STUDIES ON ANIMAL SCHISTOSOMES IN PENINSULAR MALAYSIA: RECORD OF NATURALLY INFECTED ANIMALS AND ADDITIONAL HOSTS OF *SCHISTOSOMA SPINDALE*

K Inder Singh[1] M Krishnasamy[1] Stephen Ambu[1] Rosli Rasul[1] and Chong Ngo Long[2]

[1]Division of Medical Ecology, Institute for Medical Research, Jalan Pahang, 50588 Kuala Lumpur;
[2]School of Biological Sciences, University Science Malaysia, 11800 Penang

Abstract. Surveillance studies on cercarial dermatitis were carried out in paddy growing areas in Peninsular Malaysia. It was observed that dermatitis in paddy planters occurred in paddy fields which were cultivated using animals such as bafflos or fields where domestic animals were allowed to graze during the off planting season as these animals harbored the parasite. The causative agent of cercarial dermatitis was *Schistosoma spindale*. A total of 215 small mammals trapped from Alor Setar and 126 trapped from Labu were examined for the schistosome. In Alor Setar *Bandicota indica, Rattus argentiventer* and *Rattus rattus diardii* were the only wild mammals found to be infected with the parasite, while in the Labu areas only *Rattus tiomanicus jalorensis* was positive for the schistosome. The occurrence of *S. spindale* in *R. argentiventer* and *R.r. diardii* in Alor Setar and in *R.t. jalorensis* in Labu constitute new host and geographic distribution records of the schistosome.

INTRODUCTION

Cercarial dermatitis is caused by the penetration of cercariae of non-human schistosomes into the skin of man. In Malaysia cercarial dermatitis is an important cause of economic loss as many paddy fields are left uncultivated due to the presence of the parasite in the water.

The condition known as "sawah itch" or cercarial dermatitis was first reported among paddy planters in Malaysia by Field (unpublished reports). Preliminary investigations as to the cause of the itch were based on the theory of a cercarial infection into the skin of man. It was also noted that "sawah itch" only occurred in paddy fields where snails were present. Buckley (1938) was the first to identify the causative agent of cercarial dermatitis in Malaysia (then Malaya), which was due to the penetration of the cercariae of *Schistosoma spindale*.

The snail intermediate host was identified as *Indoplanorbis exustus* which were collected at Repah and Kepis in the state of Negeri Sembilan. The normal host of the parasite in the localities where "sawah itch" occurred and the host which is mainly responsible for the infection of *Indoplanorbis exustus* in these localities was suspected to be the buffalo as this animal is employed in the cultivation of paddy fields. Subsequently, adults of *S. spindale* were found in the mesenteric veins of a buffalo in Negeri Sembilan (Buckley, 1938) and water buffalo and cattle (Euzeby, 1956; Sandosham and Lie 1969).

S. spindale was found to be a parasite of the goat and the water buffalo (Krishnasamy *et al*, 1991) and a natural host of the paddy field rat, *Bandicota indica* (Inder Singh *et al*, 1992) in Malaysia. The goat and the Bandicoot rat were recorded for the first time as new hosts of the *S. spindale* in the country.

The Division of Medical Ecology carried out surveillance studies on cercarial dermatitis mainly in paddy growing areas. It was observed that dermatitis in paddy planters occurred in paddy fields which were cultivated using animals such as buffalos or fields where domestic animals were allowed to graze or roam about during the off planting season as these animals harbored the parasite. In the present investigations morphological details and measurements of schistosomes recovered from naturally infected Malaysian wild mammals are presented.

MATERIALS AND METHODS

Small mammals were trapped in areas where snails infected with *S. spindale* were found or from

paddy growing areas where cercarial dermatitis occurring in man had been reported *ie* the 8 and 9 kilometer Labu Road, Negeri Sembilan and a paddy growing area near Alor Setar, Kedah. Animals were killed with chloroform and adult worms were recovered from intestinal and liver mesenteries of paddy field and other rats by dissection. The worms were washed in normal saline and fixed in A F A (Alcohol-Formalin-Acetic acid mixture). Whole mounts were made, stained with para- carmine, cleared in methyl-salicylate oil and mounted in permount. All measurements are in microns except the body length which is in mm.

RESULTS

The internal organs of 40 ruminants (buffalo, cow and goat) from Alor Setar and 32 from Labu were also examined for *S. spindale* (Table 1). In both the endemic areas the buffalo and cow were positive for *S. spindale*. The worms recovered from these animals morphologically resemble those reported earlier (Krishnasamy *et al*, 1991) from the goat and the water buffalo. The worms were adult males and females which were fully mature. A total of 215 small mammals trapped from Alor Setar and 126 trapped from Labu were examined for the schistosome (Table 2). In Alor Setar, *B. indica, Rattus argentiventer* and *Rattus rattus diardii* were the only wild mammals that were found to be infected with parasites, while in the Labu area only *Rattus t. jalorensis* was positive for the schistosome. Measurements of the worms recovered from *B. indica, R. argentiventer, R. r. diardii* and *R.t. jalorensis* are presented in Table 3.

