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The infestation states and changing patterns of human infecting metacercariae in freshwater fish in Kyongsang-do and Kyonggi-do, Korea

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Abstract: The infestation rates and abundances of human infecting metacercariae (*Clonorchis sinensis*, *Metagonimus* spp., *Centrocestus armatus*, *Echinostoma hortense*, *Echinochasmus japonicus*, *Clinostomum complanatum*) in freshwater fish were investigated at the three river areas — Taewhagang (river), Hyongsangang (river), Nakdonggang (river) — in Kyongsang-do and at four streams — Yonpungchon, Munsanchon, Kyonganchon, and Konjiamchon— in Kyonggi-do, Korea in 1994-1995. The fish caught at Taewhagang were heavily infested with metacercariae of *Clonorchis sinensis* and *Centrocestus armatus*. At Hyongsangang, *Zacco platypus* and *Z. temminckı* were moderately infested with metacercariae of *C. armatus*. Chomanpo, at the basin of Nakdonggang, was still endemic for *C. sinensis*. In the fish caught at four streams of Kyonggi-do, metacercariae of *C. sinensis* exhibited the highest infestation rate and intensity out of 6 species of metacercariae. The infestation intensity of *C. sinensis* metacercariae in fish flesh was markedly different according to each division of flesh. The cause of this difference was conjectured as a result of larval behavior. The metacercariae of *C. armatus* were found in almost all parts, except scales and fins, of fish. The infestation rates and intensities of *C. sinensis* and *C. armatus* metacercariae in Taewhagang greatly increased as compared with those of previous reports. *Rhinogobius brunneus* and *Acanthorhodeus macropterus* are newly recorded intermediate hosts of *Echinostoma hortense*. The reason of large differences from previous data was discussed and the standard method of metacercaria examination was proposed.

Key words: metacercaria, freshwater fish, infestation rate, abundance, standard method

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INTRODUCTION

Through the high level growth of Korea's economy, the infection rates of soil transmitted helminthiases are very rapidly diminished, but the infection rates of snail transmitted trematodiases are as high as ever. The root cause of these high rates of snail transmitted trematodiases is the Korean's dietary habit of eating raw wild freshwater fish. The representative snail transmitted trematodiases in Korea have been clonorchiasis and metagonimiasis. In addition, infections with *Echinostoma* spp., *Echinochasmus japonicus*, *Centrocestus armatus* and *Clinostomum complanatum* have been reported as the freshwater fish mediated trematodiases in Korea (Seo *et al.*, 1980, 1983 & 1985; Lee *et al.*, 1986, 1988; Hong *et al.*, 1988; Ryang *et al.*, 1986; Ryang, 1990; Chai *et al.*, 1994; Chung *et al.*, 1995).

In the present study, the infestation states of the freshwater fish with the digenean metacercariae, especially on the species of above mentioned, were investigated at several sites in Kyongsang-do and in Kyonggi-do, Korea. And the results of the present study were compared with the previous investigation results.

MATERIALS AND METHODS

1. Sampling and sampling localities of fish

1) Kyongsang-do: During the periods of July to September, 1995, various fish species were directly caught using cast-net. The sampling localities were selected in accordance with the previous other authors's surveyed areas and the place names are following;

Site 1. Taewhagang (river) — Pansong, Sayon, Samho
Site 2. Hyongsangang (river) — Angang, Kyongju
Site 3. Nakdonggang (river) — Chomanpo

2) Kyonggi-do: The first survey in July, 1994 was executed in order to select endemic areas for human infecting metacercariae and analysed the data in qualitative. The second survey in October, 1995 was carried out on the foundation of the first survey results. Namely, among many localities in the first survey, two streams (Yonpoongchon and Kyonganchon) were screened out as the high infestated places with human infecting metacercariae and the other two streams (Munsanchon and Kongiamchon), adjacent to the foregoing two streams, were surveyed, also. In the second survey, the data were analysed quantitatively. The localities of those four streams are as following;

Site 1. Yonpungchon (stream) — Yonpung-ri, Paju-up, Paju-gun
Site 2. Munsanchon (stream) — Duman-dong, Kwangtan-myon, Paju-gun
Site 3. Kyonganchon (stream) — Yangpol-ri, Opo-myon, Kwangju-gun
Site 4. Konjiamchon (stream) — Chiwol-ri, Chowol-myon, Kwangju-gun

2. Examination of metacercariae

The caughted fish were transported to the our laboratory in fresh state and identified according to Choi *et al.* (1990). In order to know the distribution states of the metacercariae, the fishes were dissected into flesh, gill, scale and fins, internal organs including kidney, spleen, liver and outer intestinal membrane, then the flesh was divided into four parts (A, upper, anterior region; B, upper, posterior region; C, lower, anterior region; D, lower, posterior region). Each parts of the flesh and the internal organs were compressed between two slides and examined for the presence of the metacercariae. The gill filaments were dissected from the gill archs and compressed between two slides. The scales and fins were expanded thinly on the slide and covered with the other slide. Only the metacercariae which can infect to human were counted.

