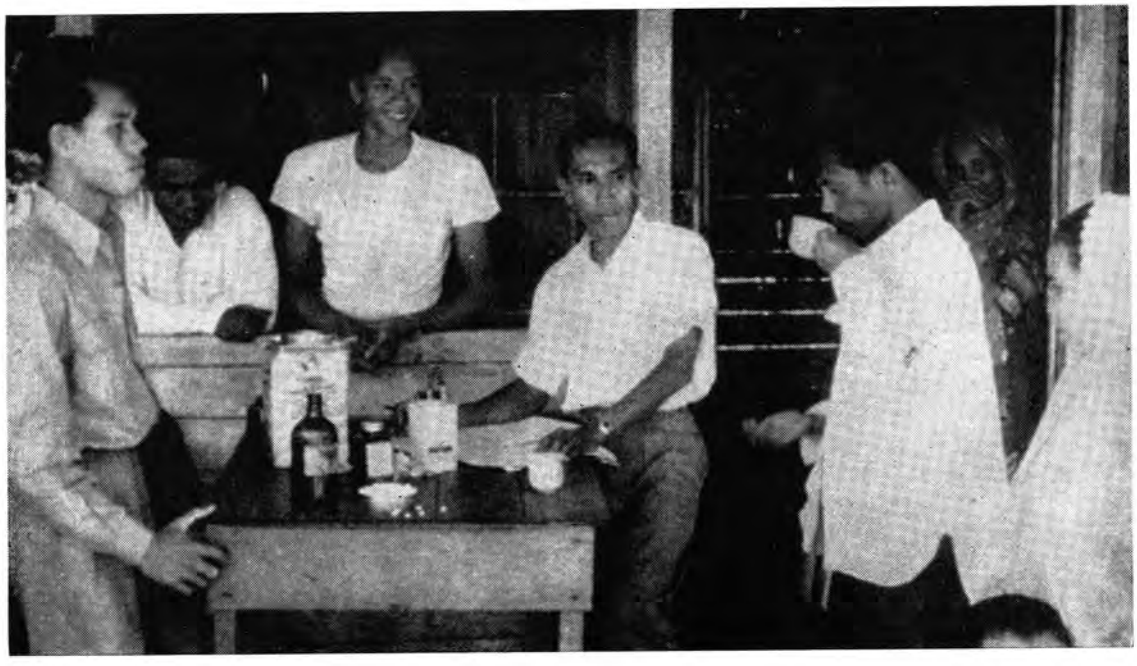
ber of microfilaria in all films upon the total number of films, both positive and negative).

MASS TREATMENT — This is done by day at a centre selected in consultation with the penghulu. Male adults who go out to work the field may not be available till the afternoon or evening. The drug is the citrate salt of diethylcarbamazine (a piperazine derivative) given orally in a standard dosage of 5 mg. per kg. body weight in weekly doses to 6 weeks. The dosage is in terms of the citrate salt put out by druggist firms such as Hetrazan (Lederle), Banocide (Burroughs-Wellcome) and Carbilazine (Union-chemique Belges) and represents approximately 50 per cent base. The people are weighed and the amount of drug is determined by reference to a table prepared in advance. There are several proprietory compounds of this drug usually made up in 50 mg. tablets and it may be prepared in syrup form for children. School children are generally treated in schools and they are provided with sweets after they have taken their drug. Pregnant women, the sick and infirm, and infants under 4 months of age are not treated.

The first dose causes a febrile reaction with headache and aches and pains which may be severe and last for periods up to five days in the case of heavy infections. Febrile reactions are unusual after the second or subsequent doses, but side effects, nausea, vomiting, abdominal pain, occur in a few persons and may be associated with **Ascaris** infection. The people are appreciative of the anthelminthic effect of the drug and generally speaking are very co-operative. Some propaganda is carried out in advance, warning the people

Fig. 9. A team engaged in taking blood films at night in a rural district.

Fig. 10. A team giving mass treatment to people living in a rural area where filariasis is prevalent.



of the possible side effects from taking the drug. As far as possible all the members of the house-hold are not treated the same day in order to prevent everyone being prostrated at the same time. House visits are made for 2 or 3 days after treatment to provide palliatives in the form of advice, aspirin, fomentation, etc. During these house visits absentees may be found and treated. Lymphatic reactions due to the effect of the drug on the adult worms occur in up to four per cent of the people treated, commonly after the second or third dose. These take the form of a circumscribed patch of lymphangitis usually in the thigh or calf, or acute adenitis in the inguino-femoral or popliteal regions with retrograde lymphangitis and œdema of the limb, and sometimes becoming suppurative with abscess formation.

The number of people who can be included in a mass treatment campaign at any one time will depend upon the density of the population and ease of access to the area. Under ordinary circumstances 300 to 400 people can be dealth with by the team in one day. The weekly programme of the team is to treat during 2 days, spend the next two days alleviating reactions due to treatment, and two days in the laboratory staining and examining blood-films, checking records, entering up the register, etc. In this way the team should be able to treat about 3,000 people in one year.

