INTESTINAL TREMATODES INFECTING HUMANS IN KOREA

Jong-Yil Chai and Soon-Hyung Lee

Department of Parasitology and Institute of Endemic Diseases, Seoul National University College of Medicine, Seoul 110-460, Korea.

Abstract. Sixteen species of intestinal trematodes have been recovered from humans in Korea. They include 10 species of the family Heterophyidae (*Metagonimus yokogawai, M. takahashii, Heterophyes nocens, H. heterophyes, H. dispar, Heterophyopsis continua, Pygidiopsis summa, Stellantchasmus falcatus, Centrocestus armatus,* and *Stictodora fuscatum*); one species of Diplostomidae (*Fibricola seoulensis*); three species of Echinostomatidae (*Echinostoma hortense, E. cinetorchis*, and *Echinochasmus japonicus*); one species of Plagiorchiidae (*Plagiorchis* sp.), and one species of Gymnophallidae (*Gymnophalloides* sp.).

Biological and epidemiological studies have shown that all of these species are endemic to Korea except *H. heterophyes* and *H. dispar*, which were imported from the Middle East, and *Plagiorchis* sp., which has not been found in Korea. Several fresh water fish were found carrying metacercarial stages of *M. yokogawai, M. takahashii, C. armatus, E. hortense, E. cinetorchis and E. japonicus*. Brackish water fish were found to be the second intermediate host of *H. nocens, H. continua, P. summa, S. falcatus*, and/or *S. fuscatum*. Terrestrial snakes were the second intermediate (or paratenic) host of *F. seoulensis*. Among these intestinal flukes, *M. yokogawai* is the most common one in Korea.

INTRODUCTION

Among the trematodes infecting the human host, the liver fluke (*Clonorchis sinensis*) and the lung fluke (*Paragonimus westermani*), transmitted by crabs or crayfish, are important parasites because of their relatively high prevalence and wide geographical distribution in Korea. Recently, however, trematodes infecting the intestinal tract of animals and man (intestinal flukes) have become important, because they cause food-borne parasitic zoonoses. There are 16 species that belong to five families (Table 1). This paper reviews the biological and epidemiological aspects of intestinal trematodes affecting humans in Korea.

FAMILY HETEROPHYIDAE

Metagonimus yokogawai (Katsurada, 1912) Katsurada, 1912

This is the most common species of intestinal trematode reported in Korea. The presence of human infection with this fluke was suggested earlier in Korea by the recovery of eggs from fecal examinations, but the identification of adult worms was not made until 1971 (Seo *et al*, 1971). Streams in eastern and southern coastal areas, where sweetfish (*Plecoglossus altivelis*) are found, are known to be the endemic foci of metagonimiasis. The overall egg positive rate of riverside people was estimated at 4.8% (Seo *et al*, 1981c). The Sumjin, Tamjin, and Boseong Rivers, and Geoje Island are highly endemic areas where the villagers have 10-20% egg positive rates (Chai *et al*, 1977; Seo *et al*, 1981c).

Morphologically, this species is distinguished from *M. takahashii* by the location and arrangement of two testes and size of the eggs (Saito, 1984). Fresh water snails, *Semisulcospira coreana* and *S. libertina*, are the first intermediate host of *M. yokogawai*. Second intermediate hosts include the sweetfish, the dace (*Tribolodon taczanowskii*) (Choi *et al*, 1966), and the perch (*Lateolabrax japonicus*) (Ahn, 1983). Dogs, rats, and cats are reported natural final hosts, but their significance as a source of human infection has not been clarified.

