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Changing patterns of infection with digenetic larval trematodes from fresh-water fish in River Taewha, Kyongnam Province*

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Abstract: Recent patterns of infection with digenetic larval trematodes in fresh-water and brackish-water fish were studied in three locations of the river Taewha during the period from April to October, 1988, and compared with the data reported previously in the same river. Of 16 species of fish examined, the encysted larvae of *Cyathocotyle orientalis* were found most frequently from 9 species of fresh-water fish. The metacercariae of *Echinochasmus* sp., *Metacercaria hasegawai* and *Metagonimus yokogawai* were found from 8 species, those of *Clonorchis sinensis* from 7 species, and *Exorchis oviformis* and *Metorchis orientalis* from 5 species of fish. The infection rates of fish with *C. sinensis* metacercariae were not lower than those reported in 1980, whereas their intensity of infection was found lowered in 3 species, *Coreobagrus brevicorpus*, *Gnathopogon atromaculatus*, and *Puntungia herzi*. The infection rates of 3 species of fish with *M. yokogawai* metacercariae were lower than the results in 1982, while the rate was higher in 2 species, *Zacco platypus*, and *Z. temmincki*, and rather stationary in *Plecoglossus altivelis*. The intensity of infection in several species of fish appeared rather higher than in 1980. The encysted larvae of *C. orientalis*, *Echinochasmus* sp., *E. oviformis* and *Metacercaria hasegawai* showed variations in infection rates of fish in 1980 and in the present study.

It was found that the rate of infection with digenetic larval trematodes in fresh-water fish was still relatively high in the river Taewha, and the metacercarial burden in the fish varied greatly by different fish in 1980 and in the present study.

Key words: *Cyathocotyle orientalis*, *Metacercaria hasegawai*, *Metagonimus yokogawai*, *Clonorchis sinensis*, *Exorchis oviformis*, *Metorchis orientalis*, metacercaria, fresh-water fish, Taewha River

INTRODUCTION

Since Kobayashi(1910) first reported on the discovery of *Clonorchis sinensis* metacercariae from cyprinoid fish in Japan, many investigators have attempted to determine the susceptibility of numerous fish species to infection with this trematode larvae. Kobayashi(1924) found them from the flesh of several kinds of fresh-water fish including *Pseudorasbora parva* and *Sarcocheilichthys morii* and reported that human clonorchiasis was found to be distributed chiefly in the southern part of Korea, especially in the vicinity of major rivers and their tributaries.

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Few works on the encysted larvae in fish hosts were done in Korea before the end of the World War II, although the fresh-water fish belonging to the families Cyprinidae, Bagridae and Clupeidae were thought to be the second intermediate hosts of intestinal and hepatic flukes of human being in Japan, China and Taiwan. After the Korean War, the cyprinoid fish have been considered as the primary target to investigate in order to provide informations for the control of human trematode infections by a number of medical parasitologists and public health officials.

To establish effective control measures of human intestinal and hepatic flukes, biological, ecological and epidemiological studies on these fluke infections have been conducted since 1956 in the vicinity of rivers, small ponds and lakes. Epidemiological studies of fluke infections such as *C. sinensis* and *M. yokogawai* in the vicinity of the river Taewha, Kyongnam Province, have been carried out since 1980 (Joo, 1980; Joo and Park, 1982; Yoo *et al.*, 1984). As for the fish intermediate host, Joo(1980) found 7 kinds of larval trematodes from 10 species of fish examined, and reported that the infection rates varied from fish to fish.

In recent years there are newly established factories and many apartments in the vicinity of the river Taewha, and massive drainage of waste products into the river together with intense spray of pesticides on nearby farms may have caused destruction of natural environment of the river. The purpose of this study is to observe the present status of larval trematode infections in fresh-water fish caught in the river Taewha, in comparison with the previously reported data in the same river.

MATERIALS AND METHODS

1. The survey area:

The river Taewha has its origin in the eastern range of the Kaji mountain and runs through the central Ulju county situated in the northeastern part of Kyongnam Province, where the river meets with many rivulets running from the Shinbool mountains. It then runs through Ulsan city and joins again with the Dongcheon stream in the northern part of the city. Finally, it runs into the eastern sea of Korea(Fig. 1).

Three localities in the vicinity of the river Taewha, *i.e.*, Sa-yeon and Cheom-chon in Beomseo myun, Ulju county and Sam-ho in Ulsan city, were selected as the survey area, which had also been surveyed by Joo(1980). The surveyed areas are from 10 to 40 meters above sea level and the bottom is composed of sand, mud, pebbles and rock (Table 1). 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-side.

