

Studies on parasitic infections in Orang Asli (Aborigines) in Peninsular Malaysia

by *Dissanaike, A. S.*

B.Sc., M.B.B.S., Ph.D., D.Sc., FRCPath.

Kan, S. P.

B.Sc., M.Sc., Ph.D.

Department of Parasitology, Faculty of Medicine,
University of Malaya, Kuala Lumpur, Malaysia.

and *Vijayamma Thomas*

B.Sc., M.Sc., Ph.D.

*Ong, H. T.**

M.B.B.S.

Gombak Hospital, Kuala Lumpur.

Introduction

A REVIEW OF the literature on parasitic infections in Orang Asli revealed that much work has been done on various parasites. Among them, malaria (Polunin 1953; Wharton *et al.*, 1963; Sandosham *et al.*, 1966; Bolton, 1972), intestinal parasites (Polunin, 1963; Sandosham, 1953; Dunn and Bolton, 1963; Bolton, 1968; Gilman and Prathap, 1971; Dunn, 1972; Gilman *et al.*, 1976a; 1976b), filarial infections (Wilson and Reid, 1951; Polunin, 1951, 1953; Laing and Wharton, 1960; Wharton *et al.*, 1963; Ramachandran *et al.*, 1964; Itam, 1967; Mak, 1974), and Pentastomid infection (Ramachandran and Prathap, 1967; Prathap *et al.*, 1968, 1969) seem to be the commonest. However, very little information was available on other blood and tissue parasites. The food and other habits of Orang Asli suggest that they would be infected with some of the rarer parasites not usually seen in the rest of the local population. In the course of this study, it was necessary to examine faeces and other excretions and secretions of a number of Orang Asli, in addition to their blood. This communication therefore summarises the prevalence and distribution of all parasites detected in this study, which commenced in 1973. No attempt has been made to compare the prevalence of parasites according to tribe, age or sex. Similarly, no attempt was made to study the parasite density of any of the infections.

Materials and methods

A total of 140 thick and thin blood films was made around midnight from patients and their relatives in the Gombak Hospital as well as in a few Orang Asli villages, whenever possible. In addition, the millipore concentration technique was used on night blood to screen patients for filarial infections.

Each of 126 stool samples was examined by direct smear, brine flotation, formol ether and sedimentation techniques. In the latter technique, 5% glycerol was used as a routine to prevent hatching of any *Schistosoma japonicum* type eggs which may have been present. This was deemed necessary in view of the report of *S. japonicum* like infection of an Orang Asli (Murugasu and Dissanaike, 1973). Where indicated, sputum samples, after treatment with 2 percent KOH, were examined for eggs of *Paragonimus* and other parasites.

Intradermal skin tests were performed on a few people for schistosomiasis and paragonimiasis. *S. japonicum* and *P. westermani* antigens were kindly supplied by Professors M. Yokogawa, T. Oshima and Shigeo Hayashi.

Sera from 271 donors were tested for antibodies to various protozoan infections. The IFA technique was employed for all except for *Entamoeba histolytica* for which the IHA technique was employed. Antigens for the IFA tests were kindly supplied by Dr. A. Sulzer, Center for Disease Control, Atlanta, USA. The antigens and other reagents used for the IHA tests were commercial preparations bought from Hoechst (Amoebiasis IHA Reagent test kit (OTMO 11)).

* Present address: Su Beng Dispensary, 104 Jalan Prangin, Penang.

In all the tests where IFA techniques were used, only sera that showed reactivity at 1:64 or higher dilutions were considered positive, although reactivity at 1:16 dilutions was recorded for information. In the IHA tests for *E. histolytica* antibodies, those sera that were reactive at 1:128 or higher dilutions were considered positive.

Results

1. Intestinal Parasites.

a. Protozoa.

Table I gives the prevalence of intestinal protozoa as diagnosed by stool examination compared with results of Dunn (1972) and Bisseru and Aziz (1970). *Entamoeba coli* (21.4%) was the most common protozoan, followed by *E. histolytica* (8.7%) and *Giardia lamblia* (4.8%). No *Balantidium coli* or *Isospora* sp. were detected during this study.

b. Helminths.