The intestinal histopathology was studied in rats, cats or dogs (Chai, 1979; Kang *et al*, 1983), with the pathology characterized by villous atrophy and crypt hyperplasia, and with variable degrees of inflammatory cell infiltrations. Experi-

Table 1
Intestinal flukes infecting humans in Korea

Family species	Second IH	Egg size (μm)	Adult size (mm)
Heterophyidae			
Metagonimus yokogawai	fresh water fish (sweet fish)	28–30 × 16–17	1.0–2.0 × 0.4–0.6
M.takahashii	fresh water fish (carps)	32–36 × 18–23	0.8–1.5 × 0.4–0.7
Heterophyes nocens	brackish water fish (mullets, gobies)	25–28 × 14–16	0.9–1.6 × 0.5–0.8
*H.heterophyes**	brackish water fish (mullets)	28–30 × 15–17	1.0–1.7 × 0.3–0.4
*H.dispar**	brackish water fish (mullets)	19–25 × 13–15	1.0–1.7 × 0.5–0.6
Heterophyopsis continua	brackish water fish (perches, gobies)	25–27 × 14–16	2.7–2.8 × 0.5–0.6
Pygidiopsis summa	brackish water fish (mullets, gobies)	19–26 × 12–14	0.5–0.8 × 0.3–0.4
Stellantchasmus faloatus	brackish water fish (mullets)	22–23 × 11–12	0.4–0.7 × 0.3–0.4
Centrocestus armatus	fresh water fish (carps)	28–32 × 16–17	0.4–0.6 × 0.2–0.3
Stictodora fuscatum	brackish water fish (mullets)	34–38 × 20–23	0.9–1.0 × 0.3–0.4
Diplostomidae			
Fibricola seoulensis	tadpoles and frogs terrestrial snakes	81–102 × 51–63	0.8–1.2 × 0.4–0.5
Echinostomatidae			
Echinostoma hortense	fresh water fish (loaches, carps)	105–128 × 43–68	8.2–14.0 × 0.9–1.6
E.cinetorchis	fresh water fish (loaches, large snails)	95–105 × 60–68	8.6–15.0 × 2.0–2.4
Echinochasmus japonicus	fresh water fish (carps)	85 × 56	0.5–1.0 × 0.3
Plagiorchiidae			
Plagiorchis sp.	fresh water fish (?)	32–38 × 20–24	2.9–3.0 × 0.8–1.0
Gymnophallidae			
Gymnophalloides sp.	marine bivalves (oyster)	20–25 × 12–14	0.4–0.5 × 0.2–0.3

* Cases were imported from Africa and Middle East.

mental immunosuppression of the host can prolong the survival time of the parasite in the host intestine (Chai *et al*, 1984b).

The most frequent complaints from humans were abdominal pain, diarrhea and lethargy (Cho *et al*, 1984). The diagnosis is usually based on recovery of eggs in feces; however, eggs may be absent in light infections with less than 100 worms. The ELISA serological test may be helpful for such cases (Chai *et al*, 1989). The

drug of choice is praziquantel, a single oral dose of 10–20 mg/kg, which gave an efficacy of 95–100% (Rim *et al*, 1978). Bithionol and niclosamide are also of therapeutic value.

Metagonimus takahashii Suzuki, 1930

This species differs from *M. yokogawai* in the position of the anterior testis (more separation from posterior one), distribution of vitelline follicles (more posterior and more abundant), and larger size of eggs (32–36 μm) (Saito, 1984). However, because of the presence of an intermediate type, *Metagonimus* Miyata type (Saito, 1984), the validity of this needs further clarification. *M. takahashii* has been reported from Japan and Korea.

The presence of this species in Korea was first reported by Chun (1960a) who recovered adult worms from experimentally infected rabbits fed metacercariae obtained from crucian carps. Human infections were reported in 1985 and 1988 (Ahn and Ryang, 1988), however, they were not based on a detailed morphological diagnosis of worms.

Unlike *M. yokogawai, M. takahashii* (and/or *Metagonimus* Miyata type) is distributed along small streams in inland areas of Korea. The snail host is *S. coreana* or *Koreanomelanis nodifila* (Cho *et al*, 1984), and the fish host is *Carrasius carrasius* (Chun, 1960a), *Cyprinus carpio, Pseudorasbora parva*, or *Zacco platypus* (for Miyata type). There have been few reports on reservoir hosts.

