

Field Studies on the Bionomics of *Neotricula aperta*, the Snail Intermediate Host of *Schistosoma mekongi*, in Khong District, South Laos

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Abstract

A search for *Neotricula aperta*, the snail intermediate host of *Schistosoma mekongi*, was made at sites around Khong Island, South Laos, during the period October 25 to November 2, 1990. The river was swollen, running in torrent and heavily silted in this season. Surprisingly, however, *N. aperta* were found underneath the rocks at depths of two to three meters in swift current with a surface velocity of 75–80 cm/sec. The snails were collected by diving and picking up from the submerged rocks to which they adhere. Another snail survey was conducted during 2 weeks in low water period in May 1991. Large numbers of *N. aperta* were widely observed in shallow water almost all over the river from the shore to several hundred meters off the shore. The gamma race extremely predominated along the eastern and western sides of the island. A total of 5,314 were collected and examined for schistosome larvae in one site near Chomthong Pakoda, Khong Town, where transmission was thought to be active. No snail was found positive. This negative result might be ascribed to the successful achievement of the recent mass administration campaign of praziquantel.

Key words: *Schistosoma mekongi*, *Neotricula aperta*, Khong, high water, low water

Introduction

Schistosomiasis due to *Schistosoma mekongi* has been recognized to be endemic in Khong District of South Laos, close to the Lao-Cambodian border. The prevalence among 7–14 year-old school children, assessed by one Kato-Katz smear per child, for 9 Khong Island villages surveyed in October–November 1989, was 30.2% (Sleigh, 1989).

The intermediate host of *S. mekongi* is a tiny aquatic prosobranch snail, *Neotricula aperta*. The species was first described as *Lithoglyphopsis aperta* by Temcharoen (1971) and subsequently placed in

the genus *Tricula* by Davis (1979), and *Neotricula* by Davis *et al.* (1986). In their monograph, Davis *et al.* (1976) described three races of the species; alpha, beta and gamma. The alpha and gamma races are found, frequently together, in Khong District. The beta race is found only in the Mun River, a tributary of the Mekong in northeast Thailand. The gamma race dominates in Khong District and is the only race found to transmit *S. mekongi* naturally (Kitikoon *et al.*, 1973). This report describes the bionomics of *N. aperta* during the periods of high and low water in the Mekong River at Khong District, South Laos.

Materials and Methods

Study area: Khong Island is the largest island in the Mekong River and is one of 4,000 islands in Khong District (Fig. 1). At its longest and widest points, the distances are 28 km and 8 km, respectively. Numerous small islands slow the river current, so creating a suitable habitat for aquatic snails during low water periods. The census data for Khong District show a population of about 61,000, but it

