On the *Sparganum mansoni* infection in some Korean terrestrial snakes

Seung Yull Cho, Koo Il Hwang, Byong Seol Seo

*Department of Parasitology and Institute of Endemic Diseases
College of Medicine, Seoul National University*

The adult stage of larval plerocercoid worm *Sparganum mansoni* was firstly subdivided from genus *Diphyllbothrium* as subgenus *Spirometra* by Faust et al. (1929) because of the characteristics in life cycle and the morphology of uterus. Mueller (1937) established *Spirometra* as independent genus. Although a number of species of various kinds of spargana have been named, some authors believe all the oriental spargana are referable to *S. erinacei* (= *mansoni*) (Joyeaux, Houdemer and Baer, 1934; Iwata, 1962). And *Sparganum mansoni* is still useful terminology nominating oriental liguloid worms found in terrestrial vertebrates (Faust, 1970).

The medical importance of these worms have been well known because human infection cases were frequently met in oriental nations. In Korea, some investigations on the infection status in vertebrates by this worm have been undertaken since Kobayashi (1925) firstly recorded 3 species of reptilia and 5 species of mammalia as intermediate hosts. And particularly the importance of snakes as main sources of human sparganosis was mentioned by many authors in Korea (Kobayashi, 1925; Weinstein et al., 1954 and Seo et al., 1964).

Authors have recently summarized on the human infection cases in Korea (Seo et al., 1972) and reconfirmed the above fact. Because of the necessities to collect further informations on the status of the natural infections of *Sparganum mansoni*, some Korean terrestrial snakes were collected in Wonju City, Kangwon Do and examined.

MATERIALS AND METHODS

Snakes were mostly purchased randomly from local collectors in Wonju City, Kangwon Do from May to July 1972. Some of them were collected by authors around the rice paddies in vicinities of same area during same periods. Total 75 collected snakes were identified in 6 species of Colubridae and one species of Viperidae (Table 1).

The skin of snakes incised around the neck annularly and striped inside out to the tip of tail entirely. The viscera were extirpated from esophagus and trachea to cloaca. Every *Sparganum mansoni* found were recorded on their habitat, pathological status and location. The habitats of worm were artificially divided into subcutis, muscular and coelomic cavity. The pathological status of *Spar-*

ganum in snakes were classified as free, encapsulated and degenerative stages. The relation between the location of larval worms and total body length of snakes were checked to evaluate the distribution in this intermediate host.

Some representative forms of free, encapsulated and degenerative stages were histologically examined after routine H-E staining. Infectivity of those pathological forms were observed by feeding to dogs. The experimental dogs were autopsied 2-3 weeks later and the number of adults in intestinal tract and larvae in tissue were counted.

RESULTS

The snakes collected were classified in 2 families of Reptilia: Colubridae and Viperidae. Colubridae included the following 6 species; *Elaphe schrenkii*, *E. dione*, *E. rufodorsata*, *Natrix tigrina lateralis*, *Dinodon rufozonatum rufozonatum* and *Zamenis spinalis*. And Viperidae included only one species, *Agkistrodon halys*. All of the above species of snakes were found to be served as intermediate hosts of *Sparganum mansoni* except *E. schrenkii* in this observation (Table 1). The

highest infection rate was observed in *D. r. rufozonatum* (100%), *N. t. lateralis* (75%) and *E. rufodorsata* (50%). And average worm burden per infected snake was in range of 3.9 ~15.0 by species (most commonly around 4.0). The maximum number per snake was 25 worms (in each one case of *N. t. lateralis* & *E. dione*).

The habitat of *Sparganum mansoni* varied from coelomic cavity (26%), muscular tissue (19%) or subcutaneous tissue (59%). Some cases involving both body cavity and subcutaneous tissue through intercostal muscle were categorized into muscular infection (Table 2).