Heterophyes nocens Onji and Nishio, 1916

This species is morphologically close to *H. heterophyes*, which is prevalent in Egypt and the Middle East, but it differs by the morphology of genital sucker, especially the number of rodlets on the gonotyl: 50–62 in *H. nocens* and 70–85 in *H. heterophyes*. This species has been reported from Korea and Japan.

In Korea, the metacercariae were first found in 1978–1979 (Seo *et al*, 1980b) from mullets (*Mugil cephalus*) captured in three southern coastal areas. Before 1990, human infections with this fluke were verified in 13 persons from scattered areas (Seo *et al*, 1981a; Chai *et al*, 1984a, 1985b; Sohn *et al*, 1989). In April 1990, a highly endemic area of *H. nocens* infection was discovered from a southwestern coastal island, where as many as 42% of the population was found infected (to be published).

The first intermediate host is suspected to be a brackish water snail. The second intermediate host is brackish water fish, such as mullets or gobies (*Acanthogobius flavimanus*) (Seo *et al*, 1981b). Domestic cats were found naturally infected (Eom *et al*, 1985).

Heterophyopsis continua (Onji and Nishio, 1916) Yamaguti, 1958

This species, first found in cats experimentally fed mullets (*Mugil cephalus*) harboring metacercariae, and is now known to be distributed in Korea, Japan and China (Seo *et al*, 1984b).

The presence of *H. continua* in Korea was first verified by Chun (1960b) who observed metacercariae in the flesh of perch and gobies. Two cases of human infection in Korea were reported by Seo *et al* (1984b); two additional cases were described by Hong and Han (1989). The first intermediate host is not known in Korea. The second intermediate hosts are perch, gobies, shad (*Clupanodon punctatus*) (Chun 1960 b), and sweetfish (Cho and Kim, 1985). Domestic cats were reported to be naturally infected (Eom *et al*, 1985). Dogs (Seo *et al*, 1984b) and chicks (Hong *et al*, 1990) have been experimentally infected.

Pygidiopsis summa Onji and Nishio, 1916

This species was first found in Japan in dogs fed mullets harboring metacercariae, and it is now known to be distributed in Korea. *P. summa* is differentiated from *P. genata* in the morphology of the ventral sucker, genital apparatus, and ceca (Chai *et al*, 1986).

The presence of *P. summa* in Korea was first described by Chun (1963), who observed metacercariae from the gill and muscle of mullets. Human infection was first reported from 8 persons living in a salt farm village who ate raw mullets (Seo *et al*, 1981a).

The first intermediate host is *Cerithidea* (= *Tympanotonus*) sp. (unpublished data). The second intermediate hosts are mullets and gobies

(Seo *et al*, 1981b). Natural infection of domestic cats was reported (Eom *et al*, 1985). In experimental rats and mice, the middle intestine is most frequently infected, and like *M. yokogawai*, the worms cause severe villous atrophy and crypt hyperplasia with inflammation of the mucosa (Seo *et al*, 1986).

Stellantchasmus falcatus Onji and Nishio, 1916

Human infections with *S. falcatus* have been reported from several Asian-Pacific countries, including Korea (Seo *et al*, 1984a; Hong *et al*, 1986). The life cycle was studied in Hawaii; the first intermediate host is *Stenomelania newcombi* or *Thiara granifera* (Noda, 1959) and the second intermediate host is the mullet (Chai and Sohn, 1988). In Korea, the snail host is not yet known.

Centrocestus armatus (Tanabe, 1922)

This fluke was first described by Tanabe (1922) from dogs, cats, rabbits, rats, and mice, fed cyprinoid fish harboring metacercariae. An experimental infection was reported in Japan (Tanabe, 1922) and a natural infection was found in Korea (Hong *et al*, 1988).