3. Infection experiments of metacercariae to hamsters and preparation of adult worms

The metacercariae of *Centrocestus* sp., *Echinostoma* sp. and *Echinochasmus* sp. were fed to the hamsters to identify the species. The recovered worms were fixed in the hot AFA and stained with Semichon's acetocarmine.

4 Explanation of abbreviations used in the present study and Korean name of each fish species

Cs, *Clonorchis sinensis*; Mt, *Metagonimus* spp.; Ca, *Centrocestus armatus*; Eh, *Echinostoma hortense*; Ej, *Echinochasmus japonicus*; Cc, *Clinostomum complanatum*

C. carpio, *Cyprinus carpio* (잉어); *C. auratus*, *Carassius auratus* (붕어); *R. uyekii*, *Rhodeus uyekii* (각시붕어); *A. imtermebia*, *Acheilognathus imtermebia* (납자루); *A. rhombea*, *Acheilognathus rhombea* (납지리); *A. macropterus*, *Acanthorhodeus macropterus* (큰납지리); *P. parva*, *Pseudorasbora parva* (참붕어); *S.n. morii*, *Sarcocheilichthys nigripinnis morii* (중고기); *S.v. wakiyae*, *Sarcocheilichthys variegatus wakiyae* (참중고기); *P. herzi*, *Pungtungia herzi* (돌고기); *S.j. coreanus*, *Squalidus japonicus coreanus* (몰개); *S.c. tsuchigae*, *Squalidus chankaensis tsuchigae* (참몰개); *P. esocinus*, *Pseudogobio esocinus* (모래무지); *A. rivularis*, *Abbottina rivularis* (버들매치); *Z. platypus*, *Zacco platypus* (피라미); *Z. temmincki*, *Zacco temmincki* (갈겨니); *C. lutheri*, *Cobitis lutheri* (점줄종개); *S. asotus*, *Silurus asotus* (메기); *O. o. interrupta*, *Odontobutis odontobutis interrupta* (얼룩동사리); *P. fulvidraco*, *Pseudobagrus fulvidraco* (동자개); *C. brevicauda*, *Culter brevicauda* (백조어); *H. kurumeus*, *Hemiramphus kurumeus* (줄공치); *C. argus*, *Channa argus* (가물치); *R. brunneus*, *Rhinogobius brunneus* (밀어).

RESULTS

1. The results in Kyongsang-do

1) The infestation states of metacercariae in each surveyed areas: From the infection experiments of the metacercariae to the golden hamsters, the recovered adult worms from *Centrocestus* sp. metacercariae were identified as *Centrocestus armatus* (Tanabe,1922), from *Echinostoma* sp. metacercariae were *Echinostoma hortense* Asada, 1926, and from *Echinichasmus* sp. metacercariae were *Echinochasmus japonicus* Tanabe, 1926, respectively (Fig. 1).

The infestation rates and abundances of each species of metacercariae are shown in Table 1.

P. parva and *S. chankaensis tsuchigae* were the most favorite 2nd intermediate hosts for the *C. sinensis*. The infestation abundances of *C. sinensis* metacercariae in those two fish hosts collected at Taewhagang were considerably high and at Hyongsangang were comparably very low. The infestation rates and relative densities of *Metagonimus* spp. were most high in *C. auratus* at Hyongsangang. *Z. platypus* and *Z. temmincki* were shown as the favorite intermediate hosts for *Metagonimus* spp., and the most favorite hosts for *Centrocestus armatus*. While the metacercariae of *Echinostoma hortense* occurred in only two fish hosts, *R. brunneus* and *A. macropterus*, the metacercariae of *Echinochasmus japonicus* occurred various fish hosts and the infestation rates and densities of this metacercariae were most high in *P. parva*. *P. parva* and *S. chankaensis tsuchigae* were infestated with the metacercariae of *Clinostomum complanatum*, but the densities were very low.

2) The distribution states of metacercariae in fish hosts: The distribution states of *C. sinensis* metacercariae in fish hosts are shown in Table 2.

Almost all (98-100%) metacercariae of *C. sinensis* occurred in flesh. The division of flesh A was the most abundant part of *C. sinensis* metacercariae and the intensities were decreased in order of A, B, C, D divisions.