2. The fish host survey:

Several kinds of fresh-water fish were caught in the river Taewha by netting and fishing with rod and line during the period from April to October, 1988. The fish, after removal of their intestinal contents to prevent autodigestion, were forwarded to the Department of Parasitology, Keimyung University School of Medicine. The specific names 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 taken 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 estimate average number of cysts per gram of flesh, the digestion technique was also applied.

The identification of encysted larvae obtained by digestion technique was made according to the methods described by Komiya and Tajimi (1940 & 1942). The cysts from the fresh-water fish were also immediately fed to golden hamsters, and adult worms were obtained from the hamsters after 2 months, flattened between

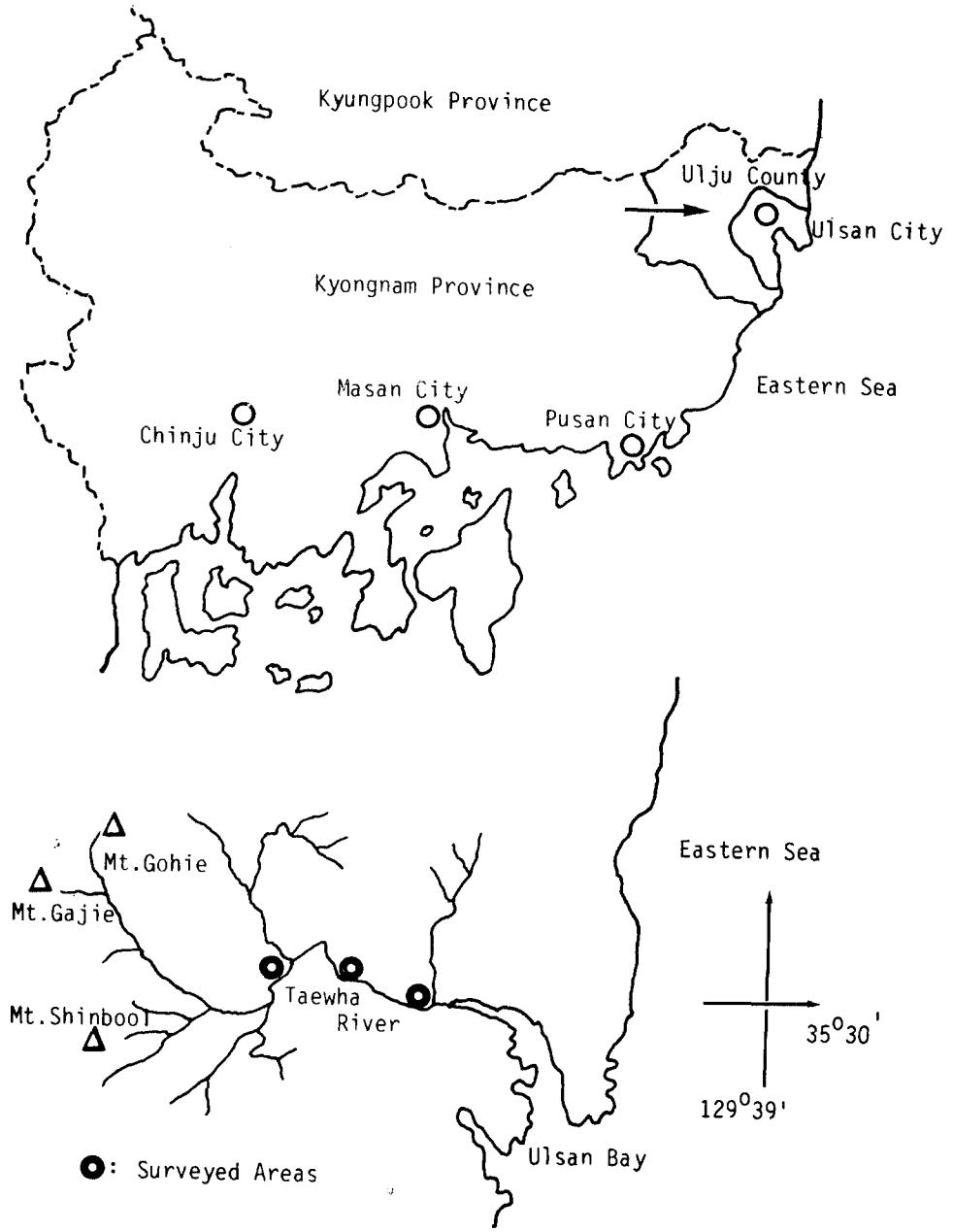

Fig. 1. Surveyed areas in the vicinity of the river Taewha, Kyongnam Province.