The prevalence of common soil-transmitted nematodes compared with previous studies is given in Table II. The prevalence of all the common soil-transmitted helminths was high as shown in Table III. The most prevalent infection was hookworm (95.2%) followed by *Trichuris* (80.9%), *Ascaris* was present only in 47.6% people examined. A large number (23.0%) of them had mixed infection with all three soil-transmitted helminths. Double infections in all possible combinations were also detected. Single infections with these nematodes were rare (Table III). Although other intestinal nematodes like *Strongyloides* and *Enterobius* were present, these were understandably low due to the techniques used. It was interesting to note that out of the 126 stool samples examined, only one was completely free of helminthic infection.

Table I

Prevalence of Intestinal Protozoa among Orang Asli compared with Bisseru & Aziz (1970) and Dunn (1972)

Protozoa	Present authors (Total 126) %	Bisseru & Aziz (1970) (Total 100) %	Dunn (1972) (Total 1273) %
<i>Entamoeba histolytica</i>	8.7	1	5.1
<i>E. hartmanni</i>	0.8		3.5
<i>E. coli</i>	21.4	4	28.1
<i>Endolimax nana</i>	6.3		6.2
<i>Iodamoeba butschlii</i>	2.4		2.8
<i>Giardia lamblia</i>	4.8	25	10.8
<i>Chilomastix mesnili</i>	1.6		2.1
<i>Trichomonas hominis</i>	1.6	7	0.4

Table II

Prevalence of commoner soil-transmitted nematodes among Orang Asli - comparison with previous studies

Author (year)	No. examined	Percent Infection			Method Used
		<i>Ascaris</i>	<i>Trichuris</i>	Hookworm	
Nevin (1938)	104	70	14	16	?
Sandosham (1953)	117	79.6	24.0	48.7	DS, BF
Polunin (1953)	131	4.6	3.1	90.8	BF
Bisseru & Aziz (1970)	100	69	80	51	DS
Dunn (1972)	1273	39.1	57.2	68.7	DS, TIF
Dissanaike et al (present paper)	126	47.6	80.9	95.2	BS, FE, BF, Sed.

DS = Direct smear; BF = Brine flotation; FE = Formol ether; Sed. = Sedimentation; TIF = Thiomersal-Iodine-Formol.

Table III

Prevalence of Intestinal helminths among Orang Asli

Helminths	No. positive (%) (from total of 126)
<i>Ascaris lumbricoides</i>	60 (47.6)
<i>Trichuris trichiura</i>	102 (80.9)
Hookworm	120 (95.2)
<i>Strongyloides stercoralis</i>	1 (0.8)
<i>Enterobius vermicularis</i>	1 (0.8)
Hookworm <i>Trichuris</i> and <i>Ascaris</i>	29 (23)
Hookworm and <i>Trichuris</i>	19 (15.1)
Hookworm and <i>Ascaris</i>	4 (3.2)
<i>Trichuris</i> and <i>Ascaris</i>	1 (0.8)
Hookworm alone	4 (3.2)
<i>Trichuris</i> alone	3 (2.4)
<i>Ascaris</i> alone	nil
Persons negative for all intestinal helminths	1 (0.8)

2. Blood and Tissue Parasites.

a. *Protozoa.*

(i) *Malaria.*

Examination of 140 single thick and thin smears showed the presence of *P. falciparum* infection in 16 Orang Asli. Two of these had mixed infections with *P. vivax*. Nine showed infections with *P. malariae*. None of the slide-

positive cases were children below the age of 10. Only 1, a 2 year old child, showed clinical malaria at the time of blood examination.