The distribution states of *C. armatus* metacercariae in fish hosts are shown in Table 3.

The metacercariae of *C. armatus* occurred mostly in flesh, but the internal organs, especially intestinal outer membrane, were the favorite habitat for *C. armatus* metacercariae, also. The divisions of flesh were not shown special pattern as in *C. sinensis* metacercariae.

The metacercariae of *Metagonimus* spp. occurred only in scales and fins. The metacercariae of *E. hortense* and *E. japonicus* were found only in gills and the larvae of *C. complanatum* were found only in muscle.

2. The results in Kyonggi-do

1) The first survey (July, 1994): The results of the first survey in two streams are shown in Table 4.

P. parva in both streams was heavily

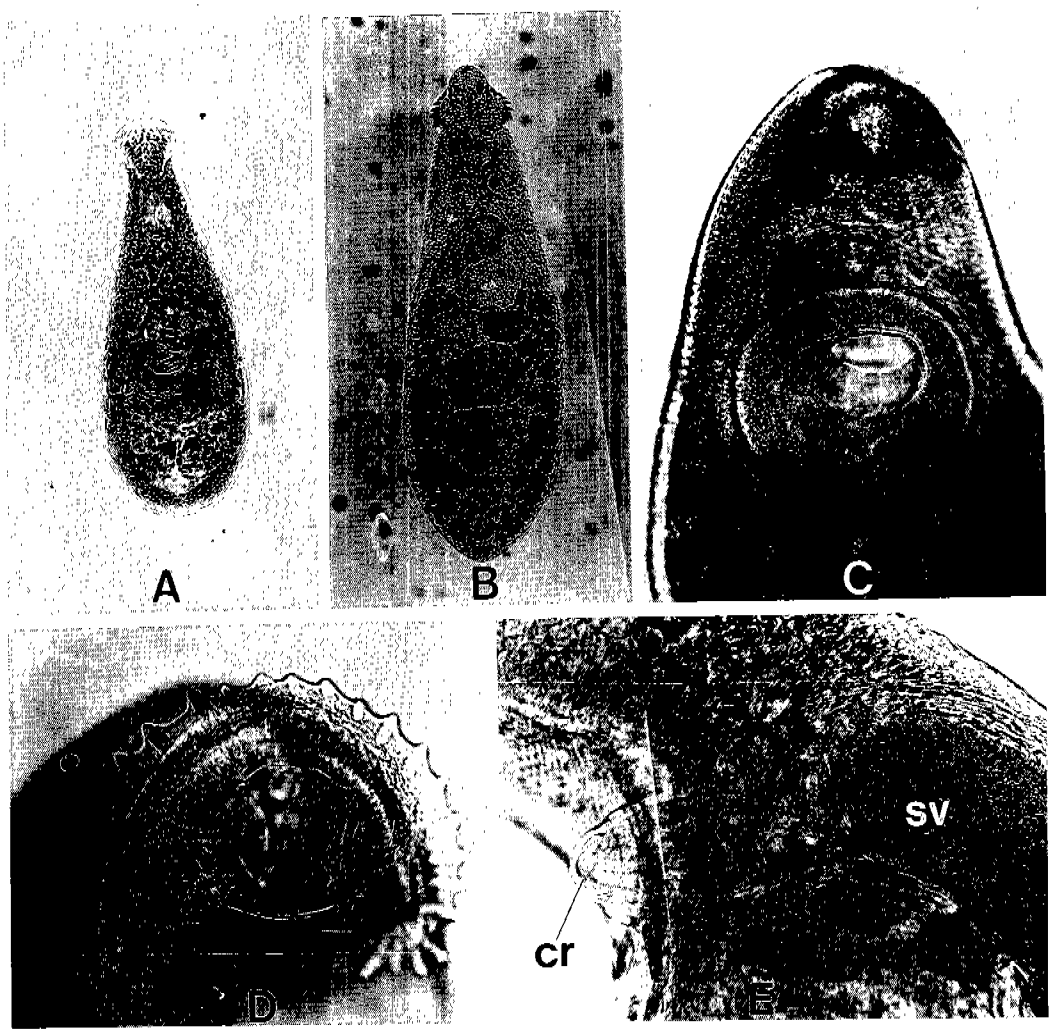

Fig. 1. The photographs of each species acquired from infection experiments. **A.** *Centrocestus armatus* (× 200) — the source of metacercariae is *Z. platypus*. **B.** *Echinochasmus japonicus* (× 100) — the source of metacercariae is *P. parva*. **C-D.** *Echinostoma hartense* — the source of metacercariae is *R. brunneus*. **C.** The anterior region of *Echinostoma hortense* (× 100). **D.** The circumoral spines of *E. hortense* (× 200). **E.** The terminal region of genital organs of *E. hortense* (× 200) (sv, seminal vesicle; cr, cirrus).