The pathological status of *Sparganum* found were classified as free, encapsulated and degenerative stages. In cases classified as free stage (82%), worms were usually found singly or conglomerated in tissue space (Fig. 2) either freely or encapsulated by thin and delicate fibrous tissue with only dusky red inhibition along the inner surface in the group of muscular infection. Among muscular infections, worms revealed multiple penetration of intercostal muscle to reveal sewing pattern. Histologically tissue reaction was quite meager

Table 1. Infection rate and worm burden of *Sparganum mansoni* in snakes

Species of snakes	No. examined	No. of snakes with <i>Sparganum</i> (%)	Total No. collected	Avg. No. per snakes
Colubridae				
<i>Elaphe schrenkii</i>	3	0	0	0
<i>Elaphe rufodorsata</i>	10	5 (50%)	21	4.2
<i>Elaphe dione</i>	23	2 (9%)	26	13.0
<i>Dinodon rufozonatum rufozonatum</i>	3	3 (100%)	28	9.3
<i>Natrix tigrina lateralis</i>	24	19 (79%)	77	3.9
<i>Zamenis spinalis</i>	4	1 (25%)	4	4.0
Viperidae				
<i>Agkistrodon halys</i>	8	1 (12%)	15	5.0
Total	75	31 (41%)	171	5.5

Table 2. Habitat and status of *Sparganum* in snakes

Species of snakes	No. of spargana	Habitat			Status		
		Subcut.	Muscle	Coelomic	Free	Encap.	Degen.
<i>E. schrenkii</i>	0	—	—	—	—	—	—
<i>E. rufodorsata</i>	21	12	4	5	20	1	—
<i>E. dione</i>	26	15	4	7	18	3	5
<i>D. r. rufozonatum</i>	28	15	5	8	15	11	2
<i>N. t. lateralis</i>	77	45	11	21	74	3	—
<i>Z. spinalis</i>	4	—	—	4	1	2	1
<i>A. halys</i>	15	6	9	—	12	3	—
Total	171	93 (54.4%)	33 (19.1%)	45 (26.4%)	140 (81.8%)	23 (13.4%)	8 (4.7%)

revealing only simple compression of surrounding tissue and focal leucocytic infiltration around the *Sparganum* (Fig. 1). The rest of worms were found in state of gray yellow encapsulated stages (18%) frequently located in body cavity (around intestine, reproductive organs, heart liver etc) (Fig. 4) and in subcutaneous but rarely in muscular tissue. These forms were most commonly met in *D. r. rufozonatum*. These were able to divide into encapsulated or degenerative stage; in the former, a viable (moving in the saline) worm was demonstrable within thick capsule, and in the latter each cyst was filled with gray

yellowish, amorphous, necrotic materials which could be ascertained by the rupture of capsules. The cyst size of degenerative stage was usually smaller than that of encapsulated stage. Microscopically the encapsulated stage disclosed thick fibrous wall with mainly lymphocytic infiltration around intact worm (Fig. 3). But in case of degenerative stage, content was made of amorphous eosinophilic material (Fig. 5) and cleft-like spaces suggestive of cholesterol crystal were admixed in the necrotic debris. The wall of capsule showed ordinary granulomatous reaction with histiocytic and fibroblastic proliferation.

Table 3. The distribution of *Sparganum* in snakes by species

Species of snakes	Proportion from snout to total length (%)							
	0—20	20—30	30—40	40—50	50—60	60—70	70—80	80+
<i>E. schrenkii</i>	—	—	—	—	—	—	—	—
<i>E. rufodorsata</i>	—	—	1	8	4	3	5	—
<i>E. dione</i>	—	—	1	3	1	19	—	2
<i>D. r. rufozonatum</i>	—	—	1	4	9	6	4	1
<i>N. t. lateralis</i>	2	1	12	17	15	12	14	4
<i>Z. spinalis</i>	—	—	—	—	1	3	—	—
<i>A. halys</i>	—	—	—	2	2	11	—	—
Total	2 (1.2%)	1 (0.9%)	15 (8.7%)	34 (20.0%)	32 (18.9%)	54 (31.6%)	23 (13.5%)	7 (4.1%)

Table 4. Infectivity of three pathological stages of *Sparganum* to dogs

Dog No.	Stage of <i>Sparganum</i>	No. given	Interval btw. feed. & exam.	No. collected Adult Larvae
1	Free	3	10 days	2 —
2	Free	3	14 days	3 —
3	Free	3	21 days	3 —
4	Encapsulated	3	14 days	— —

The distribution where the worms were located were presented in Table 3, by species. About 70% of worms were distributed in the range of 40-70% of snake body length from snout. These ranges appeared generally to represent the location of intestine of snakes. The worms were never detected in the tail part behind the anus.

