SCHISTOSOMA INCOGNITUM AND ITS ZOONOTIC POTENTIAL ROLE IN PHITSANULOK AND PHICHIT PROVINCES, NORTHERN THAILAND

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INTRODUCTION

Four species of mammalian schistosomes have been recorded in Thailand : 1) *Schistosoma japonicum*-like in man in Nakornsri-thammaraj, southern Thailand (Chaiyaporn *et al.*, 1959; Harinasuta and Krautrachue, 1962) in Phitsanulok, northern region and in Ubon, northeastern region (Lee *et al.*, 1966); 2) *S. spindale*, blood fluke of cattle and water buffalo producing cercarial dermatitis in man (Harinasuta and Sornmani, 1965) ; 3) *Orientobilharzia harinasutai* in water buffalo in southern region (Kruatrachue *et al.*, 1965); and 4) *S. incognitum*, blood fluke of a variety of rodents in Phitsanulok (Lee and Wykoff, 1966); and Khon Kaen (Harinasuta and Kruatrachue, 1967) causing dermatitis in man.

During the course of snail surveys on water-borne parasitic infections in the area under the Phitsanulok Irrigation Project in 1978 and 1979, we found a high prevalence rate of *S. incognitum* in domestic mammal and rodents and some ecological aspects of this parasite were observed and described in this paper.

MATERIALS AND METHODS

Study areas : General topographic terrain and environmental conditions of the Phitsanulok Irrigation Project were described elsewhere (Bunnag *et al.*, 1980 a, b). Trapping sites in this study were mainly around permanent natural waterbodies or reservoirs and ditches or canals where there are high water table all year round. A total of 24 waterbodies in Phitsanulok and Phichit areas were included in the study. The characteristics of these natural water reservoirs are specifically described.

Swampy habitat : 13 swamps were situated within cultivated rice fields, and were characterized by thick bushes of tall grass intermixed with herbaceous vegetation at the edge of habitat, forming a dense cover which was difficult to penetrate.

Ditch habitat : The habitat was, in general, characterized by high gradient banks covering with fast growing species of vegetation, wild banana, vines or some taller bamboos. There were also emerged, floating water plants-*Eichornia* sp., *Pistia* sp. or *Typha* sp. densely covering the water surface. Usually the habitat almost dried up or few collections of water beds were seen during the dry season.

During 1978 and 1979, 3 field trips were made to the studied areas on 3 different seasons to collect both mammal and aquatic intermediate hosts : June-July 1978 (rainy season), November-December 1978 (cool-dry season), and March-April 1979 (dry season). Physico-chemical properties of surface water from each waterbody were determined by Hach Portable water engineering's laboratory - DR - EL series (Hach Chemical Co., Iowa, U.S.A.) Weather and environmental conditions on that experimental day were also

Table 1

Analysis of water from different sources of waterbeds in Phitsanulok and Phichit provinces during 1978—1979.

Period/Habitats	Temp°C		pH	Turbidity (FTU)	D.O mg/1	Chemistry mg/1					
	Water	Air				Mg	Ca	$CaCO_3$	NaCl	Cl^-	SO_4^-
Jun.—Jul. 78											
Swampy	28.6	30.3	6.1	146	5.2	30	37	17.9	21.4	12.9	23.2
			(5.1—6.7)	(15—740)	(2.0—8.5)	(11—67)	(14—123)	(3.5—423)			
Ditch	29.5	31.3	7.2	75	5.1	26	35	20.4	21.9	13.3	17.7
			(5.4—7.8)	(12—188)	(1.2—8.5)	(5—46)	(15—52)	(3.5—77.5)			
Nov.—Dec. 78											
Swampy	25.1	27.5	8.1	22	4.9	21	25	3.7	3.4	2.04	9.7
			(7.4—8.5)	(5—40)	(3.0—7.0)	(10—40)	(12—60)	(0.7—7.7)			
Ditch	26.8	28.4	8.0	29.5	3.9	15.5	29	3.2	4.5	2.5	6.8
			(7.4—8.3)	(10—59)	(2.0—8.0)	(10.0—31.0)	(11—70)	(0.7—7.7)			
Mar.—Apr. 79											
Swampy	28.1	31.7	8.1	55	4.6	34	40	17.8	29.3	17.7	15.9
			(7.8—8.3)	(10—161)	(2.0—7.5)	(5—95)	(10—110)	(2.1—105.7)			
Ditch	29.2	31.9	8.0	74.8	4.2	35.4	46.9	21	13.9	8.5	10.1
			(7.7—8.3)	(13.0—145.0)	(2.5—6.0)	(5.0—65.0)	(14.0—110.0)	(2.1—105.7)			