infestated with *C. sinensis* metacercariae and *A. rivularis* (at Yonpungchon), *P. herzi* (at Kyonganchon) were infestated heavily with *C. sinensis* metacercaria, also. The metacercariae of *Metagonimus* spp. were found in *Z. platypus*, *C. auratus* and *P. parva*. *Centrocestus armatus* metacercariae were found in *Z. platypus* but the infestation intensity was relatively low. *O. odontodutis interrupta* was infestated with *E. hortense* metacercariae in moderate intensity. The metacercariae of *E. japonicus* were found only in *P. parva* and *C. complanatum* metacercariae were not found in any fish species.

2) The second survey (October, 1995): The infestation rates and intensities of each species of metacercariae are shown in Table 5.

The infestation intensity of *C. sinensis* metacercariae was considerably higher than that of other species of metacercariae. Especially, the intensity of *C. sinensis* metacercariae in *S. variegatus wakiyae* collected at Konjiamchon was so high that comparable to the endemic areas in

Table 1. The infestation rates and abundances of metacercariae according to the fish hosts and the sampling localities

Sites / Fish species	No. fish examined	rate (%)/abundance (relative density)					
		Cs	Mt	Ca	Eh	Ej	Cc
1. Taewhagang							
P. parva	15	93.3/590.1	20.0/0.5	33.3/4.0	0/0	100/28.3	6.7/0.1
S. c. tsuchigae	15	100/468.1	6.7/0.13	0/0	0/0	73.3/8.3	20.0/0.5
Z. platypus	8	0/0	87.5/41.1	100/142.3	0/0	25.0/0.3	0/0
Z. temmincki	8	0/0	100/27.0	100/82.4	0/0	0/0	0/0
C. auratus	5	0/0	100/277.2	0/0	0/0	0/0	0/0
R. brunneus	6	0/0	0/0	0/0	83.3/10.2	83.3/7.8	0/0
P. fulvidraco	2	0/0	0/0	0/0	0/0	50.0/17.5	0/0
R. uyekii	1	0/0	0/0	100/3	0/0	0/0	0/0
A. rhombea	1	0/0	0/0	0/0	0/0	100/66.0	0/0
2. Hyongsangang							
P. parva	10	70.0/5.8	0/0	0/0	0/0	70.0/5.7	0/0
S. c. tsuchigae	6	83.3/6.7	0/0	0/0	0/0	16.7/0.8	16.7/0.3
Z. platypus	6	0/0	66.7/4.3	83.3/28.2	0/0	50.0/0.8	0/0
C. auratus	5	0/0	0/0	0/0	0/0	0/0	0/0
A. macropterus	4	0/0	0/0	0/0	25.0/1.0	100/13	0/0
S. n. morii	1	0/0	0/0	0/0	0/0	0/0	0/0
P. herzi	1	100/4.0	0/0 0/0	0/0	100/3.0	0/0	
R. brunneus	1	0/0	0/0	0/0	100/1.0	100/1.0	0/0
3. Nakdonggang							
P. parva	10	100/165.2	0/0	0/0	0/0	100/51.3	0/0
C. brevicauda	4	75.0/10.0	0/0	0/0	0/0	100/5.0	0/0
C. auratus	2	0/0	0/0	0/0	0/0	0/0	0/0
H. kurumeus	2	0/0	0/0	0/0	0/0	100/10.0	0/0
C. argus	1	0/0	0/0	0/0	0/0	0/0	0/0

Table 2. The total number of *C. sinensis* metacercariae in various parts of fish hosts

Site / Fish species	No. fish examined	Gill	Scale	Flesh				Kidney	Spleen	Liver	Intestinal muscle
				A	B	C	D				
1. Taewhagang											
P. parva	15	18	54	3364	2140	1759	1508	8	0	0	0
S.c. tsuchigae	15	51	67	2871	1747	1255	1025	1	0	2	2
2. Hyongsangang											
P. parva	10	0	0	27	12	9	10	0	0	0	0
S.c. tsuchigae	6	0	0	15	13	8	4	0	0	0	0
3. Nakdonggang											
P. parva	10	4	8	710	406	268	254	1	0	0	1

