啓明醫大論文集 第 17 卷 第 2 號
Keimyung Med J
Vol. 17, No. 2, June, 1998

Changing Patterns of Infection with Digenetic Larval Trematodes from Fresh-water Fish in River Hyungsan, Kyungpook, Korea*

Sung Rok Kim, M.D. and Chong Yoon Joo, M.D.

Department of Parasitology,
Keimyung University School of Medicine and Institute for Medical Science
Taegu, Korea

= Abstract =

In order to determine infection patterns with digenetics larval trematodes in fresh-water fish were studied in the three localities of the river Hyungsan during the period from September, 1995 to August, 1996, and compared with the data reported previoulsy in the same river. Of 15 species of fish examined. the encysted larvae of *Cyathocotyle orientalis and Exorchis* oviformis were found most frequently from 13 species of fresh-water fish. The metacercariae of *Metacercaria hasegawai* were found from 12 species, those of *Echinochasmus* species from 10 species, *Methorchis orientalis* from 4 species, *Clonorchis sinensis* from 3 species and *Metagonimus* species from 2 species of fish.

The infection rates of 2 species of fish with *Clonorchis sinensis* cysts were lower than those reported in 1984, whereas the rate was higher in one species, *Pungtungia herzi*. The intensity of *Clonorchis* infection in *Pungtungia herzi* appeared rather higher than those reported in 1984, whereas their intensity of infection were found lower in 2 species of fish, *Gnathopogon atromculatus* and *Pseudorasbora parva*. The infection rates of fish with *Metagonimus* metacercariae were lower than the results in 1984, whereas their intensity of infection was found increased in 2 species of fish such as *Carassius carassius* and *Moroco oxycephalus*. The encysted larvae of *Cyathocotyle orientalis, Echinochasmus* species, *Exorchis oviforms, Metacercaria hasegawai* and *Metorchis orientalis* showed variations in infection rates of fish in 1984 and in the present study, and intensities in the 5 kinds of the encysted compared with those in 1984.

However, it was impossible to compare the infection rates for the encysted larvae on the scales, fins and tail as they varied so considerably in both 1984 and 1996 surveys. The infection rates of several species of fish with *Metagonimus* species in the present study decreased compared with those in 1984.

The results of this study were presented at the 38th annual meeting of the Korean Society for Parasitology (1996)

This study indicate that the rate of infection with digenetic larval trematodes in fresh-water fish is still relatively high in the river Hyungsan. And the metacercarial burden in the fish varies greatly by different fish in 1984.

Key Words: Digenetic larval trematode. Clonorchiasis.
River Hyungsan. Metacercaria. Snail and fish intermediate hosts.

Introduction

Clonorchiasis is one of the food-borne trematode infections in Korea. Since the discovery of *Clonorchis* eggs was reported by Matsumoto (1915) from the stools among the in-and-outpatients in Taegu charity hospital, the biology, morphology, and epidemiology of *C. sinensis* through the field and experimental studies have been made extensively by many investigators. Kobayashi (1920) summarized survey findings on the infections with digenetic larval trematodes in the snail and fresh-water fish hosts and the prevalence of *C. sinensis* among the residents in the Naktong Basin. Nishimura (1943) made a survey on *C. sinensis* in the River Kumho, and reported the demonstration of *Clonorchis* metacercariae in several fresh-water fish such as *P. parva, G. atromaculatus* and *P. herzi*. The human prevalence of clonorchiasis were amounted to 41.1 percent of 331 residents in the area. After the World War Ⅱ, the results of studies on the digenetic larval trematodes in fresh-water fish have been reported by Lee and Kim (1958), and Hwang and Choi (1980) in River Kumho; by Joo *et al.* (1983) in River Taechong; by Joo and Hong (1991) in River Ahnseong; by Lee and Joo (1995) in River Taega; by Choi (1976), Lee *et al.* (1992), and Hyun and Joo (1994) on comprehensive surveys in the River Naktong and its tributaries in Kyungpook Province, Korea. It was found that the results reported by previous investigators indicated a decreasing pattern in human cases and in the number of the snail and fish intermediate hosts. In the Hyungsan Basin, there are newly established many apartments and factories, and massive drainage of waste products into the river together with intense spray of pesticides on nearby farms may have resulted in the destruction of natural environment of the river. This study has been proceeded as a part of our investigation in the epidemiology and control of human clonorchiasis, since the fresh-water fish was found to play as the main vector of *C. sinensis* prevalence in Korea. This report deals with the present status of larval trematode infections in fresh-water fish collected in the river Hyungsan, in comparison with the previously reported data in the same river.

Materials and Methods

Geographical conditions of surveyed areas: The river Hyungsan, about 62 kilometers in length, has origin in the east

range of the Baekyoon mountain and runs through the Ulsan city situated in the northeastern part of Kyungnam Province, where the river joins with many rivulets running from the Gohie mountains. The main stream of the river runs through the central Kyungju city, where the river joins again with the Moryang rivulet in the southern part of the city. It then runs through Kyungju city and Pohang city, and meets with Kikae rivulet and 19 other rivulets in the basin. Finally, it runs into the East Sea of Korea. There are many ponds and two lakes, the Dukdong and Bomun lakes in the vicinity. Three localities in the river Hyungsan, i. e., Wooldong, Nogok, and Nawon in Kyungju city, were selected as the study areas because of the abundance of the fresh-water fish, and which had also been surveyed by Joo (1984) (Figure 1). The localities are from 20 to 30 meters above sea level and the bottom is mainly composed of pebble and sand, with mud (Table 1).

Table 1. Environmental conditions of surveyed areas near the River Hyungsan (1996)

Locality		Bottom structure	Mean of water depth (cm)	COD (ppm)	Aquatic inverterbrate & vegetation
Village	Draining stream				
Wool-dong	Morang str.	Pebble and sand	70-80	30-40	Leech 펄달팽이, 명아주 (*Chenopodiium album*) 나선엽주말
Nogok	Naenam str.	Pebble and sand	80-100	20-30	Snail 광택물도래 개구리밥 (*Spirodela polyrhiza*) 부레옥잠 (*Eichhornia crassipes*)
Nawon	Main str. of River Hyungsan	Sand and pebble	130-200	20-30	왕잠자리 (*Anax parthenope*) 펄조개 (*Anodeonta woodiana*) 물여뀌 (*Persicaria amphibia*) 개망초 (*Erigeron annuus*)

