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 CLEARANCE OF *PISTIA STRATIOTES*
 AS A CONTROL MEASURE FOR
F. MALAYI INFECTION

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SUBSEQUENT to a survey of North Travancore, Iyengar (1932, 1936) reported a heavy incidence of *F. malayi* infection in the Shertalai

(Continued from previous page)

Increased erythrocyte sedimentation rate in the glaucomatous patients as given in another paper by me suggests the second cause, *viz*, the intoxication to be responsible for hyper-uræmia. Low urea concentration values indicate that there is slight renal inefficiency as well in glaucomatous patients, but on the other hand there is a contradictory finding that the intra-ocular tension in cases of nephritis (table III) is the same as in normal individuals. It may be that the intra-ocular tension rises with mild hyper-uræmia and falls with gross hyper-uræmia as found in cases of nephritis.

TABLE III

Showing intra-ocular tension in cases of renal disease

Serial no.	Renal disease	TENSION		Blood urea
		R. E.	L. E.	
1	Nephritis	30	..	54 mgm. per 100 c.c.
2	Renal stone	25	..	..
3	Interstitial nephritis	25	20	48 mgm. per 100 c.c.
4	Nephritis	20	20	..
5	Do.	22	20	..
6	Do.	24	..	46 mgm. per 100 c.c.
7	Do.	24	..	..
8	Chronic parenchymatous nephritis	22	..	185 mgm. per 100 c.c.
9	Nephritis	30	..	..

It appears that mild renal disturbance and slight hyper-uræmia are both caused by some toxin in the body and might be associated with some local change in the eye causing increased intra-ocular tension.

Conclusions

(1) There is slight but definite increase in the blood urea and fall in the urea concentration values in cases of glaucoma as compared with the corresponding values in non-glaucomatous patients.

(2) There is no rise in the intra-ocular tension in cases of advanced renal diseases with very high blood urea.

taluk where night blood specimens from 6,404 persons had been examined and 1,754 found to have microfilaria present, an incidence of 27.4 per cent. Iyengar further reported (1936) that 23.0 per cent of these persons had elephantiasis or 'lymph-adenitis combined with temporary swelling of the leg during the febrile stage'; considering this finding he gave the filarial endemicity figures for the taluk as 46.6 per cent. Going over the original records it was possible to find reports of examinations of 1,348 persons, living in or near the area subsequently put under control and a surrounding comparison area, of whom 454, or 33.7 per cent, had microfilaria reported in their night blood specimens (*see* table I). The proportions of these people having microfilaria varied from 22.5 per cent in those 1 to 4 years old to 36.5 per cent in those 10 to 19 years of age. All of the microfilaria found in this taluk were reported as of the species *Mf. malayi* Brug.

By careful work on the epidemiology of this *F. malayi* infection, Iyengar (1932, 1933, 1936, 1937) found that it was carried in nature mainly by *Mansonia* (*Mansonioides*) *annulifera* Theobald, in over 900 specimens of which he found an infection rate of about 26.0 per cent, and that *Culex fatigans* was not infectible by this species even in the laboratory. Further, he found that *Mansonioides* laid eggs on the leaves of *Pistia stratiotes*, a water plant, and that the larvæ and pupæ penetrated the pistia roots by means of a strongly-chitinized structure at the tip of the breathing siphons and horns. Consequently, they never came to the surface for air. *Mansonioides* eggs and larvæ were never found on other water plants in nature. In view of these findings, he recommended that control of *F. malayi* infections be attempted in this area by the manual removal of pistia from the numerous water collections.

TABLE I

Microfilaria malayi in examinations of night blood specimens from residents of a portion of Shertalai taluk, North Travancore

April and May 1932

Ages	Number examined	Number with microfilaria	Per cent with microfilaria
1 to 4 ..	71	16	22.5 ± 3.3
5 to 9 ..	231	64	27.7 ± 2.0
10 to 19 ..	334	122	36.5 ± 1.8
20 and over	712	252	35.4 ± 1.2
All ages ..	1,348	454	33.7 ± 0.9

*Control work**

Late in 1933 control work was organized by government in an area of approximately 15 square miles centering on Shertalai town. The control unit had sixteen coolies and four overseers with a sub-assistant surgeon in charge,

Preliminary pistia clearance was begun in November 1933 but it was not until July 1934 that the first well organized round of the area was started and not until April 1935 that it was completed. Thereafter fourteen rounds were made up to the middle of January 1937



Fig. 1.—*Pistia stratiotes*.
Photograph by Dr. P. F. Russell.