(ii) *Trypanosomiasis.*

Low grade infections with trypanosomes have already been reported in 2 Orang Asli (Dissanaike *et al.*, 1974).

b. *Helminths.*

(i) *Microfilariae.*

Out of a total of 140 blood smears examined, 8 were positive for *Wuchereria bancrofti* and 12 for *Brugia*. There was no mixed infection. The distribution of the 2 species in various states of Peninsular Malaysia are given in Table IV: Orang Asli from Johore, Kelantan and Malacca did not show microfilariae. However, as the total numbers tested were below 10 for Selangor, Negri Sembilan, Johore, Kelantan, Trengganu and Malacca, this may not give a true picture of the microfilaria rates in Orang Asli populations in the various states. The prevalence of microfilaria is compared with the results of previous workers in Table V.

(ii) *Other Helminths.*

No other blood and tissue helminths were detected in this study, but skin tests carried out for *Schistosoma japonicum* and *Paragonimus westermani* have shown positive reactions in a few cases. The results of the tests are shown in Table VI.

3. Serological studies

The results of the serological studies on the protozoan infections are summarised in Table VII.

Table IV

Prevalence of microfilariae among Orang Asli from 8 states

State	Number examined	Number positive with		Total Positive
		<i>Brugia</i>	<i>Wuchereria</i>	
Selangor	7	1	—	1
Negri Sembilan	8	—	1	1
Johore	7	—	—	—
Perak	37	5	1	6
Pahang	75	6	5	11
Kelantan	4	—	—	—
Trengganu	1	—	1	1
Malacca	1	—	—	—
TOTAL	140	12	8	20

Table V
Prevalence of microfilariae – comparison with previous published studies

Author (date)	Number examined	Number positive	% infection	% <i>Brugia</i> (of total positives)	% <i>Wuchereria</i> positives	% mixed
Polunin (1953)	278	60	21.6	–	–	–
Wharton <i>et al</i> (1963)	1,099	212	19.3	62.3	30.2	7.5
Ramachandran <i>et al</i> (1964)	167	29	17.4	51.7	34.5	13.8
Itam (1967)	1,964	223	11.4	75.1	25.0	–
Mak (1974)	68	5	7.4	100	–	–
Dissanaike <i>et al</i> (present paper)	140	20	14.3	60	40	–

a. *Amoebiasis.*

Of the 16 sera tested for *E. histolytica* by IHA technique 25% showed reactivity. However, the stools of those who were positive were not examined. In the general stool survey, 8.7% infection was revealed.

b. *Malaria.*

The results obtained on the serological tests on the Orang Asli donors have already been published elsewhere (Thomas and Dissanaike, 1977).

Table VI

Results of skin tests performed on Orang Asli with *Schistosoma japonicum* and *Paragonimus westermani* antigens

Skin test with	No. tested	Positive	Doubtful positive
<i>S. japonicum</i>	130	2	9
<i>P. westermani</i>	132	1	16

Table VII

Titres obtained for sera from Orang Asli donors with various blood and tissue protozoan parasite antigens

Antigen used	Type of test	Total No. of sera tested	No. of sera that showed end-point titres of						Total No. and % +ve at 1:64 and higher titres	
			1:16	1:64	1:256	1:1024	1:4096	1:8192		
<i>E. histolytica</i>	IHA	16	–	–	–	3	–	1	4	25.0
<i>Plasmodium falciparum</i> *	IFA	271	–	80	90	67	4	–	241	88.9
<i>P. malariae</i>	IFA	271	–	114	34	17	–	–	165	60.9
<i>Toxoplasma gondii</i>	IFA	226	36	27	5	4	–	–	36	16.0
<i>Trypanosome gambiense</i>	IFA	93	17	3	–	–	–	–	3	3.2
<i>T. rhodesiense</i>	IFA	93	28	5	1	–	–	–	6	6.5
<i>T. cruzi</i>	IFA	93	8	–	–	–	–	–	–	–
<i>T. cyclops</i>	IFA	48	–	–	–	–	–	–	–	–
<i>T. lewisi</i> *	IFA	29	12	7	3	–	–	–	10	34.5
<i>Sarcocystis fusiformis</i>	IFA	71	20	22	6	–	–	–	28	39.4