Table 1. Environmental conditions of surveyed areas near the river Taewha (1988)

Locality			Bottom structure	Mean of water depth(cm)
Village	Myun	County(City)		
Sa-yeon	Beomseo	Ulju	pebble and sand	70
Cheom-chon	Beomseo	Ulju	pebble and sand	65
Sam-ho	Ulsan	Ulsan	sand and pebble	120

two slides in 70 per cent alcohol, and stained with Semichon's acetocarmine. The stained preparations were studied morphologically for the final identification of each trematode species.

RESULTS

A total of 697 fresh-water fish of 16 species were collected from the river Taewha in 1988. The individual numbers of fresh-water fish caught were compared with the data in 1980, as listed in Table 2. Of these, the crussian carp (*Carassius carassius*), the Korean shiner(*Gnathopogon atromaculatus*), the flat bitterling (*Paracheilognathus rhombea*), the southern top-mouthed minnow(*Pseudorasbora parva*), the pale chub(*Zacco platypus*), and the dark chub (*Z. temmincki*) are the most frequently collected species of fish. Three species, the carp(*Cyprinus carpio*), the blue gill(*Lipomis macrochirus*) and the round-tail fighting fish(*Macropodus chinensis*) are known to be the common fish of the river, but in this survey they were less frequently collected.

In Table 3, the infection rate and densities of encysted larvae of *C. sinensis* in fresh-water fish revealed in the present study(1988) were compared with those of Joo(1980). Of sixteen kinds of fish examined in 1988, seven species were infected with *C. sinensis* metacercariae. *P. parva* was the most highly infected, with the positive rate of 50.0 per cent, followed by *G. atromaculatus* with 45.2 per cent, *P. rhombea* with 36.0 per cent, and *Pungtungia herzi* with 30.0 per cent.

Only 4 of nine species of fish examined in 1980 were infected with the metacercariae of *C. sinensis*, whereas 7 species of fish were found infected in 1988. The metacercarial density of *C. sinensis* in fish, however, expressed in average number of encysted larvae per gram of flesh, appeared to be lower in 3 species of fish, *C. brevicorpus*, *G. atromaculatus* and *P. herzi*, in 1988 than in 1980, but was found elevated in one species, *P. rhombea*. The infection rates of 3 fish species, *Gnathopogon majimae*, *Pseudo-*

Table 2. Comparison of species and number of fresh-water fish caught from the river Taewha in 1980 and 1988

Species of fish	Common name	Korean name	No. of fish collected	
			Joo (1980)	Present author (1988)
Carassius carassius	crussian carp	붕어	123	112
Coreobagrus brevicorpus	bullhead	꼬치동자개	32	28
Coreoperca herzi	perch	꺽지	—	21
Cyprinus carpio	carp	잉어	—	12
Gnathopogon atromaculatus	Korean shiner	몰개	83	73
Gnathopogon majimae	—	긴몰개	—	28
Lipomis macrochirus	blue gill	파랑볼우럭	102	18
Macropodus chinensis	round-tail fighting fish	버들붕어	24	—
Moroco oxycephalus	common fat minnow	버들치	—	12
Paracheilognathus rhombea	flat bitterling	납지리	26	86
Pseudogobio esocinus	goby minnow	모래무지	—	9
Pseudorasbora parva	southern top-mouthed minnow	참붕어	—	94
Pungtungia herzi	striped shiner	돌고기	35	10
Rhodeus ocellatus	rose bitterling	흰줄납줄개	—	15
Zacco platypus	pale chub	피래미	36	100
Zacco temmincki	dark chub	갈겨니	43	63
Plecoglossus altivelis	sweet fish	은어	—	16

Table 3. Comparison of infection rate and density of encysted larvae of *C. sinensis* from fresh-water fish caught from the river Taewha in 1980 and 1988