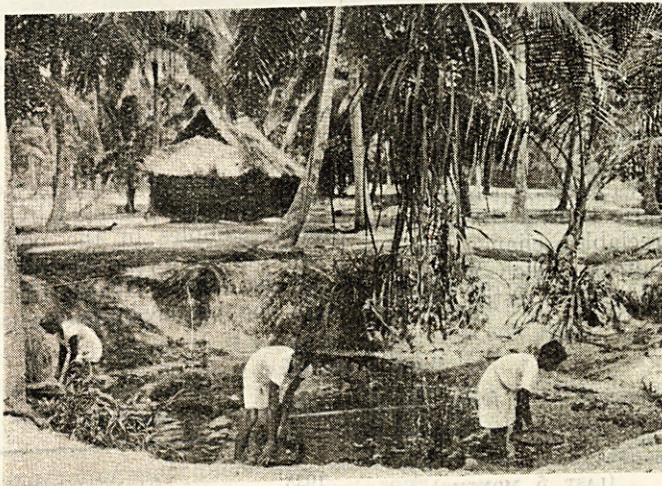


Fig. 2.—Manual removal of pistia.
Photograph by Dr. P. F. Russell.

and its work consisted of the periodic clearance of pistia from all water collections in the control area. A research assistant, stationed at Pattanakkad outside of the control area, made observations on *Mansonioides*, collected blood specimens, made mosquito catches and carried on other parts of a research programme.

*The control work here reported was begun by the Government of Travancore in 1933 and was at the suggestion and under the direction of M. O. T. Iyengar. He gave the results of the work, up to the date of his leaving Travancore, in references 3 and 4 given at the end of this article.

the fifteenth having been begun in February 1937. Table II gives the number of days required for each round and the estimated acreage of pistia removed each time.

In January 1937 the staff was increased by sixteen coolies and four overseers and an area of about 24 square miles was added to the original zone.

Mosquito collections were made monthly at eight stations, two of which were located in the middle of the control area at Shertalai and Thannirmukkam, two midway between these

central stations and the border of the control zone, two at the border, and two beyond the area under control. In table III are given the

TABLE II

Number of days required for each round of pistia clearance and estimated acreage of pistia cleared in the original control zone of about 15 square miles

	Number of days per round, (including all holidays)	Estimated number of acres of pistia cleared	Date of starting round
Preliminary	249	200	9th Nov., 1933
First ..	272	596	16th July, 1934
Second ..	125	281	14th April, 1935
Third ..	88	189	19th Aug., 1935
Fourth ..	104	137	15th Nov., 1935
Fifth ..	41	46	27th Feb., 1936
Sixth ..	32	25	8th April, 1936
Seventh ..	15	8	11th May, 1936
Eighth ..	11	5	26th May, 1936
Ninth ..	15	5	6th June, 1936
Tenth ..	20	8	22nd June, 1936
Eleventh ..	34	13	13th July, 1936
Twelfth ..	79	30	17th Aug., 1936
Thirteenth	68	48	4th Nov., 1936
Fourteenth	28	17	20th Jan., 1937

results of these catches per hour as they were reported to the director of public health.

The removal of pistia was intended as a control of the *Mansonioides* species only and, judging from the reported figures as given in table III, it was an effective measure since no specimens of these species were reported from the central catching stations after 1935; there seemed to be no appreciable change in the catches of other mosquitoes, which were not affected by the removal of the pistia. At no

time was oil used or any other measure employed for the control of culicine and anopheline species.