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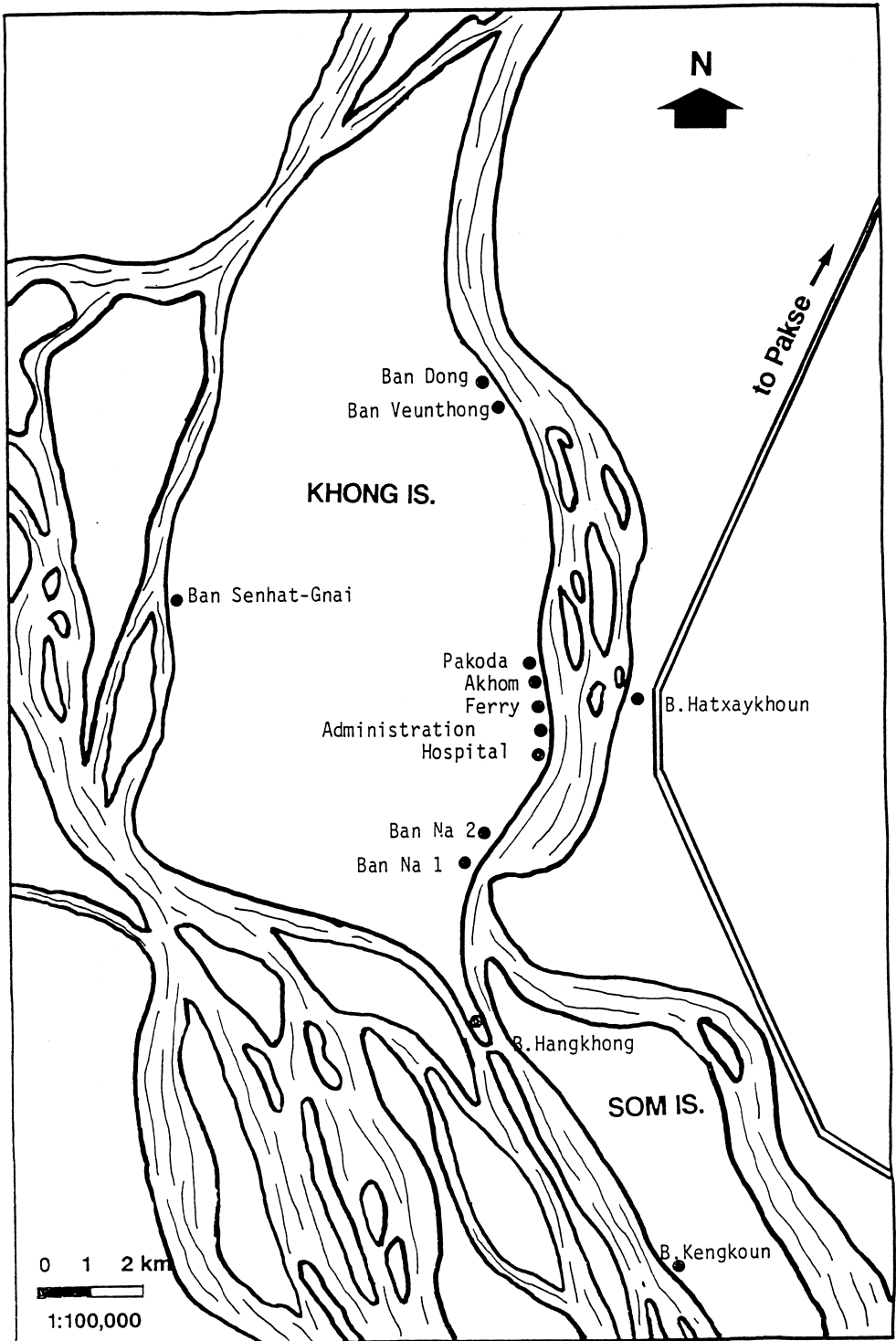


Fig. 1 Map of Khong District showing sites surveyed for *N. aperta*.

Table 1 Monthly rainfall at Khong, 1989–1990¹

Month	Rainfall in mm	
	1989	1990
January	0	0
February	0	0
March	41.3	9.8
April	34.4	65.2
May	140.2	241.0
June	85.6	343.0
July	284.7	78.4
August	229.5	298.6
September	329.5	282.5
October	141.7	230.5
November	6.5	116.9
December	0	13.5
Total	1293.4	1679.4

¹Through the courtesy of Pakse Meteorological Station.

may be less than the census registration according to another information, being close to 58,000 inhabitants.

Rainy and dry seasons are pronounced in the Mekong Basin. Tables 1 and 2 show the monthly rainfall in mm at Khong, January 1989 through December 1990, and at Pakse, January 1988 through December 1990, respectively. The rainy season is from April to October, most rain falling in May to October. The river rises rapidly and rages in torrent with extremely high turbidity. The dry season is from November to February essentially without rain. A marked decline of water levels is usual in late November. The lowest water is usually seen in April.

Snail survey: In nature *N. aperta* are found attached on solid substrata such as stones, rocks, twigs or tin cans on the riverbed, and never found on sandy bottoms (Kitikoon *et al.*, 1973; Upatham *et al.*, 1980; Staub *et al.*, 1990). In this study, snails were collected by lifting submerged stones and taking them individually by forceps from the stones to which they attached. Only gamma race of *N. aperta* are considered in this report. Gamma race snails typically have four large, distinctive black spots on their mantles that are absent in alpha and beta race snails. Hence the name "tiger-striped" snail (Fig. 2).

In the survey during high water periods the status

Table 2 Monthly rainfall at Pakse, 1988–1990¹

Month	Rainfall in mm		
	1988	1989	1990
January	0	2.5	0
February	43.4	0	18.9
March	3.4	20.7	47.9
April	50.0	125.2	38.4
May	274.6	379.9	142.7
June	411.9	231.6	363.5
July	201.8	359.5	432.9
August	334.7	415.9	306.9
September	75.4	314.7	218.0
October	278.8	40.6	123.7
November	2.6	5.2	19.9
December	0	0	0
Total	1676.6	1895.8	1712.8

¹Through the courtesy of Pakse Meteorological Station.

of the snail population was defined broadly as follows: fairly common, when more than 20 snails were collected in a period not exceeding 20 minutes; sparse, when 10–20 snails were recovered in 20 minutes; rare, when fewer than 10 snails were found in a period of not less than 20 minutes.