The first intermediate host is *Semisulcospira* sp. in Japan (Takahashi, 1929). Fresh water fish, such as *Zacco platypus, Rhodeus ocellatus, Gobius similis*, *Pseudorasbora parva*, *Pelteobagrus fulvidraco*, and several other species, were reported to harbor the metacercariae of *C. armatus* in Korea (Lee *et al*, 1984 a, b). A recent field survey on metacercarial infection of fish hosts (Hong *et al*, 1989b) showed that *Z. platypus* and *Z. temminckii* caught in the large rivers of south Korea were heavily infected.

Stictodora fuscatum Onji and Nishio, 1916

This species was originally described by Onji and Nishio (1916) from cats fed infected mullets (*M. cephalus*) in Japan. Human infection with *Stictodora* sp. was reported from a young Korean fond of eating raw mullets or gobies (Chai *et al*, 1988).

FAMILY DIPLOSTOMIDAE

Fibricola seoulensis Seo, Rim and Lee, 1964

This species was first described by Seo *et al*, (1964) from the small intestine of house rats captured in Seoul and are now known to be distributed almost all over the country (Seo, 1990). Before 1982, *F. seoulensis* failed to draw medical attention. In 1982, a human suffering from acute abdominal pain and fever (Seo *et al*, 1982) had eaten raw snake 7 days prior to admission to the hospital. Later, the snakes, *Rhabdophis* (= *Natrix*) *tigrina*, were found to carry metacercariae (Hong *et al*, 1982). Twenty-five additional human infections were found among soldiers eating snakes during survival training (Hong *et al*, 1984; 1986).

Life cycle studies revealed that the first intermediate host is a fresh water snail, *Hippeutis cantori*, and the second intermediate hosts are tadpoles and frogs (Seo *et al*, 1988). The terrestrial snake, *R. tigrina*, is regarded as a paratenic host. Mice, rats, Guinea pigs, and chicks were susceptible to experimental infection (Seo, 1990). In experimental animals, the duodenum is the most favorite site of the worms, and villous atrophy and crypt hyperplasia are the two major histopathological features of the mucosa (Lee *et al*, 1985).

The diagnosis of fibricoliasis is based upon recovery of eggs; however, the eggs should be differentiated from those of Echinostomatidae or Fasciolidae. Treatment is successful with a single dose of praziquantel, 10-20 mg/kg (Hong *et al*, 1984).

FAMILY ECHINOSTOMATIDAE

Echinostoma hortense Asada, 1926

This species was first described by Asada (1926) from the small intestine of house rats in Japan. The presence of *E. hortense* in Korea was reported by Park (1938) from rats in Seoul and human infection was reported by Seo *et al* (1983). A total of 77 egg or worm-proven cases were reported (Lee *et al*, 1988b). Cheongsong-gun, an island area in the southeastern part of Korea, was found to be highly endemic for human echinostomiasis, with an infection rate of 22.4% in the villagers (Lee *et al*, 1988b).

The first intermediate hosts in Korea are fresh water snails, such as *Lymnaea pervia* and *Radix auricularia coreana* (Ahn and Kang, 1988). Fish

hosts are *Misgurnus anguillicaudatus* (Chai *et al*, 1985a), *M. mizolepis, Odontobutis obsura interrupta, Morocco oxycephalus, Squalidus coreanus* (Lee *et al*, 1988b). Rats and dogs are natural final hosts (Cho *et al*, 1984).

Echinostoma cinetorchis Ando and Ozaki, 1923

This species was described by Ando and Ozaki (1923) from rats in Japan, and has been reported from rats in Korea (Seo *et al*, 1964). Human infections are reported from Japan (Kawahara and Yamamoto, 1933); four cases have been reported from Korea (Seo *et al*, 1980a; Ryang *et al*, 1986; Lee *et al*, 1988a).