Kyongsangnam-do. In Kyonganchon, The abundance of *C. sinensis* metacercariae in *S. japonicus coreanus* was higher than that in *P. parva*. The infestation rates and intensities of *Metagonimus* spp. metacercariae were relatively low, but one individual of *Z. platypus* collected at Kyonganchon was infestated with 106 metacercariae of *Metagonimus* spp.. The metacercariae of *C. armatus* were found only in *R. uyekii* and the intensity of this

Table 3. The total number of *C. armatus* metacercariae in various parts of fish hosts

Site / Fish species	No. fish examined	Gill	Scale	Flesh	Kidney	Spleen	Liver	Intestinal muscle
1. Taewhagang								
Z. platypus	8	14	0	730	73	27	63	231
Z. temmincki	8	6	0	428	15	61	58	91
2. Hyongsangang								
Z. platypus	6	1	0	109	11	1	19	28

Table 4. The approximate quantity of metacercariae in two streams from the first survey

Site	Fish species	Cs	Mt	Ca	Eh	Ej	Cc
Yonpungchon	*P. parva*	+++	—	—	—	+	—
	A. rivularis	+++	—	—	—	—	—
	A. intermebia	++	—	—	—	—	—
	Z. platypus	—	++	—	—	—	—
	C. carpio	—	—	—	—	—	—
	C. auratus	—	++	—	—	—	—
	O. o. interrupta	—	—	—	++	—	—
Kyonganchon	*P. parva*	+++	+	—	—	+	—
	P. herzi	+++	—	—	—	—	—
	S. v. wakiyae	++	—	—	—	—	—
	Z. platypus	—	+	+	—	—	—
	C. auratus	—	—	—	—	—	—

(—, negative; +, 1-10 in average; ++, 11-100 in average; +++, above 101 in average)

metacercariae was very low. While the metacercariae of *E. hortense* were found only in *R. brunneus*, the metacercariae of *E. japonicus* occurred in almost all fish species. *C. complanatum* metacercariae were occurred only in *S. japonicus coreanus*.

The distribution states of *C. sinensis* metacercariae according to the parts of the fish organs are shown in Table 6.

Almost all metacercariae of *C. sinensis* occurred in flesh and were not found in internal organs. The division of Flesh A was the most favorite site for *C. sinensis* metacercariae and more than 60% of *C. sinensis* metacercariae were occurred in the divisions of Flesh A and Flesh B. The infestation densities of *C. sinensis* metacercariae in Flesh A were always above two times of those in Flesh D.

The metacercariae of *C. armatus*, *E. hortense* and *E. japonicus* were found only in gills and *C. complanatum* metacercariae occurred in muscle.

DISCUSSION

It is well known that clonorchiasis is the most important and nationwide helminthiasis in Korea. Approximately 36 species of freshwater fish were found to serve as second intermediate hosts in Korea and the most frequently infestated fish was *Pseudorasbora parva* (Rim, 1994; KAPE, 1978; Choi, 1976).

The first survey of clonorchiasis in Taewhagang was carried out by Joo (1980). He examined 1,723 residents in the vicinity of the river and found 22.2% were positive for *C. sinensis*. Concurrently, also, he examined the intermediate hosts of *C. sinensis*, but the prevalence and intensitiy of metacercariae in fish hosts were relatively low. Eight years later, Joo (1988) investigated the infection state of metacercariae from fish hosts in the same area and found that the density of *C. sinensis*

Table 5. The infestation rates and abundances of metacercariae according to the fish hosts and the sampling localities

Site Fish species	No. fish examined	rate (%)/abundance (relative density)					
		Cs	Mt	Ca	Eh	Ej	Cc
1. Yonpungchon							
P. parva	8	100/81.0	0/0	0/0	0/0	100/16.3	0/0
A. rivularis	10	70.0/7.5	0/0	0/0	0/0	0/0	0/0
Z. platypus	4	0/0	100/3.0	0/0	0/0	0/0	0/0
C. auratus	4	0/0	0/0	0/0	0/0	0/0	0/0
R. uyekii	5	0/0	0/0	0/0	0/0	40.0/1.0	0/0
O. o. interrupta	2	0/0	0/0	0/0	0/0	0/0	0/0
2. Munsanchon							
P. parva	2	100/42.0	0/0	0/0	0/0	100/10.0	0/0
A. rivularis	3	0/0	0/0	0/0	0/0	0/0	0/0
Z. platypus	7	0/0	28.6/0.9	0/0	0/0	42.9/0.7	0/0
C. auratus	2	0/0	0/0	0/0	0/0	50.0/0.5	0/0
P. esocinus	1	0/0	0/0	0/0	0/0	100/7.0	0/0
S. asotus	1	0/0	0/0	0/0	0/0	100/8.0	0/0
3. Kyonganchon							
P. parva	9	100/20.7	0/0	0/0	0/0	77.8/3.1	0/0
S. j. coreanus	11	100/50.0	9.1/0.2	0/0	0/0	72.7/3.2	18.2/0.5
S. v. wakiyae	6	66.7/8.7	0/0	0/0	0/0	66.7/1.5	0/0
Z. platypus	7	0/0	57.1/18.0	0/0	0/0	14.3/0.1	0/0
C. auratus	2	0/0	0/0	0/0	0/0	0/0	0/0
P. esocinus	3	0/0	0/0	0/0	0/0	33.3/0.7	0/0
4. Konjiamchon							
S. v. wakiyae	2	100/261.5	0/0	0/0	0/0	100/1.0	0/0
R. uyeki	2	100/5.0	0/0	100/2.0	0/0	0/0	0/0
A. imtermebia	3	0/0	0/0	0/0	0/0	33.3/0.7	0/0
P. esocinus	2	0/0	50.0/1.0	0/0	0/0	0/0	0/0
R. brunneus	1	0/0	100/2.0	0/0	100/1.0	100/1.0	0/0
C. lutheri	1	0/0	0/0	0/0	0/0	0/0	0/0