Species of fish	No. of fish examined		Per cent infected		Mean No. of larvae per gram of fish	
	Joo	Present author	Joo	Present author	Joo	Present author
	(1980)	(1988)	(1980)	(1988)	(1980)	(1988)
C. brevicorpus	32	28	9.4	7.1	5.0(3~ 7)*	1.0(1~ 2)
C. atromaculatus	83	73	22.9	45.2	21.5(2~57)	8.2(1~222)
G. majimae	—	28	—	28.6	—	2.4(1~ 10)
P. rhombea	26	86	7.7	36.0	3.5(1~16)	6.3(1~ 24)
P. esocinus	—	9	—	22.2	—	1.9(1~ 14)
P. parva	—	94	—	50.0	—	8.1(1~ 56)
P. herzi	35	10	20.0	30.0	11.7(1~43)	5.9(3~ 10)

*Number in parentheses means the range of No. of larvae per gram of flesh

Table 4. Comparison of infection rate and density of *M. yokogawai* metacercariae in fresh-water fish in 1982 and 1988

Species of fish	No. of fish examined		Per cent infected		Mean No. of larvae per gram of fish	
	Joo and Park	Present author	Joo and Park	Present author	Joo and Park	Present author
	(1982)	(1988)	(1982)	(1988)	(1982)	(1988)
C. carassius	110	112	44.5	4.5	0.6	1.8
C. brevicorpus	24	28	8.3	—	0.3	—
C. herzi	—	21	—	—	—	—
C. carpio	—	12	—	—	—	—
G. atromaculatus	34	73	17.6	4.1	0.7	1.7
G. majimae	—	28	—	7.1	—	9.6
L. macrochirus	52	18	7.7	—	0.1	—
M. chinensis	7	—	42.6	—	1.1	—
M. oxycephalus	—	12	—	—	—	—
P. rhombea	16	86	25.0	1.2	0.7	12.5
P. esocinus	—	9	—	—	—	—
P. parva	—	94	—	—	—	—
P. herzi	5	10	—	20.0	—	1.8
Z. platypus	18	100	5.5	18.0	0.1	13.7
Z. temmincki	83	63	6.0	7.9	0.2	4.1
P. altivelis	19	16	100.0	100.0	139.9	125.8
*T. hakonensis**	11	—	45.5	—	40.2	—

* Brackish-water fish

gobio esocinus and *P. parva* were as shown in Table 3.

The data presented in Table 4 are to compare the 1988 results of the infection rate and density of *M. yokogawai* metacercariae in fresh-water fish with those of Joo and Park(1982). Of the fish examined in 1988, the encysted larvae of *M. yokogawai* were found in 8 fish species; the rates in 2 species, *P. herzi* and *Z. platypus*, were increased, but in five species the rates were decreased. No fluctuation was found in the infection rate of *Z. temmincki* and *P. altivelis*. The infection densities of the larvae of *M. yokogawai* in 7 species of fish were higher in 1988 and the average number of larvae varied by fish species, from 1.7 to 13.7. In *P. alti-*

Table 5. Comparison of infection rate for the encysted larvae of digenetic trematodes

Species of fish	No. fish examined		Infection rate(%) with encysted larvae of digenetic trematodes			
			C. orientalis		*Echinochasmus* sp.	
	Joo	Present author	Joo	Present author	Joo	Present author
	(1980)	(1988)	(1980)	(1988)	(1980)	(1988)
C. carassius	123	112	3.3	15.2	—	—
C. brevicorpus	32	28	3.1	10.7	—	17.9
C. herzi	—	21	—	—	—	—
C. carpio	—	12	—	—	—	—
G. atromaculatus	83	73	9.6	75.3	2.4	45.2
G. majimae	—	28	—	42.8	—	21.4
L. macrochirus	102	108	—	—	—	—
M. chinensis	24	—	—	—	—	—
M. oxycephalus	—	12	—	—	—	—
P. rhombea	26	86	—	37.2	—	20.9
P. esocinus	—	9	—	—	—	—
P. parva	—	94	—	61.7	—	35.1
P. herzi	35	10	—	10.0	—	30.0
Z. platypus	36	100	—	13.0	5.6	81.0
Z. temmincki	43	63	2.3	1.6	7.0	65.1