The infectivity of free and encapsulated stages to dogs was shown in Table 4. Neither adult nor larval worms were found in a dog which was challenged with 3 cysts of encapsulated stage, whereas the free stage of worm were easily infected to dogs to develop adult forms in majority.

DISCUSSION

By the recent review on the 45 human sparganosis cases reported in Korea (Seo et al., 1972), it has revealed that 19 (73%) out of 26 cases whose infection sources were apparent have the histories of raw eating of snakes. As discussed previously, the role of snakes as sources of human sparganosis in Korea was anticipated (Kobayashi, 1925) and experienced by many authors (Weinstein et al., 1954; Seo et al., 1964 and many others).

Superstitious and traditional belief that snakes are effective regimen on various morbid status such as tuberculosis, arthritis and impotence and that very nutritious to the weak

Table 5. List of animals which has been recorded as natural intermediate hosts of *Sparganum mansoni* in Korea since 1925

Amphibia	
<i>Rana nigromaculata</i>	Honda (1938), Kim et al. (1967)
Reptilia	
<i>Elaphe schrenkii</i>	Kobayashi (1925), Honda (1938)
<i>Elaphe dione</i>	Honda (1938), Present authors
<i>Elaphe rufodorsata</i>	Chang et al. (1966) Present authors
<i>Natrix tigrina lateralis</i>	Kobayashi (1925), Present authors
<i>Dinodon rufozonatum</i>	Weinstein et al. (1954), Seo et al. (1964) Present authors
<i>Zamenis spinalis</i>	Present authors
<i>Agkistrodon halys</i>	Kobayashi (1925), Honda (1938), Present authors
Mammalia	
<i>Lutreola sibiricus</i>	Kobayashi (1925)
<i>Charronia flavigula</i>	Ibid
<i>koreana</i>	
<i>Nyctereutes koreensis</i>	Ibid
<i>Vulpes vulpes</i>	Ibid
<i>Vulpes lupus</i>	Ibid
<i>Erinaceus amurensis</i>	Kobayashi (1928), Iwata (1932)
<i>koreans</i>	
<i>Sus scrofa domestica</i>	Jang (1964)

child, encouraged lower class or uneducated people to eat snakes in Korea (Seo et al., 1972). Nationwidely there are professional snakes collectors and supplied them any time.

There had been some investigations on the infection status of *Sparganum mansoni* in Korean wild animals and the list of reported intermediate hosts were summarized in Table 5. Interestingly no avian hosts were reported yet as the intermediate hosts of this larval worm. *Zamenis spinalis* was firstly proved

to play role in this study. Chang et al. (1966) identified *E. rufodorsata* as *Natrix* sp. and reported the role. These snakes are very commonly distributed in summer season around rice paddy or pastorage but not eaten by people because they are so slender. But *Elaphe schrenkii*, *Dinodon r. rufozonatum* and Pallas' pit viper, *Agkistrodon halys* are commonly eaten because they are fleshy. And people believe *N.t. lateralis* and *Elaphe dione* are particularly effective remedy combating some kinds of symptoms.

From this study, it was turned out *D. r. rufozonatum*, *N.t. lateralis* and *E. rufodorsata* were heavily infested with *Sparganum mansoni*. It might be explainable that they have similar ethological characters and all live around the rice paddies feeding chiefly on frogs and other small animals. Cho(1972) also surveyed on the infection status of *Sparganum* in frogs living in Wonju City concomittantly with this observation and found only one out of 51 *Rana nigromaculata* examined were infected with one *Sparganum*. Three other kinds of amphibians belonging to genera *Hyla*, *Rana* and *Bufo* were never found to be infected.

The wild and domestic carnivores were not examined to check the sources of infection of first and second intermediate hosts in nature. The relative contribution of many kinds of final hosts as sources of ova of *Spirometra* spp. must be observed further.