Table 6. The distribution states of *C. sinensis* metacercariae in various parts of fish hosts

Site	Fish species	No.	Total No. of Csm[a] recovered	No. and percentage (%) of Cs metacercariae					
				Gill	Scale	Flesh A	Flesh B	Flesh C	Flesh D
1. Yonpungchon									
	P. parva	8	648	3(0.5)	1(0.2)	282(43.5)	166(25.6)	80(12.3)	116(17.9)
	A. rivularis	10	75	1(1.3)	0(0)	30(40.0)	18(24.0)	16(21.3)	10(13.3)
2. Kyonganchon									
	P. parva	9	186	0(0)	0(0)	78(41.9)	46(24.7)	32(17.2)	30(16.1)
	S.j. coreanus	11	550	4(0.7)	0(0)	244(44.4)	162(29.5	78(14.2)	62(11.3)
	S.v. wakiyae	6	52	0(0)	0(0)	24(46.2)	20(38.5)	6(11.5)	2(3.8)
3. Konjiamchon									
	S.v. wakiyae	2	523	7(1.3)	0(0)	208(39.8)	122(23.3)	102(19.5)	84(16.1)

[a]Csm, metacercariae of *C. sinensis*

metacercariae was relatively decreased as compared with the earlier report. In the present study, however, the infestation rates and abundances of *C. sinensis* metacercariae in fish hosts were enormously increased (Table 7).

The cause of this difference can be conjectured by several ways. Firstly, the discrepancy of survey periods may generated such differences. According to the data of Kang *et al.* (1985), the infestation rates and intensities of *C. sinensis* metacercariae in *P. parva* were relatively low in March, April and November as compared with May, June, July and September. The survey period of Joo (1980) was March, 1979 — September, 1980 and Joo (1988) was April — October, 1988. These periods are not greatly different from the period of the present study. The discrepancies of survey periods, therefore, may affect in some degree but are not considered as the major cause of generating such a great differences. Secondly, the different examination methods may be considered as the cause. Joo (1980, 1988) examined only one gram of flesh for counting metacercariae. According to the present results, however, the intensities of *C. sinensis* metacercariae in a fish are markedly different according to the divisions. The intensities of *C. sinensis* metacercariae in A division was at least two times than those of D division. Therefore the difference in examination methods, probably, influenced to those results in considerable extent. Lastly, the marked increase of *C. sinensis* metacercariae in the present study may be the purely natural phenomenon. In that case, there are no proper way to explain what factors had affected to the *C. sinensis*.

From the present study, the infestation rates and intensities of *C. sinensis* metacercariae in Hyongsangang were decreased as compared with the reports of Joo (1984), and the infestation intensities were relatively very low as compared with the other two rivers — Taewhagang and Nakdonggang (Table 8).

Compared the present data with Kim *et al.*'s (1989), the infestation density of *C. sinensis* metacercariae in *P. parva* which collected from Chomanpo, Nakdonggang was continuously maintained high. Therefore, this region is considered to have favorable environments for *C. sinensis* endemicity.