Table 6. Comparison of infection rate for the encysted larvae of digenetic

Species of fish	No. of fish examined		No. of fish infected with larval trematodes(%)			
			C. sinensis		*E. oviformis*	
	Joo	Present author	Joo	Present author	Joo	Present author
	(1980)	(1988)	(1980)	(1988)	(1980)	(1988)
C. carassius	123	112	—	—	2(1.6)	—
C. brevicorpus	32	28	—	—	2(6.3)	—
C. herzi	—	21	—	—	—	—
C. carpio	—	12	—	—	—	—
G. atromaculatus	83	73	3(3.6)	1(1.4)	9(10.5)	—
G. majimae	—	28	—	—	—	—
L. macrochirus	102	18	—	—	—	—
M. chinensis	24	—	—	—	—	—
M. oxycephallus	—	12	—	—	—	—
P. rhombea	26	86	—	—	2(7.7)	1(1.2)
P. esocinus	—	9	—	—	—	—
P. parva	—	94	—	2(2.1)	—	—
P. herzi	35	10	—	—	4(11.4)	—
Z. platypus	36	100	—	—	—	1(1.0)
Z. temmincki	43	63	—	—	1(2.3)	—
P. altivelis	—	16	—	—	—	—

velis, the density of *M. yokogawai* larvae was found to be high and no significant change in the density was observed between 1982 and 1988.

The infection rates of fish with encysted larvae of digenetic trematodes other than *C.*

other than *C. sinensis* and *M. yokogawai* in fresh-water fish in 1980 and 1988

Species of fish	Infection rate(%) with encysted larvae of digenetic trematodes					
	E. oviformis		*M. hasegawai*		*M. orientalis*	
	Joo (1980)	Present author (1988)	Joo (1980)	Present author (1988)	Joo (1980)	Present author (1988)
C. carassius	33.8	—	6.5	8.9	3.3	—
C. brevicorpus	46.9	—	—	10.7	—	7.1
C. herzi	—	—	—	—	—	—
C. carpio	—	—	—	—	—	—
G. atromaculatus	48.2	2.7	10.8	1.4	4.8	1.4
G. majimae	—	—	—	3.6	—	—
L. macrochirus	—	—	7.8	—	—	—
M. chinensis	—	—	70.8	—	—	—
M. oxycephalus	—	—	—	—	—	—
P. rhombea	23.1	25.6	15.4	8.1	—	1.2
P. esocinus	—	—	—	—	—	—
P. parva	—	6.4	—	—	—	5.3
P. herzi	25.7	—	—	10.0	—	—
Z. platypus	27.8	3.0	5.6	7.0	16.7	—
Z. temmincki	32.6	3.2	—	19.0	—	1.6

trematodes on the scales of fresh-water fish in 1980 and 1988

Species of fish	No. of fish infected with larval trematodes(%)					
	M. hasegawai		*M. yokogawai*		*M. orientalis*	
	Joo (1980)	Present author (1988)	Joo (1980)	Present author (1988)	Joo (1980)	Present author (1988)
C. carassius	5(4.1)	—	123(100.0)	96(85.7)	—	—
C. brevicorpus	—	—	—	1(3.6)	—	—
C. herzi	—	—	—	—	—	—
C. carpio	—	—	—	10(83.3)	—	—
G. atromaculatus	5(6.2)	—	60(72.3)	2(2.7)	—	—
G. majimae	—	—	—	1(3.6)	—	—
L. macrochirus	—	—	22(21.6)	2(11.1)	—	—
M. chinensis	—	—	8(33.3)	—	—	—
M. oxycephallus	—	—	—	—	—	—
P. rhombea	—	—	—	4(4.7)	—	—
P. esocinus	—	—	—	—	—	—
P. parva	—	—	—	1(1.4)	—	2(2.1)
P. herzi	2(5.7)	—	7(20.0)	1(10.0)	—	1(1.0)
Z. platypus	—	—	19(52.8)	57(57.0)	—	—
Z. temmincki	1(2.3)	—	33(76.7)	29(46.0)	—	—
P. altivelis	—	—	—	16(100.0)	—	—

sinensis and *M. yokogawai* in 1988 were compared with those in 1980, as presented in Table 5. Five kinds of digenetic larval trematodes, *i.e.*, *C. orientalis*, *Echinochasmus* sp., *E. oviformis*, *M. hasegawai* and *M. orientalis* were found in this survey. Of these, *C. orientalis* larvae

Table 7. Comparison of infection rate for the encysted larvae of digenetic trematodes on the fins and tail of fresh-water fish in 1980 and 1988