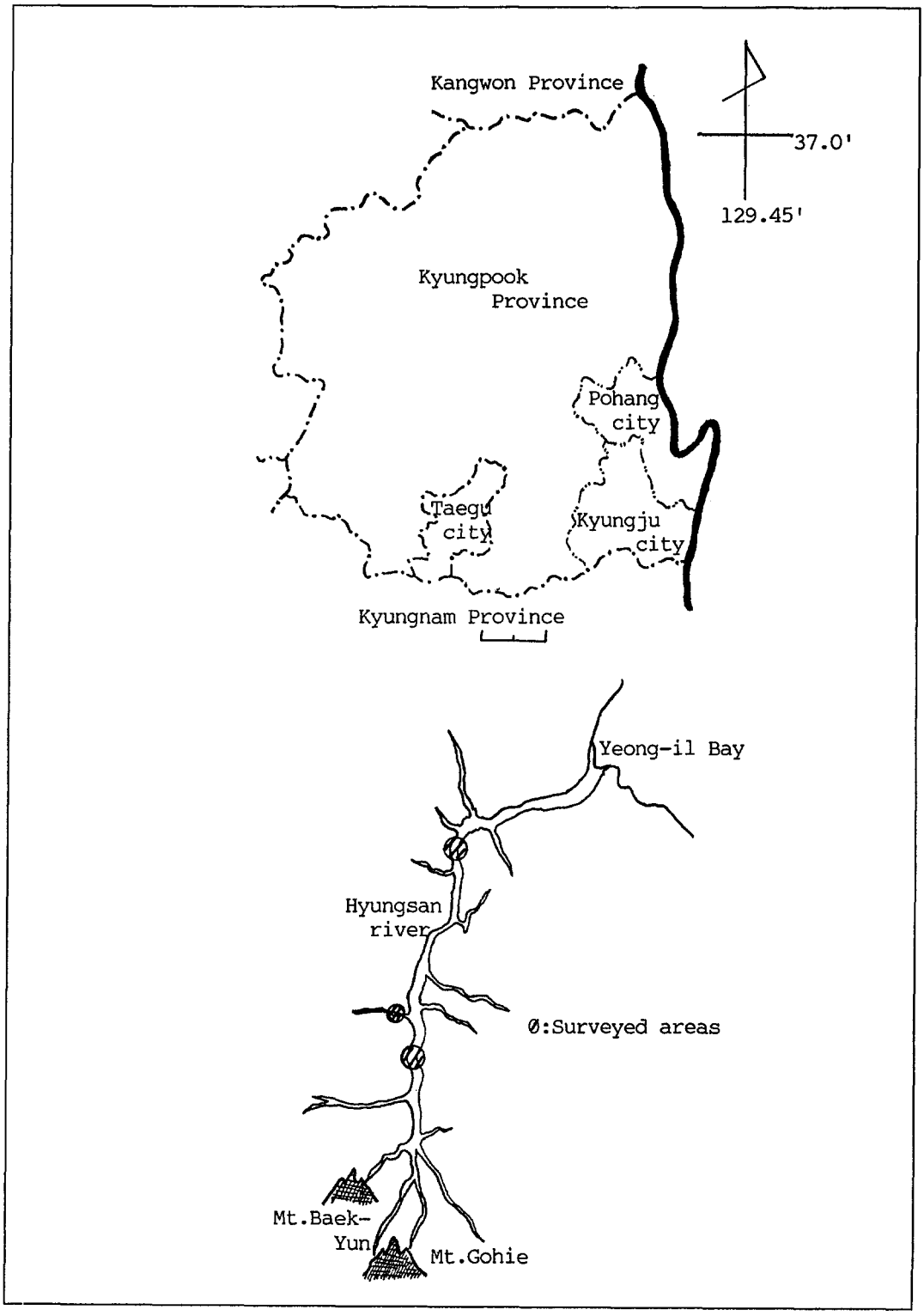

Figure 1. Surveyed areas in the vicinity of the river Hyungsan, Kyungpook Province.

The water level in these areas is fairly constant except 5-10 days after a heavy rain, and there are many kinds of plants and grasses on the river-sides. The fish intermediate host survey: Several kinds of fresh-water fish were caught in the river Hyungsan by netting and fishing with rod and line during the priod of 1 years from September, 1995 to August 1996. The fish, after removal of their intestinal contents to prevent autodigestion, were transported to the laboratory. The specific name of the fish were determined by the keys described by Chung (1977). In order to determine the distribution of encysted larvae of trematodes, the fish were dissected into their flesh, scales, fins and tail. One gram of flesh, 50 scales, all fins and tail were separated from each fish using a knife, compressed between two large slides (50 × 90 mm) and examined for the presence of metacercariae of digenetic trematodes under a binocular dissecting microscope. In order to isolate the larval trematodes and to count the average number of cysts per gram of flesh, the digestion technique was also applied; thus 1 gram of flesh was mixed with artificial gastric juice (0.2 ml diluted hydrochloric acid and 0.3 gram of pepsin per 100 ml of distilled water), and then the mixture was incubated under the temperature of 37~38℃ for 30~40 minutes. The mixture was stirred with a glass rod and was allowed to stand for a few minute to gather the isolated cysts in the central portion of the beaker.

The identification of the larval trematodes was made according to the methods described by Komiya and Tajimi (1940 a, b, 1941) and Yamaguti (1958). The metacercariae from the fresh-water fish were also immediately fed to golden hamsters, and adults worms were obtained from the hamsters after 2 months. The stained preparations were studied morphologically for the final identification of each trematode species.

Results

A total of 1,440 of fresh-water fish of 15 species belonging to Families Cyprinidae, Anabantidae, Bagridae, Centrachidae, and Eleotridae were collected from three localities of the river Hyungsan in 1996. The species and individual numbers of fresh-water fish collected were compared with previously reported data and summarized in Table 2. Of these, *C. carassius, G. atromaculatus, P. parva, Z. platypus, Z. temmincki,* and *M. oxycephalus* were the most frequent species of fish. Two species, *P. rhombea* and *P. herzi,* are known to be the common species in the river, but in present survey they were frequently collected. Seven species, such as *M. ocellatus, A. intermedia, G. macrocephalus, M. chinensis, L. andersonii, L. macrochirus,* and *M. obscura,* are first collected. In this survey *P. altivelis, C. herzi, and P. asotus* were not collected.