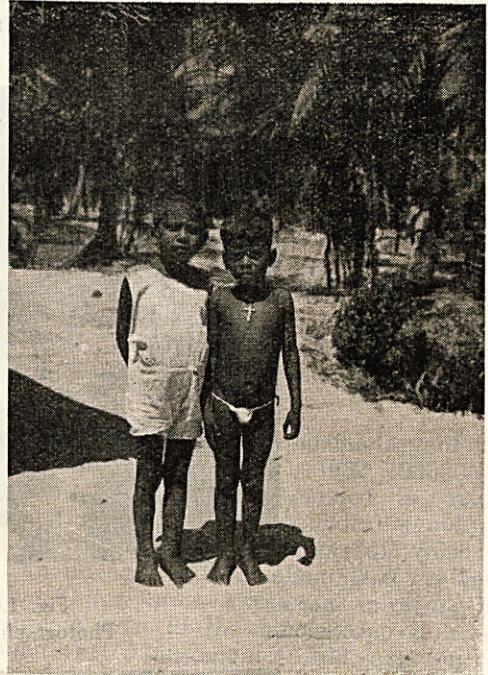


Fig. 3.—Elephantiasis of the leg in young boys four and five years old.

Photograph by Dr. P. F. Russell.

Four times during the year 1935 blood slides were collected at night by the research assistant from samples of the population living within and outside of the controlled area and examined at the Public Health Institute in Trivandrum. As the last examination was made in August,

TABLE III

Mosquito catches per hour from stations within and outside of the control area

Place	Catching station	1934 (LAST 5 MONTHS)		1935		1936		1937 (FIRST 3 MONTHS)	
		All mosquitoes	Mansonioides	All mosquitoes	Mansonioides	All mosquitoes	Mansonioides	All mosquitoes	Mansonioides
Thannir-mukkam.	At centre of control.	..	..	27.6	0.06	26.7	0.0	19.7	0.0
	Midway	..	..	26.8	0.2	28.7	0.06	20.7	0.0
	Border	..	..	26.6	1.0	32.9	1.2	23.0	3.3
	Outside of control.	..	..	34.3	2.2	40.4	3.1	25.4	5.1
Shertalai ..	At centre of control.	18.0	0.8	30.0	0.1	30.3	0.0	23.3	0.0
	Midway	19.2	0.7	28.4	0.2	27.9	0.2	26.6	0.0
	Border	30.7	2.7	32.6	1.4	35.1	1.8	30.3	4.6
	Outside of control.	36.3	12.9	35.8	3.6	44.8	3.6	37.4	7.6

1935, only four months after the end of the first complete round of pistia clearance, the figures of these examinations are not given here. It is of interest to note, however, that although there was no significant change from the microfilaria percentages of the 1932 survey in those examined inside of the controlled zone, the incidence of infection seemed to have dropped in the comparison area in persons over ten years old. There was no apparent explanation for this drop, unless it was seasonal, and no later examinations were made to confirm it. In

to judge how long after the cessation of re-infection one might expect to find microfilariae in the peripheral blood, although it seems probable that the period would not be a short one. Furthermore, since adults were more likely than children to make overnight visits to uncontrolled areas, it seemed probable, all things considered, that the only way to judge the effectiveness of the control methods would be to examine very young children only. Consequently, house to house visits were made by the writers in April 1937 on four successive nights between 8-30 and



Fig. 4.—Pistia choking an irrigation ditch.
Photograph by Dr. P. F. Russell.

August 1935 the microfilaria incidence in 17 children from one to four years old was 29.4 ± 7.5 per cent, not significantly different from the 21.2 ± 4.8 rate of 1932 (see table I).

Survey of young children

Since information is lacking as to the length of life of an infecting *F. malayi*, it is not possible

12-30 p.m., collecting thick blood slides from children under 5 years of age. It was possible to get blood slides from a total of 174 children, 87 living within the controlled zone and near the centre of it and 87 in the comparison area well removed from the possible effects of control. Results of these examinations are given in table IV.