Life cycle studies in Korea (Seo *et al*, 1984c; Lee *et al*, 1990) showed that *Hippeutis cantori*, a fresh water snail, can serve as the first as well as the second intermediate host. Other fresh water snails, such as *Radix auricularia coreanus, Physa acuta*, and *Cipangopaludina* sp., or fresh water fish, such as *Misgurnus anguillicaudatus* can carry the metacercarial stage. Rats and dogs were found to be a natural final host (Cho *et al*, 1984). Albino rats were highly susceptible to experimental infection with this fluke.

Echinochasmus japonicus Tanabe, 1926

This species was first described by Tanabe (1926) from the small intestine of experimentally infected dogs, cats, rats, mice, and birds with metacercariae from fresh water fish. Recently, natural human infections were reported in Korea (Seo *et al*, 1985).

The existence of this fluke in Korea was suggested when metacercariae were found in fresh water fish (Chun, 1964; Lee *et al*, 1984a, b), and later the successful recovery of adult worms from experimental mice was reported by Chai *et al* (1985c). The first intermediate host in Korea is *Parafossarulus manchouricus* (Lee *et al*, 1984a, b), and 18 species of fresh water fish, including *Pseudorasbora parva, Hypomesus olidus* and *Gnathopogon strigatus* (Lee *et al*, 1984a, b) are second intermediate hosts. Natural infections are reported in chickens (unpublished) and ducks (Eom and Rim, 1984).

FAMILY PLAGIORCHIIDAE

Plagiorchis sp.

Three specimens of *Plagiorchis* sp. were recovered from a man after treatment with praziquantel (Hong *et al*, 1989a). The patient recalled eating raw fresh water fish. The specific diagnosis of worms has been made.

REFERENCES

Ahn YK. *Lateolaborax japonicus*, a role of the second intermediate host of *Metagonimus yokogawai*. *New Med J* 1983; 26:135-9.

Ahn YK, Kang HS. Development and cercarial shedding of *Echinostoma hortense* in the snail host, *Radix auricularia coreana*. *J Wonju Med Coll* 1988; 1:137-52.

Ahn YK, Ryang YS. Epidemiological studies on *Metagonimus* infection along the Hongcheon river, Kangwon Province. *Korean J Parasitol* 1988; 26:207-13.

Ando R, Ozaki Y. On four new species of trematodes of the family Echinostomidae. *Dobutsugaku Zasshi* 1923; 35:108-19.

Asada J. On a new echinostomatid trematode and its life history. *Trans Jpn Path Soc* 1926; 16:293-4.

Chai JY. Study on *Metagonimus yokogawai* (Katsurada, 1912) in Korea. V. Intestinal pathology in experimentally infected albino rats. *Seoul J Med* 1979; 20:104-17.

Chai JY, Cho SY, Seo BS. Study on *Metagonimus yokogawai* (Katsurada, 1912) in Korea. *Korean J Parasitol* 1977; 15:115-20.

Chai JY, Hong SJ, Lee SH, Seo BS. *Stictodora* sp. (Trematoda: Heterophyidae) recovered from a man in Korea. *Korean J Parasitol* 1988; 26:127-32.

Chai JY, Hong SJ, Sohn WM, Lee SH, Seo BS. Studies on intestinal trematodes in Korea. XVI. Infection status of loaches with the metacercariae of *Echinostoma hortense*. *Korean J Parasit* 1985 a; 23:18-23.

Chai JY, Hong SJ, Sohn WM, Lee SH, Seo BS. Further cases of human *Heterophyes heterophyes nocens* infection in Korea. *Seoul J Med* 1985b; 26: 197-200.

Chai JY, Hong SJ, Son DW, Lee SH, Seo BS. Metacercariae of the *Echinochasmus japonicus*

encysted in a fresh water fish, *Pseudorasbora parva*, and their development in experimental mice. *Korean J Parasitol* 1985c; 23:221-9.

Chai JY, Seo BS, Lee SH. Studies on intestinal trematodes in Korea. XI. Two cases of human-infection by *Heterophyes heterophyes nocens*. *Korean J Parasitol* 1984a; 22:37-42.