In Table 3, the infection rates and densities for the encysted larvae of *C. sinensis* in the flesh of fresh-water fish in this survey (1996) were compared with those of Joo (1984). Of the fish examined in 1996, the encysted larvae of *C. sinensis*

Table 2. Comparison of species and number of fresh-water fish caught from the River Hyungsan in 1984 and 1996

Family/species	Common name	Korean	No. of fish collected	
			Lee *et al.*	authors (1996)
Cyprinidae				
Carassius carassius	crussian carp	붕어	113	426
Gnathopogon atromaculatus	Korean shiner	몰개	31	143
Moroco oxycephalus	fat minnow	버들치	4	70
Paracheilognathus rhombea	flat bitterling	납지리	39	5
Pseudorasbora parva	southern top-mouthed minnow	참붕어	31	415
Pungtungia herzi	striped shiner	돌고기	17	4
Zacco platypus	pale chub	피라미	82	190
Zacco temmincki	dark chub	갈겨니	51	111
Rhodeus ocellatus	rose bitterling	흰줄납줄개	0	23
Acheilognathus intermedia	common bitterling	납자루	0	6
Gobiobotia macrocephalus	-	꾸구리	0	9
Anabantidae				
Macropodus chinensis	round-tail fighting fish	버들붕어	0	2
Bagridae				
Liobagrus andersonii	-	퉁가리	0	1
Centrachidae				
Lepomis macrochirus	blue gill	파랑볼우럭	0	31
Eleotridae				
Mogurnda obscura	dark sleeper	동사리	0	4
Plecoglossidae				
Plecoglossus altivelis	sweetfish	은 어	24	0
Serranidae				
Coreoperca herzi	perch	꺽 지	3	0
Siluridae				
Parasilurus asotus	catfish	메 기	6	0

were found in four species. *G. artomaculatus* was the most highly infected, with infection rate of 62.9 percent, followed by *P. herzi* with 50.0 percent, and *P. parva* with 46.3 percent. Of these, the rates in species such as *P. herzi* were increased in the period from 1984 to 1996, but in 2 species, *G. atromaculatus* and *P. parva,* the rates were decreased. The average metacercarial density per gram of flesh of *C. sinensis* in fish, appear to be higher in two species such as *P. herzi* in 1996 than in 1984, but were found lowered in *G. atromaculatus* and *P. parva.*

Table 3. Comparison of infection rates and density of *Clonorchis* metacercariae from fresh-water fish caught from the River Hyungsan in 1984 and 1996

Species	No. of fish examined		Percent infected		Mean of larvae per gram of flesh	
	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)
C. carassius	113	426	0	0	0	0
G. atromaculatus	31	143	93.5	62.9	45.5	31.6
M. oxycephalus	4	70	0	0	0	0
P. rhombea	39	5	2.6	0	0.05	0
P. parva	31	415	74.2	46.3	9.7	7.7
P. herzi	17	4	17.6	50.0	11.6	14.0
Z. platypus	82	190	0	0	0	0
Z. temmincki	51	111	0	0	0	0
R. ocelllatus	-	23	-	0	-	0
A. intermedia	-	6	-	0	-	0
G. macrocephalus	-	9	-	0	-	0
M. chinensis	-	2	-	0	-	0
L. andersonii	-	1	-	0	-	0
L. macrochirus	-	31	-	0	-	0
M. obscura	-	4	-	0	-	0
P. altivelis	24	-	0	-	0	-
C. herzi	3	-	0	-	0	-
P. asotus	6	-	0	-	0	-

The infection rates and densities for the encysted larvae of *Metagonimus* species in 1996 were compared with those in 1984, as presented in Table 4. Eight species of fishes examined in 1984 were infected with *Metagonimus* larvae, whereas, only 2 species of fishes were found infected in 1996. Of the 423 *C. carassius* examined in 1996, 1.4 percent of the fish were infected with the encysted larvae of *Metagonimus* species, while, 52.2 percent of 113 crussian carp examined in 1984 were infected. Similar reduction in the infection rate in *M. oxycephalus* was also recognized The infection densities of the *Metagonimus* larvae in 2 species of fish were lower in 1996 and the average number of larvae varied by fish species, from 1.8 to 2.0.

The data presented in Table 5 are compared the 1996 results of the infection rates of larval trematodes other than *C. sinensis* and *Metagonimus* species in fresh-water fish with those of Joo (1984). Five kinds of digenetic larval trematodes, *C. orientalis, Echinochasmus* species, *E. oviformis, M. hasegawai,* and *M. orientalis* were found in this survey. Of these, the larvae

Table 4. Comparison of infection rates and density of encysted larvae of *Metagonimus* species from fresh-water fish in 1984 and 1996

Species	No. of fish examined		Percent infected		Mean of larvae per gram of flesh	
	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)
C. carassius	113	426	52.2	1.4	1.8	1.8
G. atromaculatus	31	143	74.2	0	4.1	0
M. oxycephalus	4	70	50.0	1.4	0.5	2.0
P. rhombea	39	5	12.8	0	0.23	0
P. parva	31	415	64.5	0	9.1	0
P. herzi	17	4	0	0	0	0
Z. platypus	82	190	34.1	0	0.5	0
Z. temmincki	51	111	21.6	0	0.5	0
R. ocelllatus	-	23	-	0	-	0
A. intermedia	-	6	-	0	-	0
G. macrocephalus	-	9	-	0	-	0
M. chinensis	-	2	-	0	-	0
L. andersonii	-	1	-	0	-	0
L. macrochirus	-	31	-	0	-	0
M. obscura	-	4	-	0	-	0
P. altivelis	24	-	87.5	-	32.9	-
C. herzi	3	-	0	-	0	-
P. asotus	6	-	0	-	0	-

of *C. orientalis*, *E. oviformis* and *M. hasegawai* were found from 13 species of fishes, followed by *Echinochasmus* species from 10 species, and *M. orientalis* from 4 species of fishes. In the infection rates of fish with the larval trematodes, there were considerable variations among the different kinds of fishes. The infection rate for the encysted larvae of *C. orientalis* in the flesh of *P. parva* in 1984 was found to be 25.8 percent, whereas, the rate in this survey was increased to 76.4 percent. Similarly, an increase in the rates of infection among the 12 species of fishes was also found. In the case of *Echinochasmus* species, of the 426 *C. carassius* examined in 1996, 11.3 percent of fish were found to be infected, while, no encysted larvae was found in 1984. Similar infection status was revealed among the 9 species of fishes. The encysted larvae of *E. oviformis* were found from 13 fish species: the rates in 6 species were decreased, but in 2 species the rates were increased.

