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SUSCEPTIBILITY OF GEOGRAPHIC RACES OF *ONCOMELANIA HUPENSIS* TO VARIOUS STRAINS OF *SCHISTOSOMA JAPONICUM*

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Kin-Mu Lee, Yeuk-Mui Lee and Ping-Chin Fan (1986) Susceptibility of geographic races of *Oncomelania hupensis* to various strains of *Schistosoma japonicum* *Bull. Inst. Zool., Academia Sinica* **25**(1): 47-52. Five geographic races of *O. h. chiui* in Pali, Taipei, *O. h. formosana* in Changhua, Taiwan, *O. h. hupensis* from China and *O. h. quadrasi* from Leyte and Bohol, Philippines were exposed to Changhua zoophilic strain and Chinese, Japanese and Philippine human strains of *S. japonicum* at the same time. The results showed that *O. h. chiui* (Pali) possesses high susceptibility to all of the four experimental strains of *S. japonicum* as well as *O. h. formosana* (Changhua) to the respective natural host. *O. h. hupensis* was found slightly susceptible (4%) to the Changhua strain and to be resistant to the Japanese strain of *S. japonicum*. *O. h. quadrasi* obtained from Leyte and Bohol are completely refractory to the infection of the Chinese and Japanese strains, but with 0 and 20 percentage susceptibility to the Changhua strain, respectively.

The relative infectivity of the four geographic strains of the parasite to five geographic subspecies of the intermediate host not only shows the occurring potentiality of schistosomiasis in geographic districts where susceptible snails live, but also illustrate the results of evolutionary adaptation and geographic distance.

Recently, six new foci of *Oncomelania hupensis* snails in Nantou, Chiayi, Hualien and Taitung, Taiwan were found to be susceptible to the different geographic strains of *Schistosoma japonicum* by several workers (Cross *et al.*, 1980; Lee *et al.*, 1982a, 1982b). However, the susceptibility of geographic races of *O. hupensis* (including *O. h. hupensis*, *O. h. quadrasi*, *O. h. chiui* and *O. h. formosana*) to various strains of *S. japonicum* has not been carefully assessed. Although a comprehensive study of susceptibility of different races of *O. hupensis* to different geographic strains of *S. japonicum* has been published by a number of investigators (Hunter *et al.*, 1952; Moose *et al.*, 1964; Hsu *et al.*, 1966, 1967a, 1967b; Chiu 1967, 1968; Wang *et al.*, 1972; Cross, 1976), only a few sporadic, incomplete studies confirmed the above finding.

This experiment attempts to obtain more information on the infectivity of geographic strains (Changhua, Chinese, Japanese and Philippine) of *S. japonicum* to different geographic races of *O. hupensis* snails.

MATERIALS AND METHODS

Laboratory-reared specimens of 5 subspecies of snails were employed in these experiments. They were *O. h. hupensis* from China, 2 colonies of *O. h. quadrasi* from Leyte and Bohol in Philippines. Three subspecies were originally provided by former NAMRU-2

laboratory in Taipei and subsequently maintained in our laboratory, the other 2 subspecies studied were *O. h chiui* from Pali, Taipei and *O. h. formosana* from Changhua in Taiwan. All experimental snails had been determined free of *S. japonicum* infection by repeated shedding before exposure. Fifty or 60 snails of each of the five races were used and each snail exposed individually to 5 miracidia from each of Changhua, Chinese, Japanese and Philippine strains of *S. japonicum*. All the above strains of *S. japonicum* were maintained in our laboratory by passage through suitable snail host and albino-mice. Exposure of snail were made with miracidia hatched from ova which were released from infected liver or intestine tissues of laboratory white mice which had been sacrificed 50 days after infection. Only freshly hatched miracidia were used. During exposure, each snail was placed into a small vial at room temperature (25°C±2°C) and under a fluorescent light for 3-6 hours for miracidial penetration.

Six weeks after infection, cercariae-shedding tests were made weekly for ten weeks. The positive snails were based only on the shedding of cercariae within this period. However, in order to be certain that infection did not exist, all snails which had not shed cercariae were crushed and examined for sporocysts and immature cercariae at the end of the observation period.