The search for snails in low water periods was accomplished by the stone-sampling method developed by Upatham *et al.* (1980). In the present report, however, snail population density was expressed as the number of snails per 100 cm² on a stone, by counting all snails on 5 stones collected at random.

The surface water velocity in the river was determined by measuring the time taken by a plastic float or twig to travel 10 meters downstream. Water temperature was measured 5 cm below the surface. Hydrogen-ion activity was determined with pH paper.

Results

A search for *N. aperta* in high water periods was made between October 25 and November 2, 1990 at sites around Khong Island. The water level was high and the river was a raging torrent. The water was heavily laden with silt. Surprisingly, however, *N. aperta* were found underneath the stones at depth of two to three meters in swift current having a surface



Fig. 2 Gamma race *Neotricula aperta*.

water velocity of approximately 75–80 cm/sec. The snails were collected at several sites around the perimeter of Khong Island by picking up from submerged stones to which they adhere (Table 3). The gamma race extremely predominated along the eastern and western sides of the island. The great majority of the snails collected were young speci-

mens with 3.0 to 3.5 whorls. A few snails had 4 whorls (Table 4). More than half the snails showed marked apical erosion. Sixty-five snails were examined for schistosome infection by crushing and none of them was found positive.

Another search for *N. aperta* in low water periods was conducted during a two-week period in

Table 3 Summary of survey for Gamma *N. aperta* during high water periods (October–November 1990) in Khong District

Site surveyed	Surface water velocity (cm/sec)	Depth of water (m)	Water temp. (°C)	pH	Gamma <i>N. aperta</i>
Ban Senhat-Gnai	75	3	26	6.6	Rare
Ban Xieng Vang	80	2–3	26	6.6	Fairly common
Ban Hatxaykhoun	50	1.5	26	6.6	Fairly common
District Hospital	75	2–3	26	6.8	Rare
Ban Na (1)	75	3	26	6.6	Sparse
Ban Hangkhong	50	3	26	6.8	Sparse
Ban Kengkoun	75	2	–	6.6	Sparse

– not recorded.

Table 4 Summary of survey for Gamma *N. aperta* during low water periods (May 1991) in Khong Island

Site surveyed	Surface water velocity (cm/sec)	Depth of water (m)	Water temp. (°C)	pH	Gamma <i>N. aperta</i>
<i>East side</i>					
Ban Dong	1-2	0.4	34	6.8	0
Ban Veunthong	1-2	0.8	33	6.8	0
Khong Town					
Chomthong Pakoda	20	0.5	33	7.8	1.9
Akhom	15	0.6	32	6.6	6.6
Ferry boat	0	0.5	32	6.8	2.6
Administration	15	0.6	32	6.8	5.7
Hospital	25	0.3	31	6.8	11.9
Ban Na (1)	25	0.6	34	6.6	3.2
Ban Na (2)	30	0.4	35	6.6	13.3
<i>West side</i>					
Ban Senhat-Gnai (1)	1-2	0.5	34	6.4	9.0
Ban Senhat-Gnai (2)	1-2	0.8	31	6.6	7.9

May 1991. When the observations commenced on May 6, 1991, the Mekong River was low, being ideal condition for the snail surveys. The circumstances contrasted with the previous visit in high water periods. Numerous small islands and rocks made the river flow suitable aquatic habitats for *N. aperta* snails. Large numbers of snails were observed on stones, rocks, twigs, or tin cans lying on the muddy riverbed usually in 10 to 60 cm of water. And the watercourse had a detectable current, slightly acid water and high temperatures (Table 4). No snails were collected from the sandy shores of Ban Dong and Ban Veunthong, 4-5 km north of Khong Town.

The gamma race extremely predominated along both the eastern and western sides of the island. The great majority were adult specimens with 4.0-5.5 whorls (Table 5). Only a few snails showed apical erosion.

Large numbers of *N. aperta* snails were widely observed in shallow water almost all over the river from the shore to several hundred meters off the shore, except in the main stream with its fast current (Table 6).