M. hasegawai larvae were found from 13 species of fishes examined in 1996, in frequency from 1.0 to 100.0 percent, while, only 6 species of fishes examined in 1984 were also found to be infected by the same larvae in 6.4~67.7 percent frequency. The infection rates for the encysted larval trematodes on scales and fins of fresh-water fish in 1996 were summarized in Table 6, and compared with those in 1984 (Joo, 1984). There was

Table 5. Comparison of infection rates for the encysted larvae of digenetic trematodes other than *C.sinensis* and *Metagonimus* species in fresh - water in 1984 and 1996

Species	No. of fish examined		Infection rate (%) with encysted larvae									
			C. orientalis		*E.chinochasmus sp.*		*E. oviformis*		*M. hasegawai*		*M.orientalis*	
	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)
C. carassius	113	426	42.5	43.9	0	11.3	14.2	13.1	34.5	17.6	2.7	1.2
G. atromaculatus	31	143	16.2	21.0	29.0	31.5	64.5	51.7	67.7	46.9	22.6	10.5
M. oxycephalus	4	70	0	90.0	0	2.9	25.0	0.3	0	18.6	25.0	0
P. rhombea	39	5	2.6	100.0	0	40.0	5.5	40.0	10.3	60.0	0	0
P. parva	31	415	25.8	76.4	16.1	45.5	22.6	37.8	6.4	1.0	3.2	0
P. herzi	17	4	0	100.0	0	25.0	23.5	0	0	0	0	25.0
Z. platypus	82	190	3.7	37.4	12.2	93.7	7.3	1.6	9.8	7.4	1.2	0
Z. temmincki	51	111	31.4	34.2	19.6	91.9	7.8	2.7	0	4.5	9.8	0
R, ocellatus	-	23	-	8.7	93.3	0	-	8.7	0	0	-	0
A. intermedia	-	6	-	16.7	-	16.7	-	33.3	0	16.7	-	0
G. macrochirus	-	9	-	88.9	-	0	-	22.2	0	44.4	-	11.1
M. chinensis	-	2	-	50.0	-	50.0	-	50.0	0	50.0	-	0
L. andersonii	-	1	-	0	-	0	-	100.0	-	100.0	-	0
L. macrochirus	-	31	-	0	-	0	-	3.2	-	0	-	0
M. obscura	-	4	-	75.0	-	0	-	0	-	75.0	-	0
P. altivelis	24	-	0	-	8.3	-	16.7	-	4.2	-	0	-
C. herzi	3	-	0	-	-	-	33.0	-	-	-	0	-
P. asotus	6	-	0	-	-	-	0	-	-	-	0	-

Table 6. Comparison of infection rates for the encysted larvae of digenetic trematodes on the scales and fins of fish in 1984 and 1996

Species	No. of fish examined		No. of infected with larval trematodes (%)															
			C. orientalis		*Echinochasmus* sp.		*E. oviformis*		*M. hasegawai*		*M. orientalis*		*C. sinensis*		*Metagonimus* sp.		Unknown sp.	
	Joo (1984)	Present author (1997)	Joo (1984)	Present author (1997)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)
C. carassius	113	426	16(14.2)	4(0.9)	2(1.8)	0(0)	25(22.1)	2(0.5)	17(15.0)	14(3.3)	2(1.8)	0(0)	0(0)	0(0)	96(85.0	167(39.2)	3(2.7)	34(8.0)
G. atromaculatus	31	143	0(0)	0(0)	0(0)	15(10.5)	0(0)	21(14.7)	4(12.9)	30(21.0)	0(0)	0(0)	3(9.7)	0(0)	11(35.0)	1(0.7)	5(16.1)	58(40.6)
M. oxycephalus	4	70	0(0)	0(0)	0(0)	0(0)	1(25.0)	0(0)	0(0)	1(1.4)	0(0)	0(0)	0(0)	0(0)	3(75.0)	25(7.1)	3(75.0)	1(1.4)
P. rhombea	39	5	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(5.1)	0(0)	7(17.9)	1(20.0)
P. parva	31	415	0(0)	0(0)	0(0)	1(0.2)	0(0)	1(0.2)	0(0)	0(0)	0(0)	0(0)	7(22.6)	0(0)	4(12.9)	1(0.2)	0(0)	35(8.4)
P. herzi	17	4	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Z. platypus	82	190	0(0)	1(0.5)	0(0)	2(1.1)	2(2.4)	6(3.2)	6(7.3)	1(0.5)	0(0)	0(0)	0(0)	0(0)	19(23.2)	17(8.9)	3(3.7)	25(13.2)
Z. temmincki	51	111	0(0)	0(0)	0(0)	1(0.9)	6(11.8)	0(0)	0(0)	0(0)	0(0)	2(1.8)	0(0)	0(0)	13(25.5)	18(16.2)	1(2.0)	7(6.3)
R. ocellatus	-	23	-	0(0)	-	0(0)	-	0(0)	-	0(0)	0(0)	0(0)	-	0(0)	-	0(0)	-	0(0)
A. intermadia	-	6	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)
G. macrocphaius	-	9	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	2(22.2)
M. chinensis	-	2	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)
L. andersonii	-	1	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)
L. macrochirus	-	31	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)
M. obscura	-	4	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)
P. altivelis	24	-	0	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	24(100)	-	4(16.7)	-
C. herzi	3	-	0	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-
P. asotus	6	-	0	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-	0(0)	-

considerable variations in the infection rates of fish according to their species. Six kinds of larval trematodes and two kinds of undetermined larva were found from the scales and fins, and comparative data with 1984 were obtained for *Metagonimus* larvae. In the case of *C. carassius,* 85.0 percent of 113 fishes examined in 1984 were found to be infected with *Metagonimus* larvae, whereas, 39.2 percent of 426 fishes in 1996 were infected. A reduction in the rates of infection in seven species of fish was also recognized.

The infection densities for the encyted larvae of digenetic trematodes other than *C. sinensis* and *Metagonimus* species in fresh-water fish in 1996 were compared with previously reported data (Joo, 1984) and listed in Table 7. In fact, the metacercarial burden of digenetic trematodes in the fish was greatly varied in different fishes between 1984 and 1996. In the metacercarial density of *C. orientalis* from 13 species of fishes examined in present survey, *M. chinensis* was the most heavily infected and the average number of the larvae per gram of flesh was 85.0 cysts. Five species of fishes such as *P. herzi, P. parva, G. macrocephalus, P. rhombea and A. intermedia* were moderately infected, the average number varying from 11.1 to 28.2 cysts. The remaining seven species of fishes were infected with a few cysts.

As shown in Table 7, the infectioin densities of the larvae of *C. orintalis* in 6 species of fishes were lower in 1984 compared with 1996, and the average number of larvae were varied by fish species, from 0.05 to 3.0 cysts. Similar metacercarial densities were obtained in the 3 species such as *E. oviformis, Echinochasmus* species, and *M. hasegawai.* In general, the above 4 species of the larval trematodes in the flesh of all fish species showed elevation of the metacercarial densities in 1996 compared with 1984. In the case of *M. orientalis,* the metacercarial densities were varied by fish species: the densities in 3 species of fishes, *C. carassius, G. atromaculatus* and *P. herzi* were increassed, but in four species, the densities were decreased.

