REVIEW OF RESEARCH IN PARASITOLOGY IN SINGAPORE*

By Professor R. S. Desowitz

(Department of Parasitology, University of Singapore)

I. HISTORICAL BACKGROUND

Parasitological research in Singapore has been closely associated with the University. The University in turn owes, to a large measure, its origin to the King Edward VII College of Medicine which was founded in 1905. In 1927 a Chair in Biology was established with the intention that the department be responsible for teaching biology and parasitology to medical students. The first two incumbents of the Chair in Biology, Professor K.B. Williamson and Professor B.A.R. Gater were medical entomologists and both contributed to our knowledge of Malayan insects of medical importance. Williamson introduced the "naturalistic" control of malaria, methods still largely in operation in Singapore to this present day while Gater carried out taxonomic studies on Malayan anophelines and trombiculid mites.

In 1949 the University of Malaya was established with separate departments of Botany and Zoology while the former department of Biology of the Medical College became the Department of Parasitology with Dr. A.A. Sandosham as the first Professor, a position he held until his retirement in 1960. During this period an extensive collection of endoparasites of Malayan vertebrates was made with the cooperation of the Institute for Medical Research; identification of these specimens is still being carried out. Dr. Colless, a lecturer from 1951 to 1960, studied the systematics and biology of Malaysian mosquitoes and also added to the Department's valuable collection of mosquitoes. Dr. Marshall Laird, a lecturer from 1954 to 1957, investigated, among other studies, fungal infections of mosquitoes.

I joined the Department in 1960 having previously been at the West African Institute for Trypanosomiasis Research in Northern Nigeria. It would seem that every new head of department feels obliged to enter into an initial destructive period of tearing down laboratory partitions, and changing directions of research. Perhaps this is done to exorcise the ghosts of professors past and I confess that I am not free of guilt for this sort of action. In the past parasitologists working in the tropics were, for the most part, concerned with taxonomics or the elucidation of the complicated life histories that parasites are wont to have. Fundamental research on the physiology, biochemistry and immunology of parasites were left mainly to working in temperate climates, the prevailing opinion being that a colder temperature was necessary to induce higher scientific thought. This division of scientific labors has led to confusion and important gaps in our knowledge of parasites. Generally only infections in laboratory animals could be studied in temperate climate, usually on parasites tenuously related to those causing disease in the tropics or the parasite, having gone through multiple passages through an abnormal laboratory host, bore little biological relationship to its original disease-causing form. It is important to determine the true relationship of the parasite's chemical physiology to the disease process in the natural host or the antigenic architecture to the immunological response in order that an effective method of controlling the disease may be found. This type of information is only now beginning to come from laboratories in the tropics. For better or for worse this is now the main orientation of the Department and we have embarked upon immunological and physiological investigations of parasites of local importance. Grants from the World Health Organization and China Medical Board have allowed purchase of specialized equipment and Fellowships from Wellcome Foundation, Glaxo, United States Armed Forces Epidemiological Board, and United States Visiting Professor programme have provided workers to help undertake these investigations. The Department of Zoology has also been engaged in parasitological research mainly taxonomic studies of vertebrate and some invertebrate animals. A review of their studies will be given in a succeeding section of this report.

II. PARASITIC INFECTIONS IN SINGAPORE

Intestinal parasites are chiefly responsible for parasitic infections in Singapore. It must be appreciated however that while Singapore is a small island it is composed of many types of

*A paper read at the Unesco Regional Symposium on the Scientific Knowledge of Tropical Parasitology at the University of Singapore in November 1962 and to be published in its Proceedings.

TABLE I

THE INCIDENCE OF INTESTINAL PARASITES IN SOME COMMUNITIES OF SINGAPORE ISLAND

	Per cent Infected						
	Tenement area	Urban kampong	Urban farm	Rural farm	Labour lines	Coastal kampong	Medical students
No. of persons examined	54	95	98	104	101	111	51
Per cent infected with one or more parasites	53.7	92.6	94.9	98.1	90.4	84.13	51.0
Trichuris	50.0	75.8	72.5	87.5	81.2	78.9	31.4
Ascaris	5.5	61.0	53.1	60.6	47.5	46.6	3.9
Hookworm	16.6	10.5	28.6	77.9	55.5	38.5	3.9
Taenia	—	—	—	1.0	—	—	—
Hymenolepis	—	—	—	—	1	—	—
Chlonorchis	1.8	—	—	—	—	—	—
Giardia	7.4	10.5	11.2	21.2	6.9	8.6	2.0
E. histolytica	9.2	5.3	8.2	1.9	6.1	1.9	3.9
E. coli	—	2.1	4.1	3.9	8.9	2.4	5.9
Endolimax	—	—	—	1.9	4.0	1.0	2.0
Iodamoeba	—	—	1.0	0.9	1	0.5	—
Balantidium	—	1.0	—	—	—	—	—
Chilomastix		—	—	—	—	0.5	—