In the present investigations a total of 81 *B. indica* were captured and examined for *S. spindale* and 31 (38.3%) were found to be positive with the parasite. A total of 2,954 adult worms were recovered and 1,035 (35%) were in pairs. In Peninsular Malaysia *B. indica* has been reported from the northern states of Kedah and Perlis. The rodent is mainly found in paddy fields (Harrison, 1956). *B. indica* infected with *S. spindale* was first discovered in paddy fields in the vicinity of Alor Setar (Inder Singh *et al*, 1992).

Out of 22 *R. argentiventer* trapped from both the endemic areas only one rat from Alor Setar was infected with the parasite and two sub adults were recovered. *R. argentiventer* is mainly restricted to rice fields, although the rodent can also be found in scrub, grassland and young plantations. Its diet consists of insects, young rice plants and snails (Harrison, 1954, 1962). Out of a total of 81 house rats, *R. r. diardii* collected only one was positive for *S. spindale*. One sub adult, a female was recovered. The animal was trapped from Alor Setar, Kedah. The house rat *R. r. diardii* is generally found in houses, outhouses, stores and may frequent scrub and bush (Harrison 1957). The natural diet is mixed and also includes slugs and snails (Medway, 1983).

A total of 99 rats *R.t. jalorensis* were trapped and only one rat from Labu was found to be positive with *S. spindale*. Three sub-adult male worms were recovered from this rodent species. *Rattus t. jalorensis* is found in most habitats, except tall primary forests. It is generaly found in large numbers in oil palm plantations, but can also be found in gardens, scrub, mangroves and disturbed or regenerated woodland and occasionally enters houses. The natural diet includes insects, fruits, mollusca and roots (Medway, 1983).

Table 1

Domestic animals examined for *Schistosoma spindale* from two endemic areas in Peninsular Malaysia (Alor Setar, Kedah and Labu, Negri Sembilan).

Species	Alor Setar, Kedah					Labu, Negri Sembilan				
	No. examined	No. positive	Percentage positive	Total No. worms	No. worm pairs	No. examined	No. positive	Percentage positive	Total No. worms	No. worm pairs
Buffalo	13	2	15.4	45	0	26	6	23.1	24	3
Cow	24	4	16.7	25	0	3	0	0	0	0
Goat	3	0	0	0	0	3	0	0	0	0

Table 2

Wild animals examined for *Schistosoma spindale* from two endemic areas in Peninsular Malaysia (Alor Setar, Kedah and Labu, Negri Sembilan).

Species	Alor Setar, Kedah					Labu, Negri Sembilan			
	No. examined	No. positive	Percentage positive	Total No. worms	No. worm pairs	No. examined	No. positive	Percentage positive	Total No. worms
Bandicota indica	81	31	38.3	2,954	1,035	-	-	-	-
Rattus argentiventer	7	1	14.3	2	1	15	0	0	0
Rattus rattus diardii	77	1	1.3	1	-	4	0	0	0
Rattus tiomanicus jalorensis	7	0	0	0	0	92	1	1.1	1
Rattus exulans	2	0	0	0	0	1	0	0	0
Maxomys whiteheadi	-	-	-	-	-	2	0	0	0
Sundamys muelleri	-	-	-	-	-	2	0	0	0
Maxomys rajah	-	-	-	-	-	2	0	0	0
Rattus bowersii	-	-	-	-	-	1	0	0	0
Suncus murinus	24	0	0	0	0	-	-	-	-
Tupaia glis	-	-	-	-	-	7	0	0	0
Herpestes brachyurus	17	0	0	0	0	-	-	-	-

Table 3

Summary of measurements of *Schistosoma spindale* from naturally infected field rats (All measurements are in micron except where stated).