Species of fish	No. of fish examined		No. of fish infected with larval trematodes(%)							
			Echinochasmus sp.		*E. oviformis*		*M. hasegawai*		*M. yokogawai*	
	Joo	Present author	Joo	Present author	Joo	Present author	Joo	Present author	Joo	Present author
	(1980)	(1988)	(1980)	(1988)	(1980)	(1988)	(1980)	(1988)	(1980)	(1988)
C. carassius	123	112	—	2(1.8)	3(2.4)	—	2(2.6)	2(1.8)	123(100.0)	88(78.6)
C. brevicorpus	32	28	—	—	2(6.3)	—	—	1(3.6)	3(9.4)	1(3.6)
C. herzi	—	21	—	—	—	—	—	—	—	—
C. carpio	—	12	—	—	—	—	—	—	—	6(50.0)
G. atromaculatus	83	73	—	3(4.1)	—	—	1(1.2)	10(13.7)	4(4.8)	1(3.6)
G. majimae	—	28	—	1(3.6)	—	—	—	—	—	—
L. macrochirus	102	18	—	—	—	—	—	—	20(19.6)	1(5.6)
M. chinensis	24	—	—	—	—	—	1(4.2)	—	3(12.5)	—
M. oxycephalus	—	12	—	—	—	—	—	—	—	—
P. rhombea	26	86	—	—	4(15.4)	—	4(15.4)	—	8(30.8)	—
P. esocinus	—	9	—	—	—	—	—	—	—	—
P. parva	—	94	—	1(1.1)	—	—	—	—	—	8(8.5)
P. herzi	35	10	—	—	2(5.7)	—	—	—	5(14.3)	1(10.0)
Z. platypus	36	100	—	—	—	1(10.0)	—	—	4(11.1)	10(10.0)
Z. temmincki	43	63	—	—	1(2.3)	—	1(2.3)	—	7(16.3)	13(20.6)
P. altivelis	—	16	—	—	—	—	—	—	—	16(100.0)

were found from 9 species of fish, followed by *Echinochasmus* sp. and *M. hasegawai* from 8 species, and *E. oviformis* and *M. orientalis* from 5 species of fish. In the infection rate of fish with the larval trematodes, there was considerable variation among different kinds of fishes. Of *G. atromaculatus* examined in this study (1988), 75.3 per cent were infected with metacercariae of *C. orientalis*, while only 9.6 per cent of 83 fish examined in 1980 were infected. Similarly, an elevation in general in the rate of infection among 7 species of fish was noted between 1980 and 1988. In the case of *E. oviformis*, the infection rates of 5 fish species were decreased, in 1988 which were 2.7~25.6 per cent. Similar infection status was revealed in the case of *M. hasegawai* and *M. orientalis*.

The infection rates for the encysted larval trematodes on the scales of fresh-water fish in 1988 were summarized in Table 6, and briefly compared with those in 1980 (Joo, 1980). There was considerable variation in the infection rates of fish according to their species, and comparative data were obtained for the encysted larvae of *M. yokogawai*. In the case of *M. yokogawai* in the fish, *C. carassius*, 85.7 per cent of examined were found infected, whereas 100.0 per cent of 123 fish examined in 1980 were reported infected. Otherwise a reduction in the rate of infection in 5 other species of fish was recognized.

Table 7 lists the infection rates for the encysted larval trematodes on the fins and tail of fresh-water fish examined in 1988, and compared with Joo(1980). Four kinds of larval trematodes were found from the fins and tail, and comparative data with 1980 were obtained for *M. yokogawai*. The infection rate of fish with *M. yokogawai* metacercariae revealed that this fluke infection is rather stationary between 1980 and 1988 in different species of fish.

DISCUSSION

Since the establishment of experimental infection of *Clonorchis* metacercariae obtained from

fresh-water fishes such as *Leucogobio guntheri* and *Pseudorasbora parva* to cats, and since the demonstration of the same metacercariae from 12 species of fresh-water fishes belonging to the family Cyprinidae in nature (Kobayashi, 1910 & 1912), the biological, ecological, and morphological studies on the fish intermediate hosts have been performed by many investigators in Japan, China, Korea, and Formosa. As a result, it has been demonstrated that approximately 80 piscine species belonging to 10 families, *i.e.*, Cyprinidae, Centrachidae, Eleotridae, Bagridae, Gasterosteidae, Gobiidae, Siluridae, Serranidae, Mugilidae, and Plecoglossidae, play the important role in transmitting digenetic trematodes in the endemic areas of southern Korea.

The fact that patients of clonorchiasis are present among the residents in the vicinity of the river Taewha, Kyongnam Province, has been known for a long time, since several clonorchiasis cases among the in-and-out patients of private hospitals located in the vicinity of this river were found revealing the eggs of *C. sinensis* in their stool. Joo(1980) first confirmed that the river Taewha is one of the endemic areas of clonorchiasis. He examined 1,723 residents in the vicinity of the river and found 22.2 per cent were positive for *C. sinensis*. At the same time, he also found *Parafossarulus* snails in the river and that 4 species of fish were infected with *Clonorchis* metacercariae, though very low in their metacercarial burden.