D.O = dissolved oxygen; Mg = magnesium; Ca = calcium; NaCl = sodium chloride;

Cl^- = chloride; SO_4^- = sulphate; $CaCo_3$ = calcium carbonate.

recorded. Fresh-water mollusks were collected by scooping method per man per hour along the edge habitat. Snails collected were identified and recorded. *Radix auricularia rubiginosa* snails, the intermediate host of *S. incognitum*, were shed or crushed to release trematode larvae. Laboratory mice were exposed to released schistosome cercariae to obtain adult schistosomes for species confirmation.

Wild rodents were trapped from 2 different ecological habitats of 24 sampling sites. Rodents were live trapped at night in habitats or the rice field dikes nearby where there were plenty of burrows and rats' track. All animals were killed, identified to species and examined for worms. Worms were collected by the perfusion technique described by Yolles *et al.*, (1947). Worms collected from each specimen were individually fixed in 10% formalin for further investigation. Stool samples of domestic animals obtained by direct rectal scraping in dogs and cats and by samplings from the pigsty or animal dens in large animals were kept in vials and examined for the presence of *S. incognitum* ova by merthiolate-iodine-formalin concentration method. All specimens were examined in the laboratory of Department of Tropical Medicine in Bangkok.

RESULTS

Ecological data : The climatic conditions during the studied period were unusual in that the rainy season was unusually short resulting in lengthened drought and the prolonged dry season. The average ambient and water temperature of swampy habitats were slightly lower than those of ditch habitats. Table 1 summarizes the abbreviated physico-chemical data of the 24 various habitats in different seasons. Both types of habitats exhibited low turbidity, allowing good light penetration and high photosynthesis activity which resulted in moderately high dissolved oxygen (D.O.) and pH range (6.1-8.1). Specific abiotic factor analyses such as cations (Ca^{++}, and Mg^{++}) and anions (Cl^-, $SO_4^=$) showed ralatively lower concentrations in cool-dry season than in other seasons but correlated well with observed hardness values.

Natural infection in snails : A total of 44,412 fresh water mollusks of 13 different species collected were examined during the period of 3 seasonal surveys. Of these, 7,186 snails were *R. a. rubiginosa*. The populations of *R.a. rubiginosa* fluctuated according to seasons and habitats but were lower compared with other pulmonate species such as, *Indoplanorbis exustus*. Out of 7,186 *Radix* snails examined from all sites, 149 (2.1%) were found infected with *S. incognitum*. Snails that measured over 15 mm (3.4%) exhibited the highest infective rate and 6-10 mm (0.9%) the lowest infection rate (Table 2). Schistosome cercariae shed from *R. a. rubiginosa* developed into patent *S. incognitum* adults about 6 weeks after exposure in laboratory mice but an exact prepatent period was not established.

During the study period, 483 *Rattus rattus*, 280 *Bandicota indica* 65 *B. savilei* and 8 *R. argentiventer* were trapped. These consisted of 299 rats collected in the rainy season, 124 in cool-dry season and 413 in hot season. Of total, 41.7% (349) were found naturally infected with *S. incognitum*.

Table 3 shows the prevalence of *S. incognitum* infection in wild rats at different seasons and ecological habitats. The overall infection rate in four species of rats was 46.5% (range 22-68) during rainy season, 29.8% (range 8-55) during cool-dry season and 41.9% (range 10-100) during hot season. The infection rate in these rats was statistically low during cool-dry season. *R. rattus* from both habitats showed no marked difference in

Table 2

Seasonal prevalence of *S. incognitum* in *Radix rubiginosa* from different habitats.