RESULTS

The results for each race of snails exposed to infection with the 4 strains of *S. japonicum* are shown in Table 1. All races of snails except the Leyte colony from Philippines were

TABLE 1

Susceptibility of five geographic races of *Oncomelania hupensis* snails to four strains of *Schistosoma japonicum*

S. japonicum strain	Races of *O. h.* snails	No. of snails expos.	No. of snails exam.	No. of snails infect.	Infect. rate (%)
Changhua	*O. h. chiui* (Pali)	50	21	5	24
	O. h. formosana (Changhua)	50	47	22	47
	O. h. hupensis	50	47	2	4
	O. h. quadrasi (Leyte)	50	34	0	0
	O. h. quadrasi (Bohol)	50	5	1	20
Chinese	*O. h. chiui* (Pali)	60	43	33	77
	O. h. formosana (Changhua)	60	56	1	2
	O. h. hupensis	60	44	20	45
	O. h. quadrasi (Leyte)	60	54	0	0
	O. h. quadrasi (Bohol)	60	40	0	0
Japanese	*O. h. chiui* (Pali)	50	38	19	50
	O. h. formosana (Changhua)	50	50	0	0
	O. h. hupensis	50	47	0	0
	O. h. quadrasi (Leyte)	50	40	0	0
	O. h. quadrasi (Bohol)	50	39	0	0
Philippine	*O. h. chiui* (Pali)	50	49	21	43
	O. h. formosana (Changhua)	50	43	0	0
	O. h. hupensis	50	38	1	3
	O. h. quadrasi (Leyte)	50	23	5	22
	O. h. quadrasi (Bohol)	50	—	—	—

susceptible to the Changhua strain of *S. japonicum*. The best development was in the Changhua snails, in which 47% of the snails exposed produced cercariae. This was followed by Pali (24%) and Bohol (20%) snails. Susceptibility was poor (4%) in *O. h. hupensis*.

The susceptibility of 5 colonies of *O. hupensis* snails to Chinese strain of *S. japonicum* is also shown in Table 1. The Pali snails were more susceptible (77%) than the natural snail host (45%), *O. h. hupensis*, to the Chinese schistosome. Only 2% of *O. h. formosana* from Changhua produced cercariae with Chinese parasite. Both Leyte and Bohol snails were completely refractory to the infection of this parasite.

As shown in Table 1. All races except the Pali colony of *O. h. chiui* were resistant to the Japanese strain of *S. japonicum*.

Pali snails showed a higher susceptibility (43%) against the Philippine strain of *S. japonicum* than that of the natural snail host, Leyte (22%) race, *O. h. quadrasi*. A very low susceptibility (3%) to Philippine strain of *S. japonicum* occurred in the *O. h. hupensis* snails. The Changhua snails were resistant to both the Philippine and the Japanese strains of *S. japonicum*. Because of the culture soil pollution, all the Bohol snails infected with Philippine strain were killed during the course of study, so that the infection rate could not be tested.

TABLE 2

Infection percentage of *O. hupensis* from five geographic races to the four strains of *S. japonicum* by various investigators

Strain of *S. japonicum*	*O. h. chiui* (Pali)	*O. h. formosana* (Changhua)	*O. h. hupensis*	*O. h. quadrasi* (Leyte)	*O. h. quadrasi* (Bohol)
Changhua	94(C) 24(L)	35(D) 18-36(MW 1) 42(C) 14(CL) 18(L 1) 47(L)	0(D) 4(L)	0.4(D) 0(L)	20(L)
Chinese	80(C) 77(L)	0(D) 2(L 1) 2(L)	34(D) 45(L)	0(D) 0(L)	0(L)
Japanese	45(C) 49(L 2) 50(L)	0.8(HRO) 0(D) 0(L 2) 0(L)	13(D) 0(L)	0(D) 0(L)	0(L)
Philippine	91(C) 43(L)	0(HH) 0(L 1) 0(L)	20(HH) 3(L)	44-75(P) 29-45(MW 2) 25(CL) 22(L)	—

(HRO) : Hunter, Ritchi and Otori, 1952
(D) : Dewitt, 1954
(P) : Pesigan *et al.*, 1958
(HH) : Hsu and Hsu, 1960
(MW 1): Moose and Williams, 1963
(MW 2): Moose and Williams, 1964
(C) : Chiu and Lu, 1975
(CL) : Cross and Lo, 1980
(L 1) : Lee, Fan and Wu, 1982
(L 2) : Lee and Fan, 1982
(L) : Present authors

DISCUSSION

This study was the first concurrent experiment to examine the susceptibilities of five geographic races of *O. hupensis* to the one zoophilic and three human strains of *S. japonicum*.