A lot of effort was made to find *N. aperta* infected naturally with *S. mekongi*. One site was selected near Chomthong Pakoda, where transmission was thought

Table 5 Number of whorls of Gamma *N. aperta* collected during high and low water periods in Khong District

Period surveyed	Number (percent) of snails with			
	3.0-3.5 whorls	4.0-4.5 whorls	5.0-5.5 whorls	6.0 whorls
High water (Oct-Nov 1990)	52 (76.5)	16 (23.5)	0	0
Low water (May 1991)	16 (2.1)	412 (54.8)	322 (42.8)	2 (0.3)

Table 6 Off shore distribution of *N. aperta* in the Mekong River during low water periods (May 1991)

Distance from shore* (m)	Surface velocity (cm/sec)	Depth of water (m)	Water temp. (°C)	pH	Snail population density (snail/100cm ²)
2	10	0.5	34	6.6	0.9
200	27	0.4	34	6.8	14.1
250	16	0.5	34	6.6	12.4
400	16	0.5	33	6.8	7.4
500	18	0.6	33	6.6	1.9
600	17	0.8	34	6.6	4.2

*Akhom, Khong Town.

Table 7 Sites where *N. aperta* were collected at Khong Town in May 1991 and examined for *S. mekongi* larvae

Site	Number of snails examined	Number of snails positive	% positive
Chomthong Pakoda	5,314	0	0
Akhom	60	0	0
Ferry boat	76	0	0
Administration	99	0	0
Hospital	265	0	0
Total	5,814	0	0

to be most active. There was constant human activity along the shore and gross excretory deposition. Examinations for schistosome sporocysts and cercariae were made by crushing snails between two thick glass slides and then examining the preparations under dissecting and compound microscopes. A total of 5,314 Gamma snails were examined, but no snail was found positive for schistosome (Table 7). Only metacercariae of unknown taxonomy were detected from six snails.

Discussion

According to Upatham *et al.* (1980) who conducted field studies on the bionomics of hydrobiids in the Mekong River, snail populations dwindle rapidly to zero as the water level rises and the onset of the rains then terminates the life cycle of the snails

in nature. They proposed the "egg survival" hypothesis that only the eggs can survive swift and deep water flow with high silt content during the high water period. In general, aquatic snails that transmit schistosomiasis prefer slowly running water to fast running one. *Bulinus(B.) truncatus*, the intermediate host of *S. haematobium* in the Middle East, does not occur in rapidly flowing water; a rate of 20–30 cm/sec is approximately the maximum in which it is found (Watson, 1950, 1958; Witenberg and Saliternik, 1957). *Biomphalaria alexandrina*, the intermediate host of *S. mansoni* in Egypt, is apparently even less tolerant of a high rate of flow. Laboratory experiments show that a flow of 33 cm/sec causes immobilization and 65 cm/sec causes dislodgement of *B. glabrata* attached to a smooth surface (Jobin and Ippen, 1964).

However, the results of the present survey

demonstrate that *N. aperta* occur underneath the stones at depth of 2–3 meters in swift current with a water velocity of 75–80 cm/sec. Current velocity at the surface is not necessarily indicative of flow conditions at the bottom of a stream, where the water is often moving more slowly. It has been suggested that tiny species with conical shells, such as *N. aperta*, and younger snails show high-level resistance to the dislodging effect of swiftly flowing water. *N. aperta* may survive the high water period not only in the egg stage but in the young adult stage.

N. aperta living in deeper water during high water may be of little importance in the transmission of schistosomiasis, since schistosome miracidia are negatively geotrophic and positively phototrophic and remain near the surface of water.

A total of 5,314 Gamma *N. aperta* collected from a shore of Khong Town were examined for *S. mekongi* and surprisingly all the snails were found negative. In April and May 1972, natural infection was found in 48 of 15,790 snails collected in this area, the prevalence being 0.30% (Kitikoon *et al.*, 1973). In Khong Island and other nearby areas in Khong District, a WHO-assisted schistosomiasis control program has been in progress. From October 1989 through August 1990, the drug praziquantel was administered to 37,114 individuals in 135 villages with an estimated population of 61,996 (Self, 1990). Our negative results to find infected snails with *S. mekongi* might be ascribed to the successful achievement of the mass administration campaign of praziquantel.

Accurate, simple and reproducible techniques for measuring snail population density is needed for both of epidemiological and control evaluation of schistosomiasis. While the stone-sampling method by Upatham *et al.* (1980) is recommended for *N. aperta* in the Mekong, a single quantitative method can not cover all the environmental situations in the Mekong water body. Better techniques should be developed for effective sampling of *N. aperta* along the large river.

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