The results in this study showed that the infection rates for the encysted larvae in fresh-water fish varied appreciably from fish to fish, and the degree of infection with the cysts was relatively low as compared with earlier reports available.

In the studies of fish intermediate hosts infected with larval trematodes, not many works were done before the end of the Korean War, although fresh-water fishes belonging to the family Cyprinidae were known to serve as intermediate hosts of intestinal or liver flukes in Korea. After the War, Lee(1968) conducted metacercarial studies in fishes caught along the river Kumho, a tributary of the river Naktong, and reported that 14 species of larval trematodes were found from 12 kinds of fish. He also reported that the encysted larvae of *E. oviformis* were the most common species, being found from 64.5 per cent of 12 kinds of fish, followed by *Metagonimus* sp. from 47.9 per cent of 10 kinds, and *Metacercaria hasegawai* from 36.3 per cent of 8 kinds of fish. From the studies on larval trematodes from fresh-water fish in river Oseep, Lee *et al.*(1979) reported that 7 kinds of metacercariae, including those of *C. sinensis* and 2 kinds of undetermined larvae A and D, were found from 10 species of fresh-water or brackish-water fish.

Similar results were obtained by Joo *et al.* (1983) in the river Taechong, and by Joo(1984) in the river Hyungsan. Hwang and Choi(1980), in a comparative study on infection rate of encysted trematode larvae in fresh-water fish collected in the river Kumho, with the results reported by Lee(1968), collected 13 species of fresh-water fish and found that they were infected with 10 species of larval trematodes including 3 undetermined larvae A, B, and C. Of the larvae recovered those of *E. oviformis* were found from all species of fish examined and *C. sinensis* larvae were found from 11 species. They also reported that the rate and intensity of infection with the larval trematodes varied markedly from fish to fish.

In the present study, 15 species of fresh-water fish and 1 species of brackish-water fish were collected, from which 11 species of larval trematodes including 4 kinds of undetermined larvae I, II, III and IV were found. Of the fish examined, *C. brevicorpus*, *G. atromaculatus*, *G. majimae*, *P. rhombea*, *P. esocinus*, *P. parva*, and *P. herzi* harboured the metacercariae of *C. sinensis*, and the infection rates for *Clonorchis* cyst 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 very low, ranging from 1.0 in *C. brevicorpus* to 8.2 in *G. atromaculatus*. The results in this study are

in agreement with the data obtained by Lee (1979) in the river Oseep, by Choi(1978) in the river Taeka, and by Joo(1984) in the river Hyungsan, but the degree of infection with *Clonorchis* metacercaria is much lower than those reported by Lee(1968), Hwang and Choi (1980) in the river Kumho, Choi(1976) in 5 rivers in Kyungpook Province, Joo(1980) and Yoo *et al.* (1984) in the river Taewha, and Joo(1984) in the river Hyungsan. The main factors contributing to the lower densities of infection in fish than in earlier reports were considered to be the pesticidal and artificial effects on the water, which are inhibitory on the survival of larval trematodes, and can enhance destruction of natural environment and ecology of the river.

As also indicated by Joo(1980), it was shown in this study that the intensity of infection with *C. sinensis* metacercariae in fresh-water fish is decreasing recently. It is suggested that newly established factories and apartments near by the river and massive drainage of waste products together with intense pesticide spray to the rice fields and farms may have affected the infection rate for the larval trematodes in fish.

Of the fish examined, 7 species including the sweetfish, *P. altivelis*, harboured the metacercariae of *M. yokogawai* in this study and the infection rate varied appreciably from fish to fish. Joo and Park(1982) conducted surveys for *M. yokogawai* metacercariae in fish hosts and for its prevalence among residents in Ulju county, Kyongnam Province. They reported that endemic foci of this fluke were found along the river Taewha, on the basis of high infection rates of fish hosts and high prevalence rates among residents. After then, Yoo *et al.* (1984) carried out a study on infection rates for larval trematodes in fresh-water or brackish-water fish caught in the vicinity of the same river surveyed by Joo(1980), and found the larvae of *M. yokogawai* from 11 species of fish examined. They also reported that the intensity of infection of *Metagonimus* larvae in *P. altivelis* as revealed by the average number of cysts per gram of flesh was 139.9 and that in sea-run dace was 40.2.