* Tests at CDC, Atlanta, USA by the kind courtesy of Dr. A.J. Sulzer.

c. *Trypanosomiasis.*

Serological survey on 93 sera (Table VII) with 3 human *Trypanosoma* antigens showed that 6 of these sera reacted with *T. rhodesiense*, and 3 with *T. gambiense* antigen at significant titres. None of the sera reacted with *T. cruzi* at titres higher than 1:16. Similarly, none of the 48 sera that were tested with *T. cyclops* gave positive reaction, although 10 of 29 sera reacted with *T. lewisi* antigen at significant titres.

d. *Toxoplasmosis.*

Two hundred and twenty six sera were tested and the results are shown in Table VII. A total of 36 sera (16%) were positive at 1:64 and higher titres. An equal number reacted at 1:16 showing that a good percentage of the Orang Asli population of this country has experienced infection with *Toxoplasma gondii*.

c. *Sarcosporidiosis.*

The results of the serological tests using zoites isolated from *S. fusiformis* sarcocysts from the water-buffalo muscle showed the presence of *Sarcocystis* antibodies in 39.4% of Orang Asli donors. Further details of this work will be published in a separate communication.

Discussion

The present study revealed that the prevalence of parasitic infections like amoebiasis, soil-transmitted helminths, malaria and filariasis is quite high among Orang Asli. Many of them still lead a semi-nomadic life under poor sanitary conditions and are normally barefooted. These factors may account for such a high prevalence of these infections. A comparison of the prevalence of these parasites with those obtained by Dunn (1972) and other workers showed a higher prevalence of hookworm and *Trichuris* infections (Table II). This could be because several techniques (4) were employed for each stool sample in the present study. The previous workers have used only 1 or 2 techniques to detect the eggs. The brine flotation and sedimentation techniques which were used in the present study would have brought out even the scanty infections.

The high levels of malaria antibody in a large number of people tested indicate that the transmission rate is higher than what is apparent by slide examination. This has been discussed in an earlier paper (Thomas and Dissanaiké, 1977) and is in agreement with the report of Bolton (1972).

In addition to parasites, which have already been recognised, 2 cases of trypanosome infection were detected during the study and have been reported (Dissanaiké *et al.*, 1974). The sera from these two persons were not very reactive with any of the trypanosome antigens tested (Else *et al.*, 1976). Dr. A. J. Sulzer (personal communication) tested a number of Orang Asli sera at the Center for Disease Control, Atlanta, USA, with *T. rhodesiense* and *T. cruzi* antigens. He obtained very similar results. When he tested 29 of those sera with *T. lewisi* antigen (Table VII), 10 samples reacted at 1:64 or higher dilutions and 3 samples reacted at 1:286. It was clear from these results that there was reactivity in a few sera at lower titres showing possible infections among Orang Asli with some species of trypanosome. However, the sera were not too reactive with any antigens tested, and this may have been due to the absence of homologous antigens for testing. It was interesting to note that the sera were most reactive with *T. lewisi* antigen.

In an earlier survey done with sera collected from Southeast Asia, Sulzer (personal communication) noted that one serum sample reacted with an African trypanosome antigen at 1:256. All these findings suggest the possible existence of a small focus of trypanosome infection among Orang Asli.

Serological tests for *Toxoplasma* antibodies indicated that infection was present although obvious clinical manifestations of the disease were not recognised. According to Tan and Zaman (1973); Cheah *et al.*, (1975); Thomas *et al.*, (unpublished data) the prevalence of *Toxoplasma* antibodies was highest among the Malays and lowest in Chinese. The present studies show that the prevalence of antibodies among Orang Asli is higher than that among Chinese (Table VIII) but lower than in Indians. This may be due to the fact that, being semi-nomadic, they do not have very close association with pet cats like the Malays. In fact their association is more with dogs.