The present data (Table 2) showed that both *O. h. chiui* (Pali) and *O. h. formosana* (Changhua) snails demonstrated similar susceptibilities to this four strains of *S. japonicum* as reported by previous investigators (Hunter *et al.*, 1952; Dewitt, 1954; Hsu *et al.*, 1960; Moose *et al.*, 1963; Chiu *et al.*, 1975; Cross *et al.*, 1980; Lee *et al.*, 1982a, 1982b). The Pali snails are distinguished by their high susceptibility to all strains of the parasite. All the persent experiment except for the *O. h. formosana* (Changhua) a greater number of Pali snails developed infection than the natural snail hosts. The Alilao and Pali snails of *O. h. chiui* have usually been found highly susceptible to various strains of *S. japonicum* (Chiu, 1965; Hsu *et al.*, 1966; Chiu, 1967; Hsu *et al.*, 1967a, 1967b; Chiu *et al.*, 1975; Cross, 1976; Lee *et al.*, 1982a, 1982b). These results were further confirmed by the present experiment. *O. h. formosana* from Changhua, however, was found to be resistant to all strains except its natural strain of the parasite. This result incorporated with the previous report (Lee *et al.*, 1982a) indicated that only one Changhua snail caused the Chinese strain infected.

On the other hand, the infectivity of 4 strains except the Chinese strain of *S. japonicum* to the *O. h. hupensis* snails demonstrated different results from the previous findings. Dewitt (1954) reported that *O. h. hupensis* race was shown to be non-susceptible to infection with Changhua schistosome and had a low susceptibility to the Japanese schistosome, whereas the present study showed that it still had 4 percent infection rate to the Changhua strain, and it was resistant to the Japanese strain in stead of the 13% infection rate reported by Dewitt. This is the first time showed that *O. h. hupensis* snails developed infection with the Changhua strain of the parasite. In addition, *O. h. hupensis* race indicated less susceptibility (3%) to the Philippine strain than 20% infection rate reported by Hsu *et al.*, (1960). Through the data showed that *O. h. hupensis* could still serve as an intermediate host to the Philippine schistosome.

It has been confirmed that each geographic strain of *S. japonicum* infects best in the *Oncomelania* subspecies from its own endemic area and a low susceptibility from other areas. This is exemplified by the observation that *O. h. quadrasi* from Leyte processed a higher infection rate to the respective Philippine strain, but completely resistant to the infection of Changhua, Chinese and Japanese strains of *S. japonicum*. This observation is compatible with previous reports (Dewitt, 1954; Pesigan *et al.*, 1958; Moose *et al.*, 1964; Cross *et al.*, 1980).

O. h. quadrasi from Bohol, was shown to be susceptible to *S. japonicum* from Changhua strain while this parasite did not develop in Leyte snails. However, it was still refractory to *S. japonicum* from Chinese and Japanese strains.

The relative infectivity of the four geographic strains of the parasite to five geographic subspecies of the intermediate host not only shows the occurring potentiality of schistosomiasis in geographic districts where susceptible snails live, but also illustrate the result of evolutionary adaptation and geographic distance.

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不同地區性釘螺 (*Oncomelania hupensis*) 對不同種系日本血吸蟲 (*Schistosoma japonicum*) 感受性之研究

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五個不同地理位置的釘螺，即位於臺北縣八里的邱氏釘螺、彰化的臺灣釘螺，和來自中國大陸的湖北釘螺，以及來自菲律賓雷第 (Leyto)、伯霍 (Bohol) 兩地的菲律賓釘螺，第一次在同一時間分別感染彰化動物株以及中國大陸、日本、菲律賓三種人株日本血吸蟲。研究結果顯示，八里的邱氏釘螺，再度證實對於四種系日本血吸蟲具有高度感受性，如同彰化釘螺對本身彰化株日本血吸蟲的感受性一般。湖北釘螺被發現對彰化株日本血吸蟲有輕度感受性 (4%)，而對日本種系之日本血吸蟲則呈現抵抗性。來自雷第和伯霍的菲律賓釘螺，對於中國大陸和日本種系之日本血吸蟲具有完全的抵抗性，但對彰化株日本血吸蟲則分別出現 (0%) 及 (20%) 的感受性。

四個不同種系日本血吸蟲在五個不同地理區釘螺的相關感染度，不僅顯示了日本血吸蟲病在產生可感染中間宿主之該地區傳播之可能性，亦說明了寄生蟲和宿主間演化上的適應和地理距離間的關係。