Features:	*Bandicota indica*		*Rattus argentiventer*		*Rattus diardii*		*Rattus tiomanicus*	
	N = 13	N = 12	N = 1	N = 1	No	N = 1	N = 3	No
Body length (in mm)	7-13 (11)	14-18 (16)	6	7	-	12	2-4 (3)	-
Width	23-45 (30)	10-14 (12)	38	11	-	15	9-18 (12)	-
Oral sucker length	153-315 (230)	23-44 (33)	-	39	-	46	14-18 (16)	-
Width	162-270 (205)	23-35 (30)	-	46	-	50	14-18 (16)	-
Ventral sucker length	180-325 (275)	21-35 (25)	198	-	-	28	18-27 (23)	-
Width	180-360 (237)	20-35 (25)	252	-	-	28	23-27 (25)	-
Esophagus length	225-405 (340)	161-219 (195)	360	135	-	198	288-315 (302)	-
Testis length	80-130 (95)	- -	69-104 (88)	-	-	-	-	-
Width	70-105 (95)	- -	50-92 (70)	-	-	-	-	-
Ovary length	- -	360-540 (435)	-	180	-	495	-	-
Width	- -	90-125 (100)	-	54	-	108	-	-
No. of testis	3-6 (5)	- -	4	-	-	-	Not seen	-
Eggs length	- -	230-250 (235)	-	ova not seen[a]	-	184-225 (195)[b]	-	-
Width	- -	35-40 (36)	-	-	-	23-32 (26)	-	-
Total No. of eggs in ut	- -	12-30 (20)	-	-	-	10	-	-
The distance between two suckers	255-555 (415)	160-219 (195)	375	150	-	240	345-360 (353)	-

Mean in parenthesis; [a] Denote immatue worm, no eggs in uterus; [b] Denote embryonated ova

DISCUSSION

Rodents are known to be susceptible to experimental infections with *S. spindale* (Buckley, 1938; Dutt, 1962; Parasarathorn *et al*, 1963; Bunnag *et al*, 1980). *S. spindale* recovered from *B. indica* morphologically resemble those reported from goats and water buffalo (Krishnasamy *et al*, 1991). The worms were adult males and females which were fully mature.

Previously in our preliminary investigations *R. r. diardii, R. argentiventer* and *R. t. jalorensis* were reported to be negative for the parasite (Inder Singh *et al*, 1992). However, in the present investigations, trapping of these rodents was carried out in the two endemic areas and these species of rodents were found to be positive with *S. spindale*.

Worms recovered from *R. r. diardii, R. t. jalorensis* and *R. argentiventer* were immature subadults as most of the organs are poorly developed although the measurements of the length of the testis in the males, esophagus, the distance between the two suckers and length of the ovary in the females fall within the normal adult range. The only female worm recovered from *R. r. diardii* contained 10 unembryonated ova in the uterus, while the female worm recovered from *R. argentiventer* had no ova. The number of ova found in the female recovered from *R. r. diardii* are less in number as compared to ova from normal worms. Female *S. spindale* were not recovered from *R. t. jarolensis*.

In Thailand the adults of *S. spindale* were found in naturally infected *B. indica* (Bunnag *et al.*, 1980). However, no eggs were found in the uterus of the female worms. In the present investigations, *B. indica* were found to be naturally infected with *S. spindale* in Alor Setar. The rodent is found in paddy fields and is a good swimmer (Walker, 1964). The host-parasite relationship appears to be well established as evidenced by the large number of viable eggs discharged in the faeces and by the heavy worm burdens found in the rodent species.

Indoplanorbis exustus the snail intermediate host of *S. spindale* was found in small streams and paddy fields in the same area. From the large number of adult worms recovered from *B. indica* it seems that *B. indica* is the main host of the parasite in Alor Setar. Also, the paddy fields in Kedah are ploughed mechanically and animals such as buffalo are seldom used in the cultivation of the paddy fields. Some farmers keep cattle or other domestic animals, but these were not incriminated as reservoirs in the study area in Kedah.

In India Niphadkar and Rao (1967) found another species of the bandicoot rat, *Bandicota bengalensis* naturally infected with *S. spindale*, and speculated on the role this rodent might play in the epizootiology of *S. spindale* infection of ruminants, as the schistosome has been found to infect goats, cattle and buffaloes (Fairly and Jesundasan, 1930), sheep (Bahalerao, 1932) and equines (Abdussalam and Sarwar, 1957).

B. indica and other field rats from provinces in northeast Thailand were found to be the hosts of *Schistosoma incognitum* (Lee and Wykoff, 1966; Harinasuta and Kruatrachue, 1967; Bunnag *et al*, 1980) and in Java, Indonesia (Stafford *et al*, 1977). This schistosome also causes dermatitis in man. However, in the present investigations *B. indica* has not been incriminated as a host of *S. incognitum* in Malaysia.

The low infection rate and worm recovery and the absence of fully embryonated eggs in *R. r. diardii* and *R. argentiventer* indicates that these rodents are poor hosts of *S. spindale*. Similarly, the absence of infection in a large number of *R. t. jalorensis* examined from the Labu area also indicates that this rodent is a poor host for *S. spindale*. In the endemic areas in Labu, farmers rear the water buffalo. This animal is allowed to graze and make wallows in the fields which are adjoining irrigation canals, streams, or small rivers. In endemic areas the infected snail host of the parasite were found in large numbers in the water ways. As *S. spindale* adults have been recovered from buffalo in this area (Krishnasamy *et al*, 1991) it is evident that the main host of the parasite in the Labu area is the water buffalo.