Chai JY, Seo BS, Lee SH. Study on *Metagonimus yokogawai* (Katsurada, 1912) in Korea. VII. Susceptibility of various strains of mice to *Metagonimus* infection and effect of prednisolone. *Korean J Parasitol* 1984b: 22:153-60.

Chai JY, Seo BS, Lee SH, Hong ST. Growth and development of *Pygidiopsis summa* in rats and mice with a supplementary note on its morphological characters. *Korean J Parasitol* 1986; 24:55-62.

Chai JY, Sohn WM. Identification of *Stellantchasmus falcatus* metacercariae encysted in mullets in Korea. *Korean J Parasitol* 1988; 26:65-8.

Chai JY, Yu JR, Lee SH, Jung HC, Song IS, Cho SY. An egg-negative patient of acute metagonimiasis diagnosed serologically by ELISA. *Seoul J Med* 1989; 30:139-42.

Choi DW, Lee JT, Hwang HK, Shin YD. Studies on the larval trematodes from brackish water fishes. 2. Observation on *Metagonimus yokogawai* Katsurada, 1912. *Korean J Parasitol* 1966; 4:33-7.

Cho SY, Kang SY, Lee JB. Metagonimiasis in Korea. Session V: Intestinal fluke and *Schistosoma japonicum*. *Arzneim-Forsch/Drug Res* 1984; 34:1211-3.

Cho SY, Kim SI. *Plecoglossus altivelis* as a new fish intermediate host of *Heterophyopsis continua*. *Korean J Parasitol* 1985; 23:173-4.

Chun SK. A study on the metacercaria of *Metagonimus takahashii* and *Exorchis oviformis* from *Carassius carassius*. *Bull Pusan Fish Coll* 1960a; 3:31-9.

Chun SK. A study on some trematodes whose intermediate hosts are brackish water fish. (I). The life history of *Heterophyes continua* the intermediate host of which is *Lateolabrax japonicus*. *Bull Pusan Fish Coll* 1960b; 3:40-4.

Chun SK. A study on some trematodes whose intermediate hosts are brackish water fish. (II). The life history of *Pygidiopsis summa*, the intermediate host of which is *Mugil cephalus*. *Bull Pusan Fish Coll* 1963; 5:1-5.

Chun SK. Studies on the experiment of mode of infection of *Clonorchis sinensis*. *I. Bull Pusan Fish Coll* 1964; 6:1-14.

Eom KS, Rim HJ. A study on the parasitic helminths of domestic duck (*Anas platyrhynchos* var. *domestica* Linnaeus) in Korea. *Korean J Parasitol* 1984; 22:215-21.

Eom KS, Son SY, Lee JS, Rim HJ. Heterophyid trematodes (*Heterophyopsis continua, Pygidiopsis summa* and *Heterophyes heterophyes nocens*) from domestic cats in Korea. *Korean J Parasitol* 1985; 23:197-202.

Hong SJ, Choi JH, Seo BS. A human case of *Plagiorchis* sp. *Korean J Parasit* 1989a; 27:155.

Hong SJ, Han JH. Two human infections by *Heterophyopsis continua* and *Stictodora* sp. *Korean J Parasitol* 1989; 27:344.

Hong SJ, Lee SH, Chai JY, Seo BS. Recovery rate, growth and development of *Heterophyopsis continua* in experimental chicks. *Korean J Parasitol* 1990; 28:53-62.

Hong SJ, Seo BS, Lee SH, Chai JY. A human case of *Centrocestus armatus* infection in Korea. *Korean J Parasitol* 1988; 26:55-60.

Hong SJ, Woo HC, Kim IT. Study on *Centrocestus armatus* in Korea. I. Infection status of *Zacco platypus* and *Z. temminckii* with the metacercariae of *C. armatus*. *Korean J Parasitol* 1989b; 27:41-6.

Hong ST, Chai JY, Lee SH. Ten human cases of *Fibricola seoulensis* infection and mixed one with *Stellantchasmus* and *Metagonimus*. *Korean J Parasitol* 1986; 24:94-6.