Snail size mm	Swampy habitat			Ditch habitat			Total	%
	rainy*	cool	hot	rainy	cool	hot		
< 5	0/8**	0/9	0/16	0/12	1/31	0/0	1/76	1.3
6—10	3/91	5/170	0/287	1/139	0/168	1/228	10/1083	0.9
11—15	7/727	20/675	17/1137	17/375	0/500	6/534	67/3948	1.7
> 15	6/154	32/391	19/672	3/111	8/444	3/307	71/2079	3.4

*Rainy = June – July; cool = Nov.–Dec; Hot = Mar.–Apr.
**Number positive/Number examined.

Table 3

Prevalence of *S. incognitum* in field rats from different habitats.

Rodent species	Swampy habitat		Ditch habitat	
	No. exam.	No. pos. (%)	No. exam.	No. pos. (%)
*R. rattus**	91	62 (68.1)	72	16 (22.2)
B. indica	93	48 (51.6)	37	10 (27)
B. savilei	6	3 (50)	—	— —
*R. rattus**	21	9 (42.8)	37	3 (8.1)
B. indica	40	22 (55)	19	2 (10.5)
B. savilei	7	1 (14.2)	—	— —
*R. rattus**	165	100 (60.6)	97	25 (25.8)
R. argentiventer	4	4 (100)	4	3 (75)
B. indica	42	21 (50)	49	17 (34.7)
B. savilei	30	3 (10)	22	0 (0)

*During rainy, cool and hot season.

infection rates from *B. indica* (44.5% and 42.8%) but the rates were significantly different from *B. savilei* (10.8%) ($p > 0.01$). Although the rate in *R. argentiventer* (87.5%) was found to be significantly higher than the three species, but the number examined was rather low to give meaningful interpretation. The mean worm-load per infected *B. indica* (342.2 ± 728.9) was found significantly higher than that of *R. rattus*, *R. argentiventer* and *B. savilei* in swampy habitat ($p > 0.15$). The mean worm-loads of *R. rattus* and *B. indica* did not different ($p > 0.5$) but they were significantly higher than that in *R. argentiventer* in ditch habitat ($p < 0.05$) (Table 4).

The results of stool examinations of 685 dogs, 215 cats, 166 water buffaloes, 115 cattle and 189 pigs revealed that 27 (3.9%) dogs examined were found naturally infected with *S. incognitum*. The others were negative.

Sympatric occurrence of *S. incognitum* and *S. spindale* : *S. incognitum* and *S. spindale* were found in *B. indica* and *B. savilei*, Both

Table 4

Intensity and mean worm load of *Schistosoma incognitum* in field rats.

Habitat/species	No. of rat infected	Worms recovered				Mean worm load per infected rat ($\bar{X}$ ± S.D.)	Range
		Pair	Male	Female	Total*		
Swampy							
R. rattus	116	1076	1945	1015	5,311	45.8 ± 79.5	1—584
R. argentiventer	4	153	152	85	561	140.3 ± 136.8	36—377
B. indica	86	9197	7277	3450	29,432	342.2 ± 728.9	1—3739
B. savilei	7	58	86	20	223	31.9 ± 41.3	1—102
Ditch							
R. rattus	32	511	1060	665	2,795	87.3 ± 100.3	1—368
R. argentiventer	3	6	5	46	63	21 ± 20.9	7—45
B. indica	23	530	638	246	2,018	87.7 ± 161.9	1—731

*including schistosomulae.

schistosome species were found concurrently in the same host (Bunnag *et al.*, 1980). No heterologous pair of both species was observed, only a few of *S. incognitum* males carried double females in copula in *B. indica* were seen.

DISCUSSION

The general ecological data of both swampy and ditch habitats for *R. a. rubiginosa*, an intermediate snail host of *S. incognitum*, illustrate the overall similarity as suitable habitats for *R. a. rubiginosa*. This snail is widely distributed in Thailand except in northernmost part of the country (Brandt, 1974; Viboolyavatana *et al.*, 1981). The snails were found more abundantly in swampy habitat than in ditch area. Snails infected with *S. incognitum* occurred all year round with an overall infection rate of 2.1% (Table 2). A variety of rodents live in close association with the snails in these habitats, coupled with nocturnal feeding of rats apparently result in high transmission rates observed for *S. incognitum* in the area.