It has been arranged that all areas which had been treated should be re-examined at the end of two years and all positives retreated. It is considered that if the microfilaria rates rise to ten per cent or more and there is evidence of clinical filariasis, retreatment of the whole population would probably be necessary.

Control Programme

Work was started in Penang, Province Wellesley, Kedah, Lower Perak, Kuala Selangor, Muar and East Pahang. Whereas the work in East Pahang and Kedah had progressed according to plan, the other areas have had set backs mainly from the difficulty of retaining trained men in the service of the filariasis campaign. The Health Inspectors and Hospital Assistants are in such short supply that they were withdrawn for more urgent work in the Government service or they left for more lucrative posts outside. The inaccessibility and difficult nature of the terrain in which they have to work and the inability to provide suitable housing for the staff and their families have made the campaign unpopular with some of the medical staff. In some areas there have been frequent changes with loss of efficiency and in others the campaign had to be temporarily suspended. Continuous work as scheduled has continued in Kedah and East Pahang and the results in these two areas are presented here.

The Bukit Meriam District of Central Kedah

This area is part of the Kota Area which is separated from Province Wellesley on the South by the Muda River and bounded on the North by the Merbok River. It is a low-lying swampy area of about 20 square miles with much wet rice cultivation towards the sea side of a road which runs from South to North. On both sides of the road are the villages with scattered wooden houses usually on stilts and with attap (palm thatch) roofs. The people are Malays and number about 4,000.

Mohamed Yusof (1959) had described the conditions obtaining in this area before and in the early years following the introduction of mass treatment with diethylcarbamazine in 1956. Before commencement of treatment 3,227 were examined and the microfilaria rate was 26 per cent, the mean number of microfilariæ per 20 c.m. of blood was 2.6 and 1.2 per cent had elephantiasis. Ninety-one per cent of the people were given treatment and were re-examined 7 to 12 months later. It was found that the microfilaria rate had dropped from 26 per cent to 1.5 per cent and the mean number of microfilaria in 20 c.mm. blood from 2.6 to 0.18. Treatment had no effect on elephantiasis, the rate having altered only as a result of death or emigration. In part of this area involving about 1,000 people there was a resurvey at the end of 2 years after treatment and it was found that the microfilaria rate had dropped from 23 to 0.5 per cent and the mean number of microfilaria in 20 c.mm. blood fell from 3.36 to 0.02.

In 1962 a blood survey was carried out by the Institute for Medical Research staff

in collaboration with Mohamed Yusof covering the whole of the Bukit Meriam District. A total of 2,972 people were examined and excluding the untreated new arrivals it was found that the microfilaria rate was 0.58 per cent and the mean number of microfilaria in 20 c.mm. blood was 0.058. Of the 555 new arrivals 324 had been born in the District since 1957; none of these had contracted the infection. No fresh cases of elephantiasis were encountered in the area. The immigrants were largely from the neighbouring areas from across the rivers where control measures had not been started and accounted for 13 introduced cases of filariasis.

The Pahang Tua Area of East Pahang

This had been chosen as the experimental area by the Institute for Medical Research as early as 1953. The preliminary survey which represented 90 per cent of the total population of the area showed a microfilaria rate of 41 per cent and an elephantiasis rate of 6 per cent. This was used as a base-line for judging the effects of various experimental control measures tried out in the field. It was noted that neither in the Kampong sprayed with dieldrin nor in the drug-treated areas had there been any reduction in the proportion of mosquitœs carrying the infective stages of **B. malayi** type of larvæ. Subsequent work showed that there was a reservoir of animal infection in the swamp forest, particularly the dusky leaf monkey **Presbytis obscurus.** Whereas in the drug-treated areas the microfilaria rate and mean microfilaria count had dropped considerably, there was no change in the area sprayed with the residual insecticide. This suggested that little reliance could be placed on insecticides where the mosquitœs bred in large numbers in the swamp forests and fed readily and indiscriminately on man and monkeys but that by reducing and maintaining a low level of microfilariæmia in man by periodical exhibition of drug we could prevent clinical filariasis from developing. The effect of mass treatment was the same whether it was administered in 6 weekly or 6 monthly doses and in practice the former was found more satisfactory under Malayan conditions.

Following the experience gained of mass treatment in small areas, a large scale control campaign was started in May 1957, in the Pahang Tua Irrigation Area with a population of 2,000 in four kampongs, Lamir, Pahang Tua, Langgar and Benta. Pre-treatment surveys earlier in the year revealed an overall microfilaria infection rate of 31 per cent, a mean microfilaria count in 20c.mm. of 7.1 among 1,647 persons examined. There was retreatment of positives in 1959 which showed a microfilaria rate of 3 per cent and a mean microfilaria count in 20c.mm. of 0.3. The following two years showed a slight increase in the microfilaria rate and the survey by the Institute for Medical Research staff in collaboration with Khoo in 1962 showed the fairly marked rise in the indigenous population of the microfilaria rate to 12.4 and the mean microfilaria count in 20c.mm. to 0.6.