Hong ST, Cho TK, Hong SJ, Chai JY, Lee SH, Seo BS. Fifteen cases of *Fibricola seoulensis* infection in Korea. *Korean J Parasitol* 1984; 22:61-5.

Hong ST, Hong SJ, Lee SH, Seo BS, Chi JG. Studies on intestinal trematodes in Korea. VI. On the metacercaria and the second intermediate host of *Fibricola seoulensis*. *Korean J Parasitol* 1982; 20:101-11.

Kang SY, Cho SY, Chai JY, Lee JB, Jang DH. A study on intestinal lesions of experimentally reinfected dogs with *Metagonimus yokogawai*. *Korean J Parasitol* 1983; 21:53-73.

Kawahara S, Yamamoto E. Human cases of *Echinostoma cinetorchis*. *Tokyo Iji Shinshi* 1933; 2840:11794.

Lee JK, Lee HI, Baek BK, Kim PG. Survey on encysted cercariae of trematodes from freshwater fishes in Mangyeong riverside area. *Korean J Parasitol* 1984a; 21:187-92.

Lee JK, Lee HI, Baek BK, Kim PG. Survey on encysted cercariae of trematodes from freshwater fishes in Tongjin riverside area. *Korean*

J Parasitol 1984b; 22:190-202.

Lee SH, Chai JY, Hong ST, Sohn WM. Experimental life history of *Echinostoma cinetorchis*. *Korean J Parasitol* 1990; 28:39-44.

Lee SH, Yoo BH, Hong ST, Chai JY, Seo BS, Chi JG. A histopathological study on the intestine of mice and rats experimentally infected by *Fibricola seoulensis*. *Korean J Parasitol* 1985; 23:58-72.

Lee SK, Chung NS, Ko IH, Ko HI, Sohn WM. A case of natural human infection by *Echinostoma cinetorchis*. *Korean J Parasitol* 1988a; 26:61-4.

Lee SK, Chung NS, Ko IH, *et al*. An epidemiological survey of *Echinostoma hortense* infection in Chongsong-gun, Kyongbuk Province. *Korean J Parasitol* 1988b; 26:199-206.

Miyamoto K, Nakao M, Inaoka T. Studies on the zoonoses in Hokkaido, Japan. 5. On the epidemiological survey of *Echinostoma hortense* Asada, 1926. *Jpn J Parasitol* 1983; 32:261-9.

Noda K. The larval development of *Stellantchasmus falcatus* (Trematoda: Heterophyidae) in the first intermediate host. *J Parasitol* 1959; 45:635-42.

Park JT. A rat trematode, *Echinostoma hortense* Asada, from Korea. *Keijo J Med* 1938; 9:283-6.

Rim HJ, Chu DS, Lee JS, Joo KH, Won CY. Anthelmintic effects of various drugs against metagonimiasis. *Korean J Parasitol* 1987; 16: 117-22.

Ryang YS, Ahn YK, Kim WT, Shin KC, Lee KW, Kim TS. Two cases of human infection by *Echinostoma cinetorchis*. *Korean J Parasitol* 1986; 24:71-6.

Saito S. On the validity of *Metagonimus* spp. *Proc of Jap Parasite Taxon Morphol Conf* 1984; 2:1-6 (in Jpn).

Seo BS. *Fibricola seoulensis* Seo, Rim and Lee, 1964 (Trematoda) and fibricoliasis in man. *Seoul J Med* 1990; 31:61-96.

Seo BS, Cheong SK, Chai JY, Lee SH, Lee JB. Histopathology of small intestine of rats and mice experimentally infected with *Pygidiopsis summa*. *Seoul J Med* 1986; 27:125-34.

Seo BS, Cho SY, Chai JY. Studies on intestinal trematodes in Korea. I. A human case of *Echinostoma cinetorchis* infection with an epidemiological investigation. *Seoul J Med* 1980a; 21: 21-9.

