

COMPATIBILITY BETWEEN *ONCOMELANIA HUPENSIS* AND DIFFERENT ISOLATES OF *SCHISTOSOMA JAPONICUM* IN CHINA

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Abstract. *Oncomelania hupensis* from six localities were used for infection with different isolates of *Schistosoma japonicum* in the mainland of China, ie Anhui in the east, Hubei in the center, Guangxi in the south, Sichuan in the west, Yunnan in the southwest and Fujian in the southeast. Snails from Anhui and Hubei were readily infected with the local isolate of *S. japonicum* and cross infection also took place readily between the snails and the schistosomes from these two places. Snails from Sichuan and Yunnan were refractory to infection with schistosome isolates from Hubei and Anhui, but the isolates from Sichuan and Yunnan were able to develop in snails from Hubei and Anhui. Though the Guangxi isolate developed readily in both Anhui and Guangxi snails, the average precercarial period in the former was significantly longer than in the latter. None of the other snails from Sichuan, Yunnan and Fujian became infected. On the other hand, snails from Guangxi infected with Anhui parasites also had a longer precercarial period than that in Anhui snails. Snails from Fujian were readily infected with the isolates from Anhui and Yunnan. The present results suggest that there might be different geographic strains of *S. japonicum* and their *Oncomelania* snail hosts in the mainland of China.

INTRODUCTION

Studies by various authors have shown that *Schistosoma japonicum* includes at least five geographic strains, ie the Japanese, Philippine, Indonesian, mainland of China and Taiwan Province (Hsü and Hsü, 1958; Cross, 1976). In the mainland of China, the endemic areas of schistosomiasis japonica are mainly confined to regions south of Yangtze River, but they are discontinuous, showing conspicuous geographic and topographic isolations (Fig 1). It is very likely that due to geographic isolation, more than one strain of *S. japonicum* exists in the mainland of China. So far, little is known about the characteristics of schistosomes isolated from various localities there.

It is well known that various degrees of susceptibility have been demonstrated between *Oncomelania* snails and geographic strains of *S. japonicum* (Hunter *et al*, 1952; DeWitt, 1954; Hsu and Hsu, 1960, 1967; Chiu, 1967; Chi, 1971; Iwanaga *et al*, 1976, 1979; Cross *et al*, 1976, 1980, 1984; Lee *et al*, 1982; Yuan *et al*, 1984). The purpose of the present study, therefore, was to determine whether there was a difference in compatibility between *O. hupensis* from various

localities and different isolates of *S. japonicum* in the mainland of China.

MATERIALS AND METHODS

Source of snails

O. hupensis from the following six localities were used in this study (Figs 1, 2): (1) Guichi in Anhui (30°40'32"N, 117°28'8"E), at the lower reaches of the Yangtze River in the east; (2) Jianli in Hubei (29°50'19"N, 112°53'5"E), at the middle reaches of the Yangtze River in the middle; (3) Guiping in Guangxi (23°21'25"N, 110°3'31"E), a karst land in the south; (4) Tianquan in Sichuan (30°3'14"N, 102°24'23"E), a mountainous region in the west; (5) Eryuan in Yunnan (26°2'28"N, 98°46'48"E), a high mountainous region in the southwest; and (6) Fuqing in Fujian (25°57'47"N, 119°23'38"E), a hilly region in the southeast. Laboratory-bred snails (from Anhui) and laboratory-reared snails (from Hubei, Guangxi, Sichuan, Yunnan and Fujian) maintained in the laboratory for more than 6 months were employed in these experiments. The laboratory-reared snails were determined to be free of schistosome cercariae by examination of more than 3 times repeated shedding prior to use.

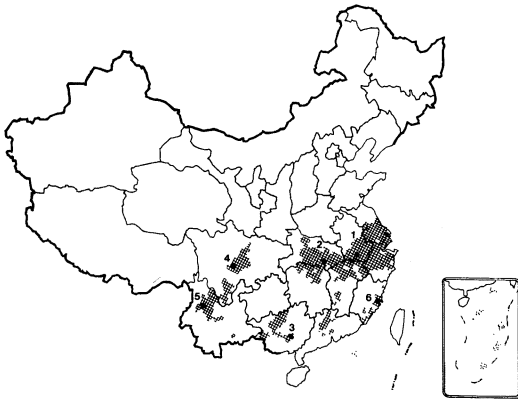


Fig 1—Map of the mainland of China showing historical endemic areas of schistosomiasis japonica and six sources of *Oncomelania* snails used in the present study

1. Guichi, Anhui; 2. Jianli, Hubei; 3. Guiping, Guangxi; 4. Tianquan, Sichuan; 5. Eryuan, Yunnan; 6. Fuqing, Fujian.

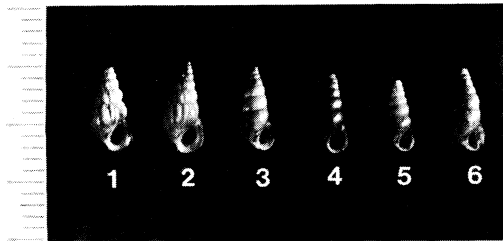


Fig 2—Shape of *Oncomelania hupensis* from six localities

1. Anhui 2. Hubei 3. Guangxi 4. Sichuan
5. Yunnan 6. Fujian

Source of miracidia

Different isolates of *S. japonicum* miracidia were hatched from ova by grinding livers of mice infected six weeks earlier with the respective isolate of 40 cercariae from naturally infected *Oncomelania* snails collected from the above-named six places, with the exception of Fujian Province where no snails could be found naturally infected with *S. japonicum*.