racial and cultural communities living under widely different socio-environmental conditions. For this reason a recent survey carried out by members of this department (Desowitz, Zaman, and Ng, 1961) typical communities of tenement, urban kampong, urban farm, rural farm, labour lines, coastal kampong communities and medical students were examined. The results of the preliminary survey are shown in Table 1. It will be seen that although the rate of parasitism is high (50% or more) for all groups, it is naturally highest in those communities associated with the soil. Hookworm was highest in the rural farm area where the soil is sandy and there is adequate shade from the palms fringing the farms. The incidence of hookworm in such areas has not diminished in the 37 years since the survey made by the Rockfeller Commission (Barnes and Russell, 1925). Further surveys are planned with emphasis on actual worm burdens and it is hoped that cooperation with clinical departments can be obtained in order to assess the effect of such level of parasitism on communities where the levels of infection are high. It is Singapore's good fortune and the parasitologists bad luck that trematode infections are rare and not indigenously acquired on the island. Sandosham (1955) reported the occurrence of *Schistosoma japonicum* in the immigrant population from Fukien and Hokkien. He also noted that local snails would not experimentally transmit *S. hematobium*. *Chlonorchis sinensis* infection also is present in the immigrant Chinese population. In 1938 Shrimpton noted a 1.6% infection rate and Sandosham (1955) just before the war a 2.5% infection rate. No instance of locally contracted Clonorchiasis has been described. Infections with *Taenia solium* or *T. saginata* are rare although *Hymenolepis nana* occurs in about 1% of the population. Danaraj, Schacher and Colless (1958) in a survey of 902 randomly sampled hospital patients showed that 5.5% of the population to be infected with *Wuchereria bancrofti* and that of 1,152 wild-caught *Culex fatigans* 1.6% were infected with larvae of this parasite. However clinical filariasis is not common in Singapore.

Approximately 5-10% of the population harbour cysts of *Entamoeba histolytica*. Amoebiasis does not appear to be a serious medical problem in Singapore there being only 28 hospital admissions for the infection in 1958. *Giardia* is relatively common in Singapore but its role as a pathogen requires further investigation. Singapore has a long and notable history of malaria control and malaria has been virtually eliminated from the island. In 1959 all of the 30 reported cases of malaria were contracted either in India, Indonesia or the Federation of Malaysia. Control has been realized by larvacidal measures, mainly directed against the breeding sites of *Anopheles maculatus*. The Government Health Department has an anti-mosquito unit which maintains and extends permanent subsoil anti-malarial drains and carries out an extensive larvacidal spraying campaign using malariol, gammexane and D.D.T.

It is probable that other parasitic infections such as visceral larval migrans and toxoplasmosis are present but as yet have gone unrecognized. The Department of Parasitology in cooperation with the Paediatric Department and the Ophthalmic Unit is attempting to establish a toxoplasmosis diagnostic service. We have been unable to employ the Sabin-Feldinan Dye test because of the failure, so far, to obtain normal human sera containing accessory factor. Trials with the tanned red cell hemagglutination test are now being carried out.

III. CURRENT RESEARCH

The bulk of the Department of Parasitology's current research will be described by the staff members during the course of this Symposium. A considerable proportion of our work centers about various aspects of immunity to parasites. Mrs. B. Stein and myself have developed a red blood cell hemagglutination test for malaria. Mrs. Stein has now modified the test using formalized tanned cells and is able to measure antibody levels in naturally infected humans and experimentally infected monkeys and rats. A microspot precipitin test on bacterial filter membranes has also given positive results and since it is a method of great simplicity further work is being carried out in conjunction with the hemagglutination test. Dr. Zaman has applied the immobilization test to *Balantidium* and has been able by this immunological method to distinguish between species derived from pigs and humans.