The occurrence of *S. spindale* in *R. argentiventer* and *R. r. diardii* in Alor Setar, Kedah and in *R. t. jalorensis* in Labu, Negeri Sembilan constitute new host and geographic distribution records for this schistosome.

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REFERENCES

Abdussalam M, Sarwar MM. 1957. *Schistosoma spindale* in equines. Proceedings of the Pakistan Science Conference, 9th, 1957; Part III: 126.

Bahalerao GD. On the identity of the schistosomes found in cases of bovine nasal granuloma and some observations of a few other members of the Schistosomatidae. *Indian J Vet Sci Anim Husbandry* 1932; 2 : 338-56.

Buckley JJS. On a dermatitis in Malaya caused by the cercaria of *Schistosoma spindale* Montgomery, 1906. *Helminthol* 1938; 16 : 117-20.

Bunnag T, Impand P, Imlarp S, Sornmani S. Sympatric occurring of *Schistosoma incognitum* and *Schistosoma spindale* in rodents. *Southeast Asian J Trop Med Public Health* 1980; 11 : 141-5.

Dutt SC. Studies on the susceptibility of the guina-pig to infection with *Schistosoma spindale* Montgomery, 1906. *Parasitology* 1962; 52 : 199-206.

Euzeby JA. Report of the government of the United Kingdom on the control of helminthic infestation in Malaya. FAO Report. 1956; 493.

Fiarley NH, Jasudasan F. Studies on *Schistosoma spindale*. Part II. The definitive hosts of *S. spindale* with special reference to alimentary infection in ruminants. *Indian Med Res Mem* 1930; 17 : 17-39, 13 pl.

Harinasuta C, Kruatrachue M. Studies of the morphology and life-cycle of *Schistosoma incognitum* in its incidence in rats. The Final Technical Report of the Bangkok School of Tropical Medicine to US Army Medical R&D Command, Washington, Grant No. DA-MD-49-193-65-G166, 1967.

Harrison JL. Natural food of rats and some other mammals. *Bull Raff Mus* 1954; 25 : 157-65.

Harrison JL. Bandicoot rats from Malaya and Thailand. *Bull Raff Mus* 1956; 27 : 27-31.

Harrison JL. Habitat studies of some Malayan rats. *Proc Zool Soc London* 1957; 128 : 1-21.

Harrison JL. The natural food of some Malayan mammals. *Bull Nat Mus Singapore* 1962; 30 : 5-18.

Inder Singh K, Krishnasamy M, Ambu S. The large Bandicoot rat, *Bandicota indica*, a new host for *Schistosome spindale*, Montgomery, 1906, in Peninsular Malaysia. *Southeast Asian J Trop Med Public Health* 1992; 23 : 537-8.

Krishnasamy M, Lee CC, Inder Singh K, Amin Babjee SM, Rehana AS, Jeffery J. Studies on animal schistosomes in Peninsular Malaysia. I. Description of *Schistosome spindale* (Montgomery, 1906) from goat and buffalo. *Trop Biomed* 1991; 8 : 161-5.

Lee HF, Wykoff DE. Schistosomiasis from wild rats in Thailand. *J Parasitol* 1966; 52 : 323.

Medway L. The Wild Mammals of Malaya (Peninsular Malaysia) and Singapore. 2nd ed. Kuala Lumpur: Oxford University Press, 1983; pp 131.

Niphadkar SM, Rao SR. Natural occurrence of *Schistosoma spindale* in *Bandicota bengalensis* in Bombay together with a note on their possible role in the dissemination of schistosomiasis spindale in domestic ruminants. *Indian Vet J* 1967; 44 : 563-5.

Parasarathorn T, Tongkoom B, Hiraniramon S, Ito J. On the discovery and prevalence of *Schistosoma spindale* (Montgomery, 1906) in Thailand. *Jpn J Med Sci Biol* 1963; 16 : 39-43.

Sandosham AA, Lie KJ. Cercarial dermatitis in West Malaysia. Proceedings 4th Southeast Asian Seminar on Parasitology and Tropical Medicine, Manila 1969: 105-109.

Stafford EE, Tanudjaja S, Purnomo. *Schistosoma incognitum* in Jakarta, Indonesia. *Southeast Asian J Trop Med Public Health* 1977; 8 : 410.

Walker EP. Mammals of the World. Baltimore: John Hopkins Press. 1964.