The results obtained in this study on *M. yokogawai* are in general similar to those reported by Lee *et al.*(1979) showing relatively high prevalence of this fluke along the river Taewha, although the degree of infection is not so high as reported by Chun(1962), Lee(1968), Hwang and Choi(1977), Suh and Choi(1979), Roh(1980), Hwang and Choi(1980), and Joo (1983). Although main reasons for high infection rates in fish hosts and residents of the river Taewha are not readily apparent, it is considered to be due to socioeconomic conditions, such as inadequate public health and improved transportation and easy availability of fish through more frequent communications between adjacent areas.

According to local officials in this river basin, there are many unusual eating houses that sell raw fresh-water or brackish-water fish, including the sweetfish, to local residents and visitors. Furthermore, in the vicinity of the river Taewha, rural and urban people often visit to these polluted waters on weekends or holidays, and majority of them enjoy fishing and consuming raw fish. They usually believe as if the fish collected in the vicinity of the river Taewha were completely free of parasites. This traditional misconcept might have elevated the incidence of fluke infections among the residents along the river Taewha.

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═國文抄錄═

慶南 太和江에서 採集된 淡水魚에 있어서 吸蟲類 被囊幼蟲 寄生狀의 變化

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1988年 3月부터 同年 10月까지 慶南 蔚州郡의 西北部와 南西部 사이에 位置하고, 太白山脈의 南쪽 끝에 形成된 가지산, 신불산 등에서 起源하여, 蔚州郡과 蔚山市를 貫流한 後 蔚山灣에 河口를 形成하고 있는 太和江에서 投網, 낚시 등으로 淡水魚와 半鹹水魚를 採集하여 魚體 部位別로 各種 吸蟲類 被囊幼蟲의 寄生狀을 調査하였다. 한편 얻은 결과를 朱(1980)의 調査成績과 比較하였다.

太和江에서 採集된 魚類는 붕어, 꼬치동자개, 꺽지, 잉어, 몰개, 긴몰개, 파랑볼우럭, 버들치, 납지리, 모래무지, 참붕어, 돌고기, 흰줄납줄개, 피래미, 갈겨니 및 은어의 16種이었다. 採集된 16種 魚類에서 7種의 被囊幼蟲(*Clonorchis sinensis*, *Cyathocotyle orientalis*, *Echinochasmus species*, *Metacercaria hasegawai*, *Metagonimus yokogawai*, *Exorchis oviformis* 및 *Metorchis orientalis*)과 4種의 所屬未定 被囊幼蟲을 檢出할 수 있었다.

人體에 寄生하는 肝吸蟲의 被囊幼蟲은 7種의 淡水魚에서 檢出할 수 있었고, 그 寄生率은 1980年 朱의 調査成績에 比하여 높았으나, 寄生程度에 있어서는 3種의 魚類(꼬치동자개, 몰개, 돌고기)에서는 1980년에 比해 낮았으며, 납지리에서는 높았다.

요꼬가와吸蟲 被囊幼蟲의 寄生率은 5種의 淡水魚(붕어, 몰개, 납지리, 꼬치동자개, 파랑볼우럭)에서는 낮았으나, 돌고기, 피래미, 갈겨니에서는 그 率이 높았고, 은어에서는 變動이 없었다. 요꼬가와吸蟲 被囊幼蟲의 寄生程度는 1980年의 調査成績에 比하여 일반적으로 增加되었으나, 은어에서는 減少된 것으로 나타났다.

Cythocotyle orientalis, *Echinochasmus* sp., *Exorchis oviformis*, 및 *Metacercaria hasegawai* 被囊幼蟲의 寄生率은 魚種에 따라 甚한 差異를 나타내었으며, 1980年의 調査 成績에 比해 높았다. 비늘, 지느러미 및 꼬리에서의 被囊幼蟲 寄生率은 變動이 심하여, 比較할 수 없었으나, 요꼬가와吸蟲 被囊幼蟲 寄生率은 일반적으로 1980年의 調査 成績에 比하여 높았다.

以上의 成績으로 미루어 太和江에서 採集된 魚類에 있어서 肝吸蟲을 비롯한 吸蟲類 被囊幼蟲 寄生率은 아직도 높으나, 그 寄生 程度는 1980年에 比해 魚種別로 甚한 變動을 나타내고 있음을 알 수 있었다.