Table VIII

Comparison of antibody titres of different ethnic groups (*Toxoplasma*)

	Tan & Zaman, 1973 IHA %	Bisseru (1974) Dye Test %	Cheah et al (1975) IFA %	Thomas et al* IFA %
Malays	25.4 (59)	—	38.8 (431)	33.9 (118)
Indians	19.6 (51)	—	25.2 (373)	23.9 (138)
Chinese	5.0 (20)	—	20.7 (635)	14.6 (212)
O. Asli	—	4.6 (44)	—	19 (268)
Others	—	—	12.5 (40)	—

Numbers of parasites — total number examined.

* Unpublished data.

Kutty *et al* (1975) reported a case of infection with *Sarcocystis* sp. in an Orang Asli girl at autopsy. Two other cases of *Sarcocystis* infection in Malaysia, one in a Malay (Kutty and Dissanaiké 1975) and the other in a Chinese (Prathap and Dissanaiké 1976) have also been reported from Peninsular Malaysia. The present serological findings show a number of Orang Asli donors (39.4%) have detectable levels of *Sarcocystis* antibodies. This indicates that the infection with *Sarcocystis* may be more common and only a more thorough study including muscle biopsy would reveal the true situation.

Thick film examination for filarial infection confirmed the earlier findings that filariasis is still prevalent among Orang Asli and that *Brugia* is the predominant species. However, mixed infections were not found in the present study.

Eggs of a *Schistosoma japonicum*-like parasite were earlier found in the liver and other tissues of the Orang Asli (Murugasu and Dissanaiké, 1973 and Murugasu and Por, 1973). Subsequently, Leong *et al.* (1975) reported 8 additional cases at autopsy. The smaller size of the eggs suggests that this was probably a different strain to the classical *S. japonicum* and may be related to the Mekong strain. Recently, Murugasu (personal communication) detected eggs in a needle liver biopsy from an Orang Asli patient at the University Hospital, whose stools were negative. Through the courtesy of Professor Benjamin Cabrera, the Circum Oval Precipitation Test (COPT) was done on seven Orang Asli sera which included the case with the positive needle biopsy. Only the latter was positive. It would therefore be worthwhile carrying out this test and doing liver biopsies whenever the skin test and the COPT are found positives in future.

Paragonimus westermani is known to be a common parasite of the wild carnivores in Malaysia (Rohde, 1965 and Groves *et al.*, 1967). It is also known in fresh water crabs (Rohde, 1966 and Lee and Miyazaki 1965).

In the skin tests, although a single positive case was detected, no eggs were present in the sputum or the faeces nor was there any radiological evidence of the infection in the lungs. A more thorough search might reveal this infection too in the Orang Asli.

In conclusion, the present study which confirms the high prevalence of malaria, soil-transmitted nematodiasis, amoebiasis and filariasis in the aborigines, focuses attention on the likelihood that blood and tissue infections like *Sarcocystis*, *Paragonimus* and perhaps other hitherto undetermined parasites would be detected with better and more thorough procedures.

Summary

During a brief study of the blood and tissue parasites of Orang Asli aborigines, the prevalence of intestinal infections, malaria and filariasis was noted and compared with results of previous authors. A higher prevalence of Hookworm and *Trichuris* infections in this study is attributed to the more comprehensive methods of examination used.

Reference is made to cases of trypanosomiasis and sarcosporidiosis reported earlier and serological studies have suggested a higher prevalence of these parasites, necessitating further detailed investigations. In view of reports of *Schistosoma japonicum*-like infections in these aborigines, a detailed search for eggs of these parasites was made but with negative results although, of two skin test positives, one case was that of a patient with *Schistosoma* eggs seen in a needle biopsy.

Acknowledgements

We are grateful to the Director, Department of Orang Asli Affairs and the Medical Officers and laboratory staff at Gombak Hospital for their willing help and cooperation; to the laboratory staff of the Department of Parasitology especially to Mr Yap Pak Leng, Mr John Loganathan and Mr Perumal s/o Ramasamy for their assistance. Grateful thanks are due to Dr A Sulzer for his assistance with antigens and for some of the serological tests he so kindly performed for us; also to Professor Benjamin Cabrera whose assistance with the COPT test we greatly appreciate.