The infection status of *Sparganum mansoni* in snake hosts were precisely examined. If people are aware the presence of larvae in snakes, most of them could be extracted by hand because they are sufficiently large in size and distributed conspicuously. The pathological findings of 3 stages were already described. Various degree of fibrous proliferation

with peculiar cellular infiltration around the worm were common findings. The findings of degenerative stages were completely different from that occurred in human being and eosinophilic, crystalline degeneration was already discussed by Weinstein et al. (1954).

The infectivity of encapsulated stage of *Sparganum mansoni* might be negligible to other kinds of animals. As shown in Table 4, neither adult nor larval stages were found in dog when infection with 3 encapsulated stage larvae was undertaken per os. It might be a clue that these stages of larvae could not be infective to human hosts as causes of human sparganosis though further observations are necessary.

SUMMARY

Distribution of *Sparganum mansoni* in 7 species of terrestrial snakes in Wonju City was surveyed. All kinds of snakes were found to be served as intermediate hosts of this larval worm except *Elaphe schrenkii* which has already been recorded as important host. Authors believe that *Zamenis spinalis* was firstly recorded as intermediate host of *Sparganum mansoni* in Korea.

Some aspects of infection status, host-parasite relations and sources of human infection were briefly discussed.

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LEGENDS FOR FIGURES

- Fig. 1:** A section through mass of free stage of *Sparganum mansonii* (× 30). Thin encapsulation with meager inflammatory response.
- Fig. 2:** The conglomerated masses of *S. mansonii* on the subcutaneous tissue of *Agkistrodon halys*.
- Fig. 3:** Section through encapsulated stage (×30). Viable worm is still present within wall and thick fibrous encapsulation is infiltrated by lymphocytes.
- Fig. 4:** Encapsulated stage of *S. mansonii* in subcutaneous tissue of *Dinodon rufozonatum*.
- Fig. 5:** Section through degenerative stage (×30). Amorphous eosinophilic material is filled within the granulomatous encapsulation.
- Fig. 6:** Elevated portion of snake muscle suggests the hidden intramuscular infection.

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韓國產 蛇類의 *Sparganum* 感染狀態에 對하여

서울大學校 醫科大學 寄生蟲學教室 및 風土病研究所

趙 昇 烈 · 黃 邱 一 · 徐 丙 高

著者等은 1972年 5月부터 7月까지 2個月間 江原道 原州市 地域에서 蒐集한 陸棲蛇類 7種에 對하여 리구라狀 幼裂頭條蟲(*Sparganum mansoni*)의 感染狀態를 檢査하고 그 寄生蟲—宿主關係를 觀察한바 그 結果를 報告한다.

檢査한 蛇類는 蛇科(Colubridae) 4屬 6種으로 구렁이(*Elaphe schrenkii*) 3마리, 무자치(*E. rufodorsata*) 10마리, 누룩뱀(*E. dione*) 23마리, 능구렁이(*Dinodon rufozonatum rufozonatum*) 3마리, 유혈목이(*Natrix tigrina lateralis*) 24마리, 실뱀(*Zamenis spinalis*) 4마리이었으며 鎖蛇科(Viperidae)는 1屬 1種으로 살모사(*Agkistrodon halys*) 8마리등 모두 75마리였다.

1) 種類別 感染狀態(感染率 및 感染된뱀 1마리當의 *Sparganum* 수)는 구렁이 0%, 무자치 50%(4.2마리), 누룩뱀 9%(13.0마리), 능구렁이 100%(9.3마리), 유혈목이 75%(3.9마리), 실뱀 25%(4.0마리) 및 살모사 12%(15.0마리)였다.

2) 寄生部位는 皮下組織에 54.4%, 筋肉層에 19.1%, 體腔內 26.4%이었고 寄生狀態는 游離形(Free stage) 81.8%, 被膜形(Encapsulated stage) 13.4% 및 變性形(Degenerative stage) 4.7%이었다.

3) 寄生位置는 胴體 前半部에 31.9%, 胴體後半部에 68.1%이었고 尾部에서는 全히 發見되지 않았다.

4) 游離形 및 被膜形을 各各 終宿主인 개에 經口投與하였던바 被膜形에서는 成蟲, 幼蟲期가 發見되지 않았다.

5) 실뱀(*Zamenis spinalis*)은 우리나라에서 *Sparganum mansoni*의 中間宿主로서 처음 記錄되는 것이다.