Infecting snails with miracidia

Oncomelania snails from various localities were individually exposed to 20 freshly hatched miracidia of each isolate of *S. japonicum* from the above-named places. Snails from each locality infected

with local isolate of *S. japonicum* was used as controls. The snails were placed singly in wells, 17 mm in diameter, of plastic titer plates with 3 ml water containing miracidia and exposed synchronously at room temperature (25°C) under a fluorescent light for 4-6 hours. After exposure, snails were transferred back to containers which were installed in a room with the temperature of 22-25°C.

Beginning 60 days after exposure, the snails were tested weekly for cercarial shedding and determined individually for the precercarial period. After approximately 120-150 days, negative snails were crushed and examined for the presence of schistosome sporocysts and cercariae. The infection rate of snails was calculated from the number of cercariae-shedding snails and crushed snails with daughter sporocysts by total number of snails survived. The total number of snails from each locality exposed to infection was variable because of supply limitations.

For each locality of snails experimented, ten snails of 2, 4, 10, 17, 28 days after exposure to different isolates of *S. japonicum* were fixed in 10% neutral formalin for paraffin serial section and observed for the presence of schistosome sporocysts.

RESULTS AND DISCUSSION

The results of various localities of *O. hupensis* infected with different isolates of *S. japonicum* miracidia are presented in Tables 1-2.

Snails from Hubei and Anhui were readily infected with the local isolates of *S. japonicum* and cross infection also took place readily between the snails and the parasites from these two places, the infection rates of Hubei snails infected with Hubei or Anhui parasites were 57.7% and 43.8%, as well as those with Anhui parasites being 44.6% and 52.2% respectively. This suggested that the schistosomes and their snail hosts from both Hubei and Anhui, the middle and lower reaches of the Yangtze River, were compatible.

Snails from Sichuan and Yunnan were refractory to infection with schistosome isolates from Hubei and Anhui, the infection rates were 0, 0, 1.9 and 0% respectively. Similar results have reported the refractoriness of *Oncomelania* snails from the

Table 1

Results of various localities of *Oncomelania hupensis* infected with different isolates of *Schistosoma japonicum*.

Source of miracidia	Infection rate of snails (No. snails infected/No. snails survived)					
	Anhui	Hubei	Guangxi	Sichuan	Yunnan	Fujian
Anhui	52.2 (303/580)	43.8 (56/128)	20.0 (36/180)	1.9 (5/270)	0 (0/173)	(1/4)
Hubei	44.6 (120/269)	57.7 (82/142)		0 (0/126)	0 (0/71)	
Guangxi	30.7 (59/192)		9.4 (12/128)	0 (0/67)	0 (0/12)	0 (0/66)
Sichuan	7.0 (62/881)	10.2 (25/244)		1.7 (6/360)	1.3 (3/229)	
Yunnan	13.4 (53/397)	44.5 (61/137)	14.9 (7/47)	1.0 (2/198)	12.5 (12/96)	4.0 (1/25)

Table 2

Precercarial period of various localities of *Oncomelania hupensis* infected with different isolates of *Schistosoma japonicum*.

Source of miracidia	Precercarial period of snails (days) $\bar{X} \pm SD$					
	Anhui	Hubei	Guangxi	Sichuan	Yunnan	Fujian
Anhui	81.6 \pm 13.7	74.3 \pm 13.1	92.7 \pm 14.5	68.8 \pm 10.7	0	76.0
Hubei	72.0 \pm 6.2	72.9 \pm 7.3		0	0	
Guangxi	100.9 \pm 13.3		76.9 \pm 2.6	0	0	0
Sichuan	79.3 \pm 12.5	67.9 \pm 8.7		74.8 \pm 4.3	68.0	
Yunnan	70.1 \pm 14.7	75.8 \pm 12.9	70.0 \pm 0	82.0 \pm 0	71.6 \pm 8.2	63.0

southwest infected with miracidia from east China (Shao *et al*, 1957; Yuan, 1958). According to the snail sections examined, early sporocysts could be found in the tissue of head-foot region of the snails from Yunnan with an infection with Hubei or Anhui parasites two days after exposure (Fig 3). This demonstrated that although the miracidia from Hubei or Anhui can penetrate into the snails from Yunnan or Sichuan, cercarial stages were found rarely in these snail hosts or no developmental stages of parasite were found. In contrast to these results, the isolates from Sichuan and Yunnan were able to develop in *Oncomelania* snails from Hubei and Anhui, resulting in infection rates of 10.2% and 7.0%, or 44.5% and 13.4% respectively.



Fig 3—Early sporocyst in the head-foot tissue of Yunnan snail on infection with miracidia of Anhui isolate of *S. japonicum* 2 days after exposure. x400

Although the Guangxi isolate of *S. japonicum* developed readily in both Anhui snails (30.7%) and Guangxi snails (9.4%), the average preercarial period was 100.9 days in the former which was significantly longer than 76.9 days of the latter ($p < 0.01$). None of the other snails from Sichuan, Yunnan and Fujian became infected. On the other hand, snails from Guangxi infected with Anhui parasites also had a longer preercarial period of 92.7 days, than that of 81.6 days in Anhui snails. The difference between the preercarial period was statistically significant ($p < 0.05$). This indicated that the relationships between the Guangxi isolate of *S. japonicum* and the *Oncomelania* snails from various localities were unique.

Snails from Fujian were readily infected with the isolates from Anhui and Yunnan, although the number of snails for respective experiments was small because of supply limitation due to the fact that the snails in endemic areas of Fujian were nearly eradicated.

The present results suggest that analysis of the compatibility between the schistosomes and their snail hosts could be made completely when the data of snails infected with shedding cercariae and preercarial periods were obtained and that there might be different geographic strains of *S. japonicum* and their *Oncomelania* snail hosts in the mainland of China.

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