This represents about a 300 per cent increase in 3 years in the number of positive cases, strongly suggesting continuation of transmission; and since the microfilaria rate and load were fairly low (3% and 0.3 respectively) following retreatment of positives in 1959 it would be logical to assume that the increase was due to the presence of an animal reservoir and with a high infection rate in the neighbouring swamp forests. This is supported by the findings in Bukit Meriam area of Kedah where there is no reservoir of infection among the animals. From enquiries made during the survey in the Pahang Tua Irrigation Area there was some evidence of increased clinical manifestations although it was not so evident as in the early years of the campaign. It would seem that retreatment of all positives every two years would not be sufficient in such areas but mass treatment should be resorted to every six years or so in areas where there was a reservoir of infection in animals and where control of vectors is not a practicable proposition.

Discussion

It has been found that the co-operation of the rural Malays has been very good, the control teams often being able to get 90 per cent or more of the people submitting themselves for the blood survey or mass treatment. The value of good public relations has been emphasised and public meetings are organised with the aid of the District Officer and head-

Effect of mass treatment in Kedah and Pahang compared

Kedah (Bukit Meriam)

	No. exam.	Mf. rate %	Mean No.Mf.20c.mm.
1956/7. Before treatment	3,227	26	2.59
1958. 7–12 months later	3,135	1.5	0.18
1960. Survey of 4 villages 10 months after treatment of Mf. positives	815	0.5	0.02
1962. Survey of whole area	2,972	0.9	0.1
Excluding immigrant adults from untreated areas	2,741	0.51	—

E. Pahang (Pahang Tua Irrigation Area)

	No. exam.	Mf. rate %	Mean No.Mf.20c.mm.
1953. Before treatment	1,519	36	17.5
1957. Commencement of mass treatment ...	1,632	31	7.1
1958.	1,712	5	0.5
1959. Retreatment of Mf. positives	1,009	3	0.3
1960.	851	4	0.3
1961.	804	5	0.3
1962.	729	12.4	0.6

man, sometimes with a film show to enlist support for the campaign. The inclusion in the team of a hospital assistant who can provide some medical aid in the case of reaction to treatment and also for minor ailments like coughs and colds has helped to maintain morale and the appreciation of the filariasis campaign by the people.

In the planning of the campaign in Kedah it would have been preferable to carry out mass treatment with the people of both sides of the river banks at the same time because often river boats provide the only means of communication and there is considerable movement of people from one side of the river to the other. If this had been done the introduction of infected people from across the Muda River or Merbok River could have been avoided and the prevention of transmission more easily achieved.

The good results obtained in Kedah have not been solely due to mass treatment; they are partly due also to anti-mosquito measures adopted in the district by the Health Department. However, the main vector appears to be **A.campestris** which breeds on the sides of the rice fields and little can be done to control the breeding of this species without interfering with the rice crops. The spraying of houses with residual insecticides has been haphazard and occasional. The **Mansonia** spp. appear to play a relatively smaller part in the transmission of the periodic **B.malayi** and the occasional clearing of water hyacynths **(Eichornia crassipes),** water lettuce **(Pistia stratrotes)** and water convolvulus **(Ipomœa reptans)** from the swamps, borrow pits and deep roadside drains is unlikely to have played a big part in lowering transmission. The resurvey this year of the neighbouring Merbok area to which the team has just moved over shows that in spite of similar health measures there the incidence of filariasis is much the same as before. Among the points that favoured the greater success of the campaign

in Kedah as compared with East Pahang are (1) the absence of an animal reservoir of infection, (2) the relatively lower microfilaria rate and microfilaria load to start with, (3) the relative fewness of vectors (which do not breed much when the rice fields are in fallow) and (4) the generally higher living standards obtaining here.

Mass treatment of an area may be necessary when the microfilaria rate in a community goes up above ten per cent and there is reappearance of clinical filariasis. It is proposed to do that in Pahang Tua Irrigation Area.

ACKNOWLEDGEMENTS

The staff of the Institute for Medical Research at Kuala Lumpur has carried out considerable pioneering research in filariasis in Malaya. They have shown the existence of the strains of **B.malayi,** the occurence of animal sources of infection of human filariasis, the distribution of filariasis and the vectors in different areas. They have unravelled an extremely complex epidemiological situation. They have carried out much experimental work on animals particularly on longevity, periodicity of human and animal filarial worms and the susceptibility of mosquitoes. They have carried out pilot control projects and compared the relative merits of residual insecticides and drugs and laid down firm foundations for the extension of control to all parts of Malaya where the infection occurs. It now remains for the Health Department to pursue a vigorous policy of bringing relief to the unfortunate rural population affected with this crippling and unsightly disease. It is difficult to give credit to any one person for any particular advance made in the course of these studies; it has been largely a co-operative endeavour among my predecessors in the Malaria and Filariasis Division and the Entomology Division. I would like to pay special tribute to Drs. T. Wilson, J.F.B. Edeson, J.A. Reid, R.H. Wharton, L.H. Turner, L.S. Sodhy, J.D. Poynton, E.P. Hodgkin, I. Polunin, J.C.C. Buckley, A.B.G. Laing, D. Colless, J.H. Strahan, V.N. Norris, Mohamed Yusof b. Hassan, C.L. Khoo and many others for our present knowledge of the disease in Malaya.

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