Dr. Zaman has also used the gel-diffusion method to identify the antigens of mosquitoes. Antibodies were prepared by multiple infections of mosquito extracts. He has been able to show that antigenic structure changes from stage to stage of the insects life history. So far it has been possible to distinguish different genera by this technique but not species. Further refinement of the method could make it a useful taxonomic tool. Research in hookworm immunity and physiology is also being carried out. As with mosquito antigens it has been demonstrated that hookworms show stage specific antigens. The same stage of different species appear to be more closely related than different stages of the same species. Antigenic analysis has been carried out by gel-diffusion methods and antibody measurement by the respiratory technique originally developed to estimate antibody levels in trypanosomal immunity. Amino acid analysis of hookworms have been made. There is little difference in composition between hydrolyzates of larvae and adults the free amino acids differ quantitatively there being greater amounts of lysine and arginine in the adult than in the larvae.

Dr. M.A. Fernando has carried out research on the physiology of hookworms. The basic metabolism of infective larvae and adults has been compared and considerable differences noted. The main object of the present research is to elucidate the mechanism by which serum seems to be necessary for glycogen synthesis in the adult hookworm.

Dr. Pacheco has been investigating the etiology of Tropical Pulmonary Eosinophilia using an immunochemical approach to the problem. Much of the evidence of a filarial etiology has been adduced from the results of the complement fixation test with Dirofilarial antigen. Dr. Pacheco has now found that antigens prepared from a wide variety of trematode and nematode helminths also give positive results. Gel-diffusion precipitin lines have been obtained with patient's serum and antigens from both *Ascaris lumbricoides* and *Dirofilaria immitis*. Investigations on the susceptibility of mosquitoes to *Brugia* is also in progress. *Culex fatigans*, a mosquito not normally susceptible to infections with this filaria were found to show an infection rate of 25% to 32% if aged 2 weeks before giving an infective feed on the cat. Inbreeding for susceptibility and non-susceptibility has led to the development of two strains of *C. fatigans* one showing an infection rate of 50% to 60% the other of 0% to 5%. The development of these strains provides a good tool for further investigations on the mechanism of the mosquitoe's susceptibility to filarial infection.

Dr. Barr, Visiting Professor of Parasitology, has succeeded in maintaining a laboratory colony of *Armigeres subalbatus* (=*obturbans*) and this species is also to be employed in filarial transmission studies. Dr. Barr is also investigating the mosquitoes which breed in pitcher plants.

Dr. C.H. Fernando of the Department of Zoology, University of Singapore, has been carrying out taxonomic studies on the helminths of Malayan amphibia, reptiles and fresh-water fishes. He is now preparing a comprehensive bibliography of literature on non-medical, non-veterinary Malayan helminth parasites. Members of the department are also interested in the life cycle of *Rhabdisoidea* nematodes, *Fasciolia gigantica* in cattle, survey of hemogregarines of reptiles and the life cycle of anocephaline gregarines of earthworms.

IV. TEACHING

Parasitology is taught for three terms during the 4th year of the medical curriculum, about 90 hours of instruction being given for the course. In addition an advanced course in Parasitology of about 110 to 120 hours is given to physicians taking the Diploma in Public Health. Parasitology including medical entomology is also taught to government health inspectors taking the diploma of the Royal Institute of Health. A Science Faculty course in Microbiology is now being planned, the syllabus of which will include mycology, bacteriology and parasitology. In the last two years of the course the student will have the elective of taking advanced instruction in parasitology. The courses are designed to give the student as much practical work as possible, systematics not being emphasized. It is my belief that a major obstacle of teaching parasitology in the tropics is the lack of suitable textbooks. Available textbooks are usually designed for students of temperate zones and a global picture of parasitology is presented. In the tropics the future physician, veterinarian or parasitologist will meet with very special problems and since the time allotted to teach the subject is limited the material presented must bear relationship to the problems of the area.

REFERENCES

Barnes, M. E. and Russell, P. F. (1925). Final report of the survey of hookworm infection, general sanitary conditions and organized health work in the Straits Settlements, Pub. 1, Straits Settlement Rural Sanitation Campaign.

Danaraj, T. J., Schacher, J. F. and Colless, D. H. (1958). Filariasis in Singapore, *Med. J. Malaya, 12*, 605.

Desowitz, R. S., Zaman, V. and Ng, W. K. (1961). The incidence of intestinal parasites in various communities of Singapore Island, *Sing. Med. J., 2*, 91.

Sandosham, A. A. (1955). A check list of the helminth parasites of man in Malaya with brief notes on their incidence. *Proc. Alumn. Asson. Malaya, 8*, 1.