This work was assisted by a Research Grant from the University of Malaya.

References

- Bisseru, B. and Aziz, A.A. (1970). Intestinal parasites, eosinophilia, haemoglobin and gamma globulin of Malay, Chinese and Indian school-children. *Med. J. Malaya*, **25**: 29-33.
- Bisseru, B. and Lim, K.C. (1974). *Toxoplasma* antibody in West Malaysia (Peninsular Malaya). *Trans. R. Soc. trop. Med. Hyg.*, **68**: 172-173.
- Bolton, J.M. (1968). Medical Services to the Aborigines in West Malaysia. *Br. med. J.*, **2**: 818-823.
- Bolton, J.M. (1972). The control of malaria among the Orang Asli in West Malaysia. *Med. J. Malaysia*, **27**: 10-19.
- Cheah, W.C., Cheah, S.F. and Chan, W.F. (1975). Pattern of toxoplasma antibodies in Malaysian pregnant women. *Med. J. Malaysia*, **29**: 275-279.
- Dissanaike, A.S., Ong, H.T. and Kan, S.P. (1974). Trypanosome infections in Orang Aslis (Aborigines) in West Malaysia. *Trans. R. Soc. trop. Med. Hyg.*, **68**: 494-495.
- Dunn, F.L. (1972). Intestinal parasites in Malayan aborigines (Orang Asli). *Bull. Wld. Hlth. Org.*, **46**: 99-113.
- Dunn, F.L. and Bolton, J.M. (1963). The MIF Direct smear (DS) method in the study of intestinal parasitism in Malayan Aborigines. *Singapore med. J.*, **4**: 175-176.
- Else, J.G., Thomas, V., Kan, S.P. and Dissanaike, A.S. (1976). Further studies on trypanosomiasis in Orang Asli (aborigines) in West Malaysia. *Trans. R. Soc. trop. Med. Hyg.*, **70**: 170-171.
- Gilman, R.H. and Prathap, K. (1971). Acute intestinal amoebiasis - proctoscopic appearances with histopathological correlation. *Ann. trop. Med. Parasit.*, **65**: 359-365.
- Gilman, R.H., Davis, C., Gan, E. and Bolton, M. (1976a). Seroepidemiology of amoebiasis in the Orang Asli (Western Malaysian Aborigines) and other Malaysians. *Am. J. trop. Med. Hyg.*, **25**: 663-666.
- Gilman, R.H., Davis, C. and Fitzgerald, F. (1976b). Heavy *Trichuris* infection and amoebic dysentery in Orang Asli children. A comparison of the two diseases. *Trans. R. Soc. trop. Med. Hyg.*, **70**: 313-316.
- Groves, M.G., Umathevy, T. and Lim, B.L. (1967). Helminth infections in a black panther (*Felis pardus* Linn) *Med. J. Malaya*, **21**: 374.
- Itam, Onyah (1967). Filariasis among Malayan aborigines examined at the Gombak Hospital during the period 1961-1966. *Med. J. Malaya*, **21**: 384-385.
- Kutty, M.K., Das, A.M. and Dissanaike, A.S. (1975). *Sarcocystis* infection in an Orang Asli: the second human case from Malaysia. *S. East Asian J. trop. Med. Publ. Hlth.*, **6**: 400-401.
- Kutty, M.K. and Dissanaike, A.S. (1975). A case of human *Sarcocystis* infection in West Malaysia: *Trans. R. Soc. trop. Med. Hyg.*, **69**: 503-504.
- Laing, A.B.G. and Wharton, R.H. (1960). Filariasis investigations. *Rep. Inst. med. Res. Fed. Malaya*, 114-131.
- Lee, H.F. and Miyazaki, I. (1965). *Paragonimus westermani* infection in wild mammals and crustacean host in Malaysia. *Am. J. trop. Med. Hyg.*, **14**: 581-585.
- Leong, S.H., Murugasu, R. and Chong, K.C. (1975). Schistosomiasis in the Orang Asli (A report of 9 cases). *Proc. 10th Malaysian/Singapore Congress of Medicine*. **10**: 21-24. Stamford College Press (Pte.) Ltd. Singapore 15.
- Mak, J.W. (1974). Filariasis surveys carried out in various places in West Malaysia. *Rep. Inst. med. Res. Malaya*. for 1973. p. 82.
- Murugasu, R. and Dissanaike, A.S. (1973). First Case of Schistosomiasis in Malaysia. *Trans. R. Soc. trop. Med. Hyg.*, **67**: 880.
- Murugasu, R. and Por, P. (1973). First case of Schistosomiasis in Malaysia. *S. East Asian J. trop. Med. publ. Hlth.* **4**: 519-523.
- Nevin, H.M. (1938). Ipoh Branch Laboratory. Health Survey. *Rept. Inst. med. Res. Fed. Malaya States* for 1937. 145-148.
- Polunin, I. (1951). Observations on the distribution of filariasis in the interior of the Malay Peninsular. *Med. J. Malaya*, **5**: 320-323.
- Polunin, I. (1953). The Medical Natural History of Malayan Aborigines. *Med. J. Malaya*, **8**: 55-174.
- Prathap, K. and Dissanaike, A.S. (1976). Third case of *Sarcocystis* from man in Malaysia. *S. East Asian J. trop. Med. publ. Hlth.*, **1**: 489.
- Prathap, K., Ramachandran, C.P. and Huag, N. (1968). Hepatic and pulmonary porocephalasis in a Malaysian Orang Asli (Aborigines). *Med. J. Malaysia*, **23**: 92-95.
- Prathap, K., Lau, K.S. and Bolton, J.M. (1969). Pentastomiasis: a common finding at autopsy among Malaysian aborigines. *Am. J. trop. Med. Hyg.*, **18**: 20-27.
- Ramachandran, C.P., Hoo, C.C., Omar bin Abu Hassans (1964). Filariasis among aborigines and Malay-living close to Kuala Lumpur. *Med. J. Malaya*, **18**: 193-200.