Discussion

Fresh-water fishes are one of the most important intermediate reservoir hosts of food-borne trematodes in Korea. Results from this survey indicate that the rates of infection with digenetic larval trematodes in fresh-water fish were still relatively high in river Hyungsan, and the metacercarial density in the fish varied greatly different fish in both 1984 and in the present study. Because the species and individual numbers of fishes collected by netting and with rod and line are not sufficient, there are some difficulties that showed the true infection rates and metacercaridal density in the fresh-water fish.

In the present survey, a total of 1,440 fishes were collected with net and rod. Among them, *C. carassius* was the most species, being constituted in 29.6 percent, followed by *P. parva* with 28.8 percent, *Z. platypus* with 13.2 percent, and *G. atromaculatus* with 9.9 percent. As a matter of fact, except for the several species

Table 7. Comparison of infection density for the encysted larvae of digenetic trematodes other than *C.sinensis* and *Metagonimus* species in fresh - water fish in 1984 and 1996

Species	Average No. of metacercariae per gram of flesh											
	No. of fish examined		*C. orientalis*		*Echinochasmus* sp.		*E. oviformis*		*M. hasegawai*		*M. orientalis*	
	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)	Joo (1984)	Present author (1996)
C. carassius	113	426	3.0	8.9	0	4.3	0.3	5.8	0.6	5.2	0.03	2.7
G. atromaculatus	31	143	0.4	8.5	0.5	9.7	2.3	40.9	9.1	14.5	1.2	10.8
M. oxycephalus	4	70	0	2.0	0	1.0	0.4	16.2	0	2.8	0.2	0
P. rhombea	39	5	0.05	19.4	0	1.5	0.05	1.5	0.2	1.3	0	0
P. parva	31	415	0.7	28.2	0.6	11.0	0.4	19.7	0.1	1.8	0.03	0
P. herzi	17	4	0	11.1	0	3.0	0.3	0	0	0	0	5.0
Z. platypus	82	190	0.08	4.7	0.14	17.7	0.18	1.3	0.18	1.6	0.01	0
Z. temmincki	51	111	0.7	3.7	0.7	17.4	0.2	2.1	0	1.4	0.13	0
R. ocellatus	-	23	-	2.5	-	0	-	15.0	-	0	-	0
A. intermedia	-	6	-	16.3	-	1.3	-	4.2	-	1.3	-	0
G. macrocephalus	-	9	-	27.4	-	0	-	12.5	-	29.3	-	18.0
M. chinensis	-	2	-	85.0	-	2.0	-	50.0	-	18.0	-	0
L. andersonii	-	1	-	0	-	0	-	1.0	-	7.0	-	0
L. macrochirus	-	31	-	0	-	0	-	2.0	-	0	-	0
M. obscura	-	4	-	7.0	-	0	-	0	-	16.7	-	0
P. altivelis	24	-	0	-	0.1	-	0.1	-	0.2	-	0	-
C. herzi	3	-	0	-	0	-	0.05	-	0	-	0	-
P. asotus	6	-	0	-	0	-	0	-	0	-	0	-

of fish such as *C. carassius, G. atromaculatus, M. oxycephalus, P. parva, Z. platypus* and *Z. temmincki,* it is now almost impossible to collect the desired species and/or number of fishes in the river Hyungsan.

Kobayashi (1924) examined many species of fishes collected from various localities and reported for the first time that the principal intermediate host of digenetic trematodes was the fresh-water fishes belonging to the family Cyprinidae in Korea. According to Lee (1968) reported that 14 species of larval trematodes were found from 12 different kinds of fresh-water fish collected in the river Kumho. He also reported that the encysted larvae of *E. oviformis* were the most frequently found from all 12 species of fish, followed by the cysts of *Metagonimus* species from 10 species. The larvae of *C. sinensis* were found from 9 species, *M. hasegawai* from 8 species, and *C. orientalis* from 7 species of fish.

From the studies on larval trematodes in both fresh-water and brackish-water fish in river Taewha, Yoo *et al.* (1984) reported that the encysted larvae of 7 kinds, including those of *C. sinensis* and *Metagonimus* species, and undetermined larvae were found from 14 species of fresh-water fish or brackish-water fish. Similar results were obtained by Joo *et al.* (1983) in the river Taechong, by Lee *et al.* (1979) in the river Ossep, by Hwang and Choi (1980) in the river Kumho. Joo and Park (1982), and Yoo *et al.* (1984) in the Taewha river, collected 16 species of fish and found that they were infected with 11 species of larval trematodes including 4 undetermined larvae, A, B, C, and D. He also reported that the encysted larvae of *C. orientalis* were found most frequently from 9 species of fresh-water fish examined, those of *Metagonimus* species from 8 species, and *E. oviformis* from 5 species of fish. He also reported that 7 species such as *C. brevicorpus, G. atromaculatus, P. parva, G. majimae, P. rhombea, P. esocinus,* and *P. herzi* harboured the *Clonorchis* larvae, and the infection rates for the encysted larvae of *C. sinensis* were higher than those reported by Joo (1980) and Yoo *et al.* (1984) in the same river. However, the average number of encysted larvae of *C. sinensis* per gram of flesh was relatively low, ranging from 1.0 in *C. brevicorpus* to 8.2 in *G. atromaculatus.* Similar results were obtained by Lee *et al.* (1979) in the river Ossep, by Joo *et al.* (1983) in the river Taechong, by Joo and Jheon (1990) in the river Wyangpi. In the present study, 15 species of the fresh-water fish were collected, from which 9 kinds of larval trematodes including 2 species of undetermined larvae A and D were found. Of the fish examined, 3 species such as *G. atromaculatus, P. parva,* and *P. herzi* harboured the metacercariae of *C. sinensis.* Their rates ranged from 46.3 percent in *P. parva* to 62.9 percent in *G. atromaculatus.* The average number of encysted larvae of *C. sinensis* per gram of flesh was relatively low, from 7.7 in *P. parva* to 31.6 in *G. atromaculatus.* The results in present study are similar to Yoo *et al.* (1984) who observed in the river Taewha, but the metacercarial burden of *C. sinensis* is