In Thailand, Harinasuta and Kruatrachue (1967) reported overall infection rates of 6.5% in *Lymnaea* snails and 45.5% in rodents (*B. indica*, *R. r. thai* and *R. berdmori*). In the present investigation, the overall infection rate of *S. incognitum* in *R. rattus*, *R. argentiventer*, *B. indica* and *B. savilei* was 41.7%. *B. savilei* and a few *R. argentiventer* were added to the new mammalian host list in this area. Recently, Artchawakom (1981) found 10.8% of *R. argentiventer* infected with *S. incognitum* in Nakhon Pathom. *R. rattus* and *B. indica* exhibited higher rates of infection and mean worm-loads than *B. savilei*, which could be due to habitat preference and to the susceptibility status of the rodent hosts. These two species are primarily field rats, are confined to the open only, and feed at night within or close to water habitats. Thus, their chances of coming into contact with the snail intermediate hosts of the parasite are greater. *R. argentiventer* are rice field and grassland inhabitants, and confined to low lands in central and southern parts of Thailand (Lekagul and McNeely, 1977). The very low number of *R. argentiventer* trapped in the study area could be due to ecological niche competition with the predominant *R. rattus* and *B. indica*. The high rate of individual infection (87.5%) and high mean worm-load (78 ± 112.36) indicate that they may also play as an important role as host of this parasite. Similarly, in Indonesia, Carney *et al.*, (1977) reported a high infection rate in *R. argentiventer*, averaging 84%. Thai and Javanese strains of *S. incognitum* are apparently well adapted to rodent hosts that live in close association with *Lymnaea* snails.

In India, *S. incognitum* has been reported from naturally infected dogs and domestic pigs, as well as from a wide range of experimental hosts including sheep, goats, cattle, rabbits (Sinha and Srivastava, 1965). In Indonesia, Carney *et al.*, (1977) incriminated the Timor deer, *Cervus timorensis*, as a natural host of *S. incognitum* in Central Sulawesi. In the present survey, 3.9% of 685 dogs showed *S. incognitum* eggs in their stools whereas other domestic mammals yielded negative results. This may be due to the fact that dogs followed the owners to the rice fields and thus exposing themselves to infected waters.

In view of the zoonotic potential of *S. incognitum* to humans, surveys for intestinal parasites of humans throughout areas where this schistosome is hyperenzootic in Indonesia have not revealed a single instance of *S. incognitum* eggs in human stool specimens (Carney *et al.*, 1974, 1977; Clarke *et al.*, 1974) Similarly, in our study, where *S. incognitum* is hyperenzootic in rice field rats and domestic dogs, 1974 human stool specimens were examined but with negative results. Caution should be exercised in assessing a schistosome's zoonotic potentiality only using the presence and absence of eggs in faeces as a criterion. Chronic disease, especially in "asymptomatic" case or less well adapted human or zoonotic strain in which wormload is low and less irregular egg production, can occur in the absence of eggs in stool specimens.

Evidently, *S. incognitum* appears to be highly enzootic in this area where 42% of the rice field rats, 4% of domestic dogs and 2% of *R.a. rubiginosa* examined were infected. Also wet rice cultivation is the main occupation of the population. Thus, there is the possibility of frequent exposures of residents to this animal schistosome. In man, *S. incognitum* is likely to cause cercarial dermatitis and the possibility of patent infection cannot be excluded.

SUMMARY

A study on *Schistosoma incognitum*, a blood fluke of a variety of mammals, was conducted in different ecological conditions in Phitsanulok and Phichit, northern Thailand. The intermediate host of *S. incognitum* in permanent water habitats studied, i.e; swamps and ditches is *Radix (Lymnaea) auricularia rubiginosa*. Of 44,412 mollusks representing 13 different species collected from 24 water habitats studied, 7,186 were *R. a. rubiginosa*. *S. incognitum* infection rate in the snails was 2.1%. 483 *Rattus rattus*, 8 *R. argentiventer*, 280 *Bandicota indica* and 65 *B. savilei* were found infected with *S. incognitum* with an overall infection rate of 41.7%. *R. argentiventer* and *B. savilei* are reported as new mammalian hosts of the parasite. Also, 3.9% of dogs in the study area were found excreting *S. incognitum* eggs in their stools for the first time.

The possibility of *S. incognitum* as a zoonotic potentiality to humans is discussed and is still an equivocal issue deserving further study.

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