The prevalences and infestation intensities of *C. sinensis* metacercariae in four streams of Kyonggi-do were relatively higher than those of the other metacercariae. Although the prevalences and intensities of *C. sinensis* metacercariae in Kyonggi-do areas are relatively lower than those in Nakdonggang

Table 7. Comparison of infestation states of metacercariae with the previous reports in Taewhagang

Metacercariae	Fish species	No. of examined/infestation rate/infestation density per gram		
		Joo (1980) Joo & Park (1982)[a]	Joo (1988)	Present study
C. sinensis	*P. parva*	—	94/50.0%/8.1	15/93.3%/199.8
	S.c.tsuchigae	83/22.9%/21.5	73/45.2%/8.2	15/100%/139.0
Metagonimus spp.	*C. auratus*	110/44.5%/0.6	112/4.5%/1.8	5/100%/38.2
	Z. platypus	18/5.5%/0.1	100/18.0%/13.7	8/87.5%/5.8
	Z. temmincki	83/6.0%/0.2	63/7.9%/4.1	8/100%/4.69
C. armatus	*Z. platypus*	36/0%/0	100/0%/0	8/100%/20.0
	Z. temmincki	43/0%/0	63/0%/0	8/100%/14.3
E. japonicus	*P. parva*	—	94/35.1%/?	15/100%/9.9
	S.c.tsuchigae	83/2.4%/?	73/45.2%/?	15/73.3%/2.5
	Z. platypus	36/5.6%/?	100/81.0%/?	8/25.0%/0.04
	Z. temmincki	43/7.0%/?	63/65.1%/?	8/0%/0

[a] *Gnathopogon atromaculatus* which was reported in the previous studies was treated as the same species of *S. chankaensis tsuchigae* in the present study.

Table 8. Comparison of infestation states of metacercariae with the previous reports in Hyongsangang

Metacercariae	Fish species	No. of examined/ infestation rate/infestation density per gram	
		Joo (1984)	present study
C. sinensis	*P. parva*	31/74.2%/9.7	10/70.0%/1.5
	S.c. tsuchigae	31/93.5%/45.5	6/83.3%/2.0
Metagonimus spp.	*C. auratus*	113/52.2%/1.8	5/0% /0
	Z. platypus	82/34.1%/0.5	6/66.7%/0.44
C. armatus	*Z. platypus*	82/0%/0	6/83.3%/2.9
E. japonicus	*P. parva*	31/16.1%/0.6	10/70.0%/1.5
	S.c. tsuchigae	31/29.0%/0.5	6/16.7%/0.25
	Z. platypus	82/12.2%/0.14	6/50.0%/0.1

areas (Kang *et al.*, 1985; Kim *et al.*, 1989), these regions still have a potentiality to give rise severe clonorchiasis. The mean number of parasites/host provides the most useful indicator for utilizing host species. Considering of this parameter, *P. parva*, *S. japonicus coreanus* and *S. variegatus wakiyae* can act complementarily as the most heavily utilized second intermediate hosts for *C. sinensis* according to the composition of fish fauna.

The heterogeneity in the distribution pattern of *C. sinensis* metacercariae in the four divided body parts may be interpreted in two ways. Namely, the cercariae of *C. sinensis* penetrate into the fish body, then moved into the anterior-upper region or the attack orientation of *C. sinensis* cercariae is beginned from the anterior-upper side to the fish.

The metacercariae of *Metagonimus* spp. in the present surveyed areas infestated mainly in the cyprinid fishes and maintained relatively low infestation intensities except *C. auratus* in Taewhagang.

The most conspicuous difference among the previous reports and the present study is the presence of *C. armatus* metacercariae. From the results of the present study, the infestation rates and densities of *C. armatus* metacercariae in *Z. platypus* and *Z. temmincki* which collected from Taewhagang were considerably high. But Joo (1988) made no mention of *C. armarus* metacercariae in spite of the same surveyed areas and the same hosts. At present, we can not properly interprete this difference. The second intermediate hosts for *C. armatus* in Korea are known to be the freshwater fish such as *Zacco platypus*, *Z. temmincki*, *Rhodeus ocellatus*, *Gobius similis*, *Pseudorasbora parva*, *Pelteobagrus fulvidraco* and several other species (Lee *et al.*, 1983 & 1984; Hong *et al.*, 1989). Hong *et al.* (1988) reported the first natural human infection case of *C. armatus* in Korea. Later, Hong *et al.* (1989) surveyed the infestation states of *C. armatus* metacercariae in *Z. platypus* and *Z. temmincki* which were caught from various rivers in Korea and reported that these two fish hosts were heavily infested with *C. armatus* metacercariae. Compared the results of the present study with that of Hong *et al.* (1989), the infestation rates and intensities of *C. armatus* metacercariae in Taewhagang were similar with the mean values of Hong *et al.*'s, but those in Hyongsangang were lower than the average values. In the course of examination, Hong *et al.* (1989) removed the internal organs of fish to prevent rotting and mentioned that the infestation intensities would be increased if the removed organs were included. From the present results, the infestation intensities in internal organs were considerably high. Therefore, to investigate the intensity of *C. armatus* metacercariae exactly, also the internal organs must be investigated.