much lower than those reported by Lee (1968), Hwang and Choi (1980) in the river Kumho, by Lee *et al.* (1992), Hyun and Joo (1994) in the river Naktong and its tributaries, by Joo and Hong (1991) in the river Ahnseong, by Choi (1978), Lee and Joo (1995) in the river Taega. These finding support the assumption that scarcity of fish and lower densities of infection may be due to pesticidal and artificial effects on the water which would be inhobitary to the survival of larval trematodes, and can enhance destruction of natural environment and ecology of the river. Other factors might be related to ecological changes. A long drought round in recent years and the destruction of natural environment by constructing dams in the upper streams may have affected the ecology of the fish in the rivers and streams. As also indicated by Lee and Joo (1995), it was shown that the metacercarial burden of *C. sinensis* in fresh-water fish is decreasing recently. Lee and Joo (1995) found *Metagonimus* metacercariae in several fresh-water fishes such as *A. taenianalis, Z. platypus,* and *Z. temmincki,* and they also reported that *A. taenianalis* had been heavily infected with its metacercaria, whereas, *P. rhombea, G. atromaculatus, H. longirostris,* and *P. herzi* had been found very few in number. Joo and Park (1982) found *Metagonimus* metacercariae from 9 fresh-water fish species and 2 brackish-water fish species collected from the river Taewha, Kyungnam Province, and they reported that *P. altivelis* was the most frequently infected fish, being found in 100.0 percent, followed by *T. hakonensis, C. carassius, M. chinensis,* and *P. rhombea* with infection rate of 45.5 percent, 44.5 percent, 42.9 percent, and 25.0 percent, in decreasing order. Similar results were reported by Lee (1968), Hwang and Choi (1980) in the river Kumho, by Joo (1980, 1988), and Yoo *et al.* (1984) in the river Taewha, by Lee *et al.* (1979) in the river Ossep, and by Kim and Choi (1981).

In the present study, 15 species of fresh-water fishes belonging to the families Cyprinidae, Anabantidae, Bagridae, Contrachidae, Eleotridae, were collected. Of which 6 species such as *C. carassius, G. atromaculatus, M. oxycephalus, P. parva, Z. platypus,* and *Z. temmincki* harboured the encysted larvae of *Metagonimus* species. Of these, the encysted larvae of *Metagonimus* species were mostly found on the scales and fins, and the infection rates ranged from 0.2 percent to 39.2 percent, whereas, in the muscles and subcutaneous tissues of fish such as *C. carassius* and *M. oxycephalus* were very a few in number. It is obvious that in the brackish-water fishes such as *P. altivelis* and *T. hakonensis, Metagonimus* larvae were mostly found in the muscles and subcutaneous tissues, while in the case of fresh-water fishes such as *C. carassius, C. carpio, Z. platypus,* and *Z. temmincki* were vice versa, therefore the encysted larvae of *Metagonimus* species were found on the scales and fins.

In the present study, the average number of *Metagonimus* metacercaria pergram of flesh varied from 1.8 in *C. carassius* to 2.0 in *M. oxycephalus.* Our results are

much lower than those reported by Hwang and Choi (1980) in the river Kumho, by Joo and Park (1982) in the river Taewha, by Lee and Joo (1995) in the river Taega. Although the main factors contributing to the lower intensity of infection in fish than those in previous reports can be hardly be explained, it is considered to be due to the ecology of fish such as habitats and migration of fish in the topical and/or seasonal condition. As to the other factors such as the water temperature, snail habitats and final hosts are to taken into account. Of the fish collected in the river Hyungsan, *Metagonimus* metacercariae are found most frequently in the small-sized fresh-water fishes.

According to local officials, these fishes are apparently negrected by the residents for raw consumption, but are eaten only by residents living near the river basin usually cooked such as roasted, boiled, and fried, *etc.* In fact, the residents eat *C. carpio nudus* in a state of raw. This assumption is supported by the fact that most cases of clonorchiasis and metagonimiasis among the residents previously reported by Joo and Hong (1991), Joo and Lee (1992), Woo and Joo (1993), Hyun and Joo (1994), Kwak (1994), and Kim (1995) showed mild infections. As for the rates and intensity of infection with *E. oviformis* cysts in the fresh-water fishes, Lee (1968) found that 11 species of fishes collected from the river Kumho harboured the encysted larvae of *E. oviformis*. The most frequently infected species was *C. sinensis* with a rate of 97.2 percent, the less frequently infected was *Z. platypus* with 25.8 percent, and intermediate one was *A. taenianalis*. Afterward, Hwang and Choi (1980) reported infection rate to be 96.2 percent in *H. labeo*, 90.2 percent in *G. atromaculatus*, 88.6 percent in *P. parva*, 88.0 percent in *C. carassius* and others, collected in the same river, and Joo (1980) also reported that *G. atromaculatus* was the most frequently infected, being found in 48.2 percent, followed by *C. brevicorpus*, *C. carassius*, *Z. temmincki*, and *Z. platypous* with the rate of 46.9 percent, 33.8 percent, 32.6 percent and 27.8 percent, in decreasing order. Similar findings were obtained by Chun (1962), Lee (1979) and Joo (1988).

Lee and Joo (1995) conducted recentely a metacercarial study in fish hosts collected from the river Taega, and reported that the encysted larvae of *E. oviformis* were found from 12 species of fish. They also reported that the average number of encysted larvae of *E. oviformis* per gram of flesh was very low, ranging from 1.0 in *G. atromaculatus*, *C. brevicorpus* and *P. herzi* to 16.3 in *A. taenianalis*. In the present study, 15 species of fresh-water fish were collected in three localities of the river, in which 13 species of the fishes harboured encysted larvae of *E. oviformis*. The rates of infection with *E. oviformis* varied markedly. In the metacercarial burden, *G. atromaculatus*, *M. chinensis*, *P. parva*, *M. oxycephalus* and *R. ocellatus* harboured a large number of cysts, whereas, *P. rhombea*, *Z. platypus*, *Z. temmincki*, *L. andersonii* and *L. macrochirus* were infected with only a few cysts. The results in this