Seo BS, Cho SY, Chai JY, Hong ST. Studies on intestinal trematodes in Korea. II. Identification of the metacercariae of *Heterophyes heterophyes nocens* in mullets of three southern coastal areas. *Seoul J Med* 1980b; 21:30-8.

Seo BS, Hong ST, Chai JY. Studies on intestinal trematodes in Korea. III. Natural human infection of *Pygidiopsis summa* and *Heterophyes heterophyes nocens*. *Seoul J Med* 1981a; 22:228-35.

Seo BS, Hong ST, Chai JY, Cho SY. Studies on intestinal trematodes in Korea. IV. Geographical distribution of *Pygidiopsis* and *Heterophyes* metacercariae. *Seoul J Med* 1981b; 22:236-42.

Seo BS, Hong ST, Chai JY, Lee SH. Studies on intestinal trematodes in Korea. VII. A human case of *Echinostoma hortense* infection. *Korean J Parasitol* 1983; 21:219-23.

Seo BS, Lee SH, Chai JY, Hong SJ. Studies on intestinal trematodes in Korea. XII. Two cases of human infection by *Stellantchasmus falcatus*. *Korean J Parasitol* 1984a; 22:43-50.

Seo BS, Lee SH, Chai JY, Hong SJ. Studies on intestinal trematodes in Korea. XIII. Two cases of natural human infection by *Heterophyopsis continua* and the status of metacercarial infection in brackish water fishes. *Korean J Parasitol* 1984 b; 22:51-60.

Seo BS, Lee SH, Chai JY, Hong SJ. Studies on intestinal trematodes in Korea. XX. Four cases of natural human infection by *Echinochasmus japonicus*. *Korean J Parasitol* 1985; 23:214-20.

Seo BS, Lee SH, Chai JY, Hong SJ, Hong ST. The life cycle and larval development of *Fibricola seoulensis* (Trematoda: Diplostomatidae). *Korean J Parasitol* 1988; 26:179-88.

Seo BS, Lee SH, Cho SY, et al. An epidemiologic study on clonorchiasis and metagonimiasis in riverside areas in Korea. *Korean J Parasitol* 1981 c; 19:137-50.

Seo BS, Lee SH, Hong ST, Hong SJ, Kim CY, Lee HY. Studies on intestinal trematodes in Korea. V. A human case infected by *Fibricola seoulensis* (Trematoda: Diplostomatidae). *Korean J Parasitol* 1982; 20:93-9.

Seo BS, Park YH, Chai JY, Hong SJ, Lee SH. Studies on intestinal trematodes in Korea. XIV. Infection status of loaches with metacercariae of *Echinostoma cinetorchis* and their development in albino rats. *Korean J Parasitol* 1984c; 22:181-9.

Seo BS, Rim HJ, Lee CW. Studies on the parasitic helminths of Korea. I. Trematodes of rodents. *Korean J Parasitol* 1964; 2:20-6.

Seo BS, Rim HJ, Lee SH, *et al.* Two cases of metagonimiasis with special reference on the egg laying capacity in the human host. *Seoul J Med* 1971; 12:234-41.

Sohn WM, Chai JY, Lee SH. Two cases of natural human infection by *Heterophyes nocens* and the infection status of heterophyid metacercariae in mullets from Samcheonpo, Kyongnam Province. *Inje Med J* 1989; 10:443-52.

Takahashi S. A contribution to the life-history of *Stamnosoma armatum* Tanabe. *Okayama Igakkai Zasshi* 1929; 4:1759-71.

Tanabe H. Studien uber die Trematoden mit Susswasserfischen als Zwischenwirt. I. *Stamnosoma armatum* n.g., n.sp. *Kyoto Igaku Zasshi* 1922; 19:239-52.

Tanabe H. Studies on trematodes with fresh water fishes as their intermediate host. III. On a new species, *Echinochasmus japonicus* (n. sp.) *Nippon Byori Gakkai Kaishi* 1926; 16:295-6.