TABLE IV

Results of examination of night blood specimens taken from children in the Shertalai area April 1937

Age	LIVING NEAR THE CENTRE OF THE CONTROLLED AREA			LIVING IN A COMPARISON AREA		
	Number examined	Number with microfilaria	Per cent	Number examined	Number infected	Per cent
Under 1 year	14	0	0.0	12	1	8.3
1 year	25	0	0.0	18	2	11.1
2 years	32	0	0.0	26	8	30.8
3 years	13	1	7.7	25	10	40.0
4 years	3	0	0.0	6	2	33.3
Total	87	1	1.1 ± 0.8	87	23	26.4 ± 3.2
1 to 4 years	73	1	1.4 ± 0.9	75	22	29.3 ± 3.5
2 years and under	71	0	0.0	56	11	19.6 ± 3.6

In the controlled area there was only one child, three years and six months old, who had microfilariæ in its night blood specimen whereas in the comparison area there were found 23 infected children in a group of approximately the same ages. All of the microfilariæ found were *Mf. malayi*. The percentage of infected children one to four years old in the comparison area, 29.3 ± 3.5 , was not significantly different from the percentages found in the same general area in 1932 and 1935, so it would seem to be practically certain that the drop in infection in the controlled area can be regarded as a result of the control work. As the first complete pistia clearance in the controlled area was finished in April 1935 and these examinations were made in April 1937 it seemed fair to use children two years old and under as a test. When this test was applied, there were found no infections in 71 controlled-area children as against eleven infections, or 19.6 per cent, in 56 children living in the comparison area. If the true incidence of infection is taken as 20.0 per cent, one would not find fewer than five infections among 70 children as often as once in 200 trials (Pearl, 1930). There was a real and large reduction in filariasis in children born since control measures were begun.

Since one infection in 16 children three and four years old, examined from the controlled area, by Pearl's table is within the sampling error of the comparison area incidence, it cannot be concluded on the basis of the 1937 examinations that there was any reduction of infection in the controlled-zone children of these particular ages. In the control of filariasis one cannot expect that any change will occur in the existing elephantiasis rate of the area. Furthermore, what will occur in the persons already infested with filarial worms is unknown; the worms may die without later effect or they may go on to develop elephantiasis. It is quite possible that the public will see no change in this disease until the generation now two years old has grown up, and then only if the pistia clearance is continued throughout the years with its present efficiency.

It is possibly of interest to emphasize again that the pistia clearance was a control method aimed entirely at the *Mansonioides* species and that it had no apparent effect on other species of mosquitoes. The control of the *F. malayi* infection in children makes an excellent example of the suppression of a mosquito-borne disease by a strictly limited species control of the carrier.

Summary

The control in young children, by means of *Pistia stratiotes* destruction, of the *Mansonioides*-carried *F. malayi* infection in a 15-square mile area of the Shertalai taluk of North Travancore, is reported. In 71 children two years old and under there were no infections in the controlled

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THE EFFECT OF REDUCED PRESSURE COMBINED WITH INCREASED TEMPERATURE ON THE VIABILITY OF BED BUGS AND OF THEIR EGGS

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THERE is little, if any, literature on this subject either in parasitological or entomological publications. At the instance of the Chief Medical Officer of the M. & S. M. Railway, experiments were carried out in 1934 at the King Institute, Guindy (Madras), to investigate the effects of reduced pressure on bed bugs and their eggs (Webster, 1934).

The results of that investigation showed that much reduced pressures were insufficient to destroy the eggs. The question is one of great importance to administrations involved in the carrying of passengers in vehicles; it is of particular importance to railway authorities in India, where constant reinfestation of passenger vehicles takes place and where conditions are eminently favourable for the development and multiplication of bugs. Further experiments were therefore conducted to discover the effect of increased temperature combined with reduced pressure. A sketch of the apparatus used is given.

Bugs and their eggs were collected from passenger vehicles; the eggs were examined microscopically to ensure that the opercula were intact. It was, however, discovered that a large proportion of eggs thus collected failed to hatch out under normal laboratory conditions. To overcome this difficulty live bugs were kept in test

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zone while 19.6 per cent of 56 children in a nearby comparison area were found to have *Mf. malayi* in specimens of blood taken at night.

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[Note.—The parent worm of *Microfilaria malayi* has never yet been seen so the use of the generic name *Filaria* is not strictly admissible. It appears preferable to use the term *Mf. malayi*, only, for the present and to defer naming the adult worm until it has been found and correctly classified.—EDITOR, I. M. G.]