study are similar to those obtained by Hwang and Choi (1980) and Lee and Joo (1995), but the intensity of infection with *E. oviformis* is much higher than those reported by Lee *et al.* (1979), Joo (1983, 1984 and 1988), and Yoo *et al.* (1984). Tanabe (1920) first discovered the encysted larvae of *M. orientalis* from several kinds of fresh-water fishes including *P. parva* and *Z. platypus*. In the studies of fish hosts with *M. orientalis* larvae belonging to the family Opisthorchidae in Korea, Chun (1964) first found from the flesh of fresh-water fishes including *C. carassius* collected in Kimhae, Ulsan, Pohang, and Kunsan. Lee *et al.* (1979) also found the *M. orientalis* larvae from 6 fish species such as *C. brevicorpus, E. erythropterus, G. atromaculatus, M. oxycephalus, Z. platypus,* and *T. hakonensis* collected in the river Ossep, and the infection rates ranged from 5.3 percent to 19.1 percent. Lee and Joo (1995) also reported that *M. oxycephalus* was the most frequently infected species, being found in 22.2 percent, followed by *S. dabryi, P. esocinus,* and *P. herzi* with the infection rate of 11.4 percent, 1.8 percent and 0.6 percent, in decreasing order, and the metacercarial density was from 1.5 in *M. oxycephalus* to 4.9 in *S. dabryi*. Similar results were reported by Hwang and Choi (1980) in the river Kumho, Kim and Choi (1981) in the natural and breeding ponds, Joo *et al.*(1983) in the river Taechong, Joo (1980 and 1988) and Yoo *et al.* (1984) in the river Taewha. In the present study, 4 species of fish harboured the encysted larvae of *M. orientlais*. Their rates ranged from 1.2 percent to 25.0 percent, and the average number of the cysts per gram of flesh was from 2.7 cysts in *C. carassius* to 18.0 cysts in *G. macrocephalus*. In the fish host survey of *Echinochasmus* metacercariae, a relatively high infection rate has been reported by some investigators such as in the vicinity of the river Kumho by Hwang and Choi (1980), in the river Hyungsan by Joo (1984), in the river Taechong by Joo *et al.* (1983), in the river Taewha by Joo (1980 and 1988) and Yoo *et al.* (1984), in the river Taega by Lee and Joo (1995). As a result, it is obvious that the metacercaria of *Echinochasmus* species are widely distributed in fresh-water fishes in Korea. By the previous paper presented in the river Hyungsan, the infection rates of *Echinochasmus* metacercariae in fresh-water fish, Joo (1984) reported 29.0 percent in *G. atromaculatus,* 19.6 percent in *Z. temmincki,* 16.1 percent in *P. parva,* and 12.2 percent in *Z. platypus,* while, that in brackish-water fish was 8.3 percent in *P. altivelis*. Yoo *et al.* (1984) also conducted a metacercarial study in fish hosts caught along the river Taewha, and reported that the encysted larvae of *Echinochasmus* species were found in 6 species of fishes. And the metacercarial burden of *Echinochasmus* species per gram of flesh was very low, ranging from 0.01 in *C. brevicorpus* and *P. altivelis* to 0.7 in *P. parva*. In this study, and of 15 species of fresh-water fish, 9 species belonging to the family Cyprinidae and one species belonging to the family Anabantidae, harboured the encysted larvae of *Echin-*

ochasmus species. Of these, *A. platypus, Z. temmincki* and *M. chinensis* were heavily infected with *Echinochasmus* cysts. Their rates ranged from 50.0 percent to 93.7 percent. *C. carassius, A. intermedia,* and *M. oxycephalus* were less infected with the cysts of the fluke showing as low as 20.0 percent. The intensity of *Echinochasmus* infection in the 10 species of fishes varied markedly from fish to fish. The average number of the cysts was from 1.0 in *M. oxycephalus* to 17.7 in *Z. platypus*. The results in this study are close to data by Joo (1988) in the river Taewha and by Lee and Joo (1995) in the river Taega.

The metacercarial burden of *Echinochasmus* species is much higher than those by Lee *et al.* (1979) in the river Ossep, by Hwang and Choi (1980) in the river Kumho, by Joo *et al.* (1984) in the river Hyungsan, by Joo (1980) and Yoo *et al.* (1984) in the river Taewha. In our figures and some of the previously reported data (Joo, 1988; Lee and Joo, 1995), it is of interest to note that the infection rates and densities of *C. sinensis* and *Metagonimus* species have lower been found in fresh-water fishes than that of infectioin patterns of *Echinochasmus* species, *E. oviformis, C. orientalis*. The main factors contributing to the higher infection with larval trematodes other than *C. sinensis* and *Metagonimus* species may be due to the ecological change of river. The wide scale use of pesticides in the paddy-fields and farms in the many rivers and their tributaries would affect the natural environmental conditions of the rivers. It seems quite possible explanations that some cercariae such as *Echinochasmus* species, *E. oviformis,* and *C. orientalis* are resistant to many kinds of pesticides, whereas other cercariae such as *C. sinensis* and *Metagonimus* species are sensitive to pesticides. As also indicated by Joo (1988) and Lee and Joo (1995), it was shown that the infection rates and densities of *Clonorchis* and *Metagonimus* metacercariae in fresh-water fishes have been decreasing in this study. It is suggested that the ecological changes of the rivers may have affected the infection patterns for digenetic larval trematodes in fish hosts.

References

Choi DW: *Clonorchis sinensis* in Kyungpook Province, Korea 2. Demonstration of metacercaria of *Clonorchis sinensis* from fresh-water fish. *Korean J Parasitol* 1976; 14:10-16.

Choi DW: Prevalence of *Clonorchis sinensis* in vicinity of Seongju, Kyungpook Province, Korea. *Korean J Parasitol* 1978; 14:140-147.

Chun SK: Studies on some trematodes whose intermediate hosts are fish in Naktong River (in Korean). *Bull Pusan Fish Coll* 1962;4:21-38.

Chung MK: *The fishes of Korea.* Ilchi Publ co., Seoul 1977.

Hwang JT, Choi DW: Changing pattern of infestation with larval trematodes from fresh-water fish in river Kumho, Kyungpook Province, Korea. *Kyungpook Univ Med J* 1980;21:460-475.

Hyun MC, Joo CY: Epidemiological studies of *Clonorchis sinensis* in the upper stream areas of Naktong River. *Keimyung Univ Med J* 1994;13:22-46.

Joo CY: Epidemiological studies of *Clonorchis sinensis* in vicinity of river Taewha, Kyungnam Province, Korea. *Korean J Parasitol* 1980;18:199-214.

Joo CY: Infestation of larval trematodes from fresh-water fish and brackish-water fish in river Hyungsan, Kyungpook Province, Korea (in Korean). *Korean J Parasitol* 1984;22:78-84.

Joo CY: Changing patterns of infection with digenetic larval trematodes from fresh-water fish in river Taewha, Kyungnam Province. *Korean J Parasitol* 1988;26:263-274.

Joo CY, Hong YA: Epidemiological studies of *Clonorchis sinensis* in the vicinity of river Ahnseong, Kyungpook Province, Korea. *Japan J Parasitol* 1991;40:542-552.

Joo CY, Jheon SH: Infestation of larval trematodes from fresh-water fish and brackish-water fish in river Wyangpi, Kyungpook Province, Korea. *Keimyung Univ Med J* 1990;9:36-42.

Joo CY, Lee DS: Recent patterns of intestinal parasite infection among residents in Kolyung county, Kyungpook Province, Korea. *Keimyung Univ Med J* 1992;11:550-560.

Joo CY, Park SG: Epidemiological survey of *Metagonimus yokogawai* in Ulju county, Kyungnam Province, Korea. *Kyungpook Univ Med J* 1982;23:1-9.

Joo CY, Park MK, Choi DW: Infestation of larval trematodes from fresh-water fish and brackish-water fish in river Taechong, Kyungpook Province, Korea (in Korean). *Korean J Parasitol* 1983;21:6-10.

Kim SJ: Changing patterns of *Clonorchis sinensis* infections in Kyungpook, Korea. Theses Graduate School Keimyung Univ 1995:1-40.