- Ramachandran, C.P. and Prathap, K. (1967). Hepatic and pulmonary Porocephaliasis in a Malaysian Orang Asli (aborigine). *Med. J. Malaya*, **22**: 246.
- Rohde, K. (1965). *Paragonimus* in Malaya. *Singapore med. J.*, **6**: 51-52.
- Rohde, K. (1966). Possible sources of human infections with *Opisthorchis* and *Paragonimus* in Malaya. *Med. J. Malaya*, **20**: 350-351.
- Sandosham, A.A. (1953). Worm infections of some Malaysian aborigines. *Studies from the Inst. for Medical Research Fed. Malaya, No. 26*: 210-211.
- Sandosham, A.A., Eyles, D.E., Pull, J.H. and Ling, D.S. (1966). Chloroquine-resistant *falci-parum* malaria in a semi-immune indigenous population in North Malaya. *Med. J. Malaya*, **21**: 115-124.
- Tan, D.S.K. and Zaman, V. (1973). Toxoplasma antibody survey in West Malaysia. *Med. J. Malaysia*, **27**: 188-191.
- Thomas, V. and Dissanaiké, A.S. (1977). Malaria endemicity among Orang Asli (Malaysian Aborigines) determined by indirect fluorescent antibody tests. *Am. J. trop. Med. Hyg.*, **26**: 601-611.
- Wharton, R.H., Laing, A.B.G. and Cheong, W.H. (1963). Studies on the distribution and transmission of malaria and filariasis among aborigines in Malaya. *Ann. trop. Med. Parasit.*, **57**: 235-254.
- Wilson, T. and Reid, J.A. (1951). Filariasis section - Institute for Medical Research Federation of Malaya Jubilee Vol. p. 209-227. Study No. 25. The Institute for Medical Research 1900-1950. Govt. Press, Kuala Lumpur.