The metacercariae of *Echinostoma hortense* occurred concentratively in *R. brunneus* which were caught at Taewhagang. The second intermediate fish hosts of *E. hortense* in Korea are *Misgurnus anguillicaudatus* (Chai *et al.*, 1985), *M. mizolepis*, *Odontobutis obscura interrupta*, *Moroco oxycephalus*, *Coreoperca kawamebari* (Ryang, 1990), *Squalidus coreanus* (Lee *et al.*, 1988), and *Rhinogobius*

brunneus, Acanthorhodeus macropterus from the present study. The metacercariae of *Echinochasmus japonicus* occurred in the widest range of fish hosts among examined metacercariae kinds. While the metacercariae of *Clinostomum complanatum* were found in only two fish hosts, *P. parva* and *S. chankaensis tsuchigae*, and the infestation densities were very low.

Because there are great differences according to the examination methods which adopt by each author, a standard method of metacercarial examination must be established. From this point of view, we propose following method as a standard method. As much as possible, ten individuals of each species of fish should be examined for statistical analysio. The two slides pressure method is preferable to the digestion method because of more accurate method than digestion method. The examination of parts of fish should include total flesh, gills, scales, fins, and the internal organs. Moreover, surveying through year — monthly or seasonally — is important for monitoring of fluctuations. This method may be somewhat laborious but can solve several problems of different data according to authors.

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=초록=

식이성 윤충류질환의 관리전략수립을 위한 감염원의 역학 및 병원체의 생물학적 특성에 관한 조사연구 — 경상도내 3개 강 및 경기도내 4개 하천에서 채집한 민물어류의 인체기생 흡충류 피낭유충 감염상 및 변동

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경상도내 3개 강유역(태화강, 형산강, 낙동강) 및 경기도내 4개 하천(연풍천, 문산천, 경안천, 곤지암천)에 서식하는 민물어류의 인체기생 흡충류 피낭유충(*Clonorchis sinensis, Metagonimus* spp., *Centrocestus armatus, Echinostoma hortense, Echinochasmus japonicus, Clinostomum complannatum*)의 감염률 및 감염강도를 조사하였다. 태화강에서 채집된어류 중 참붕어와 참몰개는 *C. sinensis*의 피낭유충에, 피라미와 갈겨니는 *C. armatus*의 피낭유충에 중감염되어 있었다. 형산강에서 채집된 피라미와 갈겨니 역시 *C. armatus* 피낭유충에 상당히 높은 감염률과 감염강도를 나타냈지만 태화강에 비하면 그 감염강도가 낮은편이었다. 낙동강의 조만포는 간흡충 피낭유충이 상당히 안정된 상태로 유지되고 있었다. 경기도내 하천에서 조사한 흡충류 피낭유충의 종류 중에서는 간흡충 피낭유충이 가장 높은 감염률 및 감염강도를 나타내었다. 경기도내 간흡충 피낭유충의 감염률 및 감염강도는 경상도 지역에 비해 낮은 수준이지만, 인체 간흡충증을 일으키기에는 충분한 요건 및 잠재력을 갖추고 있는 것으로 나타났다. 어체의 근육부위별 간흡충 피낭유충의 감염강도는 A부위에서 가장 높게 나타났으며, 그 다음은 B. C, D순으로 낮아졌다. A부위와 D부위간의 간흡충 피낭유충의 감염강도 차는 2배 이상으로 나타났으며, 이와 같은 심한 불균등성의 원인은 아마도 간흡충 유미유충 혹은 초기 피낭유충의 행동학적 특성때문일 것으로 추측하였다. *C. armatus*의 피낭유충은 비늘과 지느러미를 제외한 전 부분에서 출현하였으며, 특히 피라미와 갈겨니가 타어종에 비해 월등한 감수성을 보였다. 태화강의 어류내 간흡충의 감염률 및 감염강도는 그 전의 보고들에 비해 엄청난 증가를 나타냈으며, *C. armatus*의 피낭유충은 그 전의 보고들에서는 전혀 언급되지 않았었으나 금번 조사에서는 매우 높은 감염률 및 강도를 나타내었다. 밀어와 큰납지리는 새로이 *E. hortense*의 중간숙주로 밝혀졌다. 조사시기 및 조사자에 따라 피낭유충의 감염상에 많은 차이가 생겨나는 원인에 대해 고찰하였으며, 민물어류의 피낭유충의 검사시 적절하다고 여겨지는 하나의 표준화방법을 제안하였다.

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