Kim JH, Choi DW: Infestation with larval trematodes from fresh-water in natural and fish-breeding ponds. *Korean J Parasitol* 1981;19:157-166.

Kobayashi H: Intestinal parasites of Koreans (in Japanese). *Nippon no Ikai* 1920;10:889-892.

Kobayashi H: On the human liver fluke in Korea and a note on the intermediate host of liver fluke in China. *Mitt D Med Hochsch z Keijo 1924*;7:1-10.

Komiya Y, Tajimi T: Study on *Clonorchis sinensis* in the district of Shanghai 5. The cercaria and metacercarial of *Clonorchis sinensis* with special reference to their excretory system. *J Shanghai Sci Inst* (Sect. 4) 1940a;5:91-106.

Komiya Y, Tajimi T: Study of *Clonorchis sinensis* in the district of shanghai 6. The lofe cycle of *Exorchis oviformis*, with special reference of the similarity of its forms to that of *Clonorchis sinensis*. *J Shanghai Sci Inst* (Sect. 4) 1940b;5:109-123.

Komiya Y, Tajimi T: Metacercaria from Chinese *Pseudorasbora parva* Temminck and Schlegel with special reference to their excretory system: Metacercaria from Chinese Fresh-water (1). *J Shanghai Sci Inst* 1941;1:69-106.

Kwak KW: Epidemiological studies of

Clonrchis sinensis in the vicinity of Cheongdo river, Kyungpook, Korea. Theses Graduate School Keimyung Univ 1994: 1-41.

Lee BK, Kwon TC, Joo CY: Changing patterns of infection with *Clonorchis* metacercaria from fresh-water fish in Kyungpook Province, Korea. *Keimyung Univ Med J* 1992;11:356-368.

Lee DM, Ahn DH, Choi DW: Larval trematodes from fresh-water fish in river Ossep (in Korean). *Kyungpook Univ Med J* 1979;20:219-233.

Lee JT: Studies on metacercaria from fresh-water fishes in the Kumho River (in Korean). *Korean J Parasitol* 1968;6: 77-99.

Lee SK, Kim KS: An epidemiological study of *Clonorchis sinensis* (in Korean). *J Taegu Med Soc* 1958;1:1-7.

Lee SW, Joo CY: Infection patterns with larval trematodes from fresh-water fish in river Taega, Kyungpook, Korea. *Keimyung Univ Med J* 1995;14:193-214.

Matsumoto S: The present situation of incidence of intestinal parasites among the Korean people, especially among the residents of Taegu and Yeongcheon areas (in Japanese). *J Koseikan Med Res* 1915;23:13-16.

Nishimura S: Incidence of intestinal parasites in Taegu and Yeongcheon areas (in Japanese). *J Taegu Med Coll* 1943; 4:40-50.

Tanabe H: Ein neuer Metorchis aus der Gallenblase der Hausente (in Japanese). *Kyoto Daigaku Igakubu kiyo* 1920;33: 4-13.

Woo JJ, Joo CY: Epidemiological survey of *Metagonimus yokogawai* in Kolyung county, Kyungpook Province, Korea. *Keimyung Univ Med J* 1993;12:127-139.

Yamaguti S: *Systema helminthum volume* 1. The digenetic trematode of vetebrates part 1 and part 2. Interscience Publishers, Inc., NY, 1958,

Yoo CK, Choi DW, Joo CY: Infestation of larval trematodes from fresh-water fish and brackish-water fish in river Taewha, Kyungnam Province, Kora (in Korean). *Keimyung Univ Med J* 1984; 3:139-145.

慶北 兄山江에서 採集된 淡水魚에 있어서 吸蟲類 被囊幼蟲 寄生狀의 變化

啓明大學校 醫科大學 寄生蟲學 敎室 및 醫科學 硏究所

金星錄 · 朱鍾潤

=國 文 抄 錄=

1995年 9月부터 1996年 8月까지 慶南 蔚山市의 西北部와 南西部 사이에 位置하고, 太白山脈의 南쪽 끝에 형성된 白雲山과 고위산등에서 起源하여 慶州市를 貫流한 다음 浦項市 松亭洞에

河口를 形成하고 있는 兄山江에서 投網, 낚시등으로 淡水魚를 採集하여 漁體 部位別로 各種 吸蟲類 被囊幼蟲의 寄生狀을 調査한 다음 朱 (*1984*)의 調査成績과 比較하였다.

採集된 淡水魚는 붕어, 몰개, 버들치, 납지리, 참붕어, 돌고기, 피라미, 갈겨니, 흰줄납줄개, 납자루, 꾸구리, 버들붕어, 퉁가리, 파랑볼우럭, 동사리의 *15*種이었고, 이들 淡水魚에서 *7*種의 吸蟲類 被囊幼蟲 *C. sinensis, C. orientalis, Echinichasmus species, E. oviformis, M. hasegawai, Metagonimus species, M. orientalis* 및 2종의 所屬未定 A 및 D를 찾아볼 수 있었다.

C. orientalis 와 *E. oviformis* 幼蟲은 13 종의 魚類에서 찾아볼 수 있었는데 비하여 *M. hasegawai* 幼蟲은 12種, *Echinochasmus species* 幼蟲은 10種, M. orientalis 는 4種의 魚類에서 찾아볼 수 있었다.

肝吸蟲의 被囊幼蟲 寄生率은 몰개, 참붕어에서는 1984年의 寄生率에 비해 낮았는데 반하여 돌고기 에서는 오히려 높았으며, 납지리에서는 전혀 檢出할 수 없었고, 寄生程度에 있어서는 2種의 魚類 몰개, 참붕어에서는 1984年에비해 낮았으나, 돌고기에서는 높았다.

요코가와吸蟲 被囊幼蟲의 寄生率은 2種의 魚類 魚肉에서는 그 率이 1984年에 비해 낮았으며, 寄生程度는 1984年의 調査成績에 비하여 一般的으로 增加되었다.

Cyathocotyle orientlais, Echinochasmusspecies, Exorchis oviformis, Metacercaria hasegawai, 및 *Metorchis orientalis* 被囊幼蟲의 寄生率은 魚種에 따라 심한 差異를 나타내었으며 1984年의 調査成績에 비해 높았다. 비늘, 지느러미 및 꼬리에서의 被囊幼蟲 寄生率은 變動이 심하여 比較할 수 없었으나 요코가와吸蟲 寄生率은 一般的으로 1984年에 비하여 낮았다.

以上의 成績으로 미루어보아 兄山江에서 採集된 魚類에 있어서 肝吸蟲을 비롯한 被囊幼蟲 寄生率은 아직도 높으나 寄生程度는 1984年에 비해 심한 變動을 나타내고 있음을 알 수 있었다.