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Changing patterns of infection with *Clonorchis* metacercaria from fresh-water fish in Kyungpook Province, Korea*

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Introduction

The biology and epidemiology of *C. sinensis* through field and experimental studies have been carried out extensively by many investigators of Korea, Japan, China and other countries. Kobayashi(1924) first found *Clonorchis* metacercariae from the flesh of several kinds of fresh-water fish collected in seven localities of southern Korea, and reported that fresh-water fish belonging to the Family Cyprinidae served as the second intermediate hosts of *C. sinensis*. Nishimura(1943) reported the demonstration of *Clonorchis* metacercaria from the seven kinds of fresh-water fish caught in the River Kumho, a tributary of the River Naktong in Kyungpook Province, Korea.

After the World War II, Lee and Kim(1958) made a survey of the first and second intermediate hosts of *C. sinensis* in the River Kumho, and reported that the vector snail was found distributed in the Kumho district. They also found *Clonorchis* metacercariae in several fresh-water fish such as *P. parva, G. atromaculatus*, and *P. herzi* from these water areas. The human incidence of clonorchiasis there amounted to 10.8 per cent of 2,700 primary school children in the area.

After the establishment of the first "Five-year Economic Development project" in 1962, many investigations have been done on the infection rates and intensity of *Clonorchis* metacercaria in different fish groups in the Province(Shin, 1964; Lee, 1968; Joo and Choi, 1974; Choi, 1976; Hwang and Choi, 1980; Kim and Choi, 1981; Joo et al., 1983; Hong, 1990). As a result, the infection rates of *Clonorchis* metacercariae are found to be constantly high, and the metacercarial burden in the fish varied by different fish.

In recent years there are newly established factories and many apartments in the vicinity of the rivers and their tributaries, and massive drainage of waste products into the Rivers together with intense use of insecticides for agriculture may have caused destruction of natural environment of the rivers.

The purpose of this study is to estimate the present status of *C. sinensis* metacercaria infections in fresh-water fish caught in the rivers and their tributaries, small ponds, and swamps in Kyungpook Province, in comparison with previously reported data in the same Province.

Materials and Methods

1. Geographical conditions of surveyed areas: Kyungpook Province is situated in the southeastern part of the Korean peninsula, having an area of 19,700 square kilometers, and is bordered of the northeast by the Sobaek range branches of Taebaek and runs from northeast to southwest along the border of Kangweon, Chungpook, and Cheonpook Provinces. In the south along the border of Kyungnam Province there are many mountains, arranged in a circle that

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make the Province seem to be a big hollow.

This Province is chiefly separated into the eastern and western hilly areas, and the central low land located in the valley of the River Naktong and its tributaries between the two hilly areas. Generally, the hilly country covers the upper stream of the River Naktong and its tributaries and the average elevation is rather high. The seven rivers in Kyungpook Province were selected as the study areas because of their consideration as the endemic foci of *C. sinensis*, and of the abundance of fresh-water fish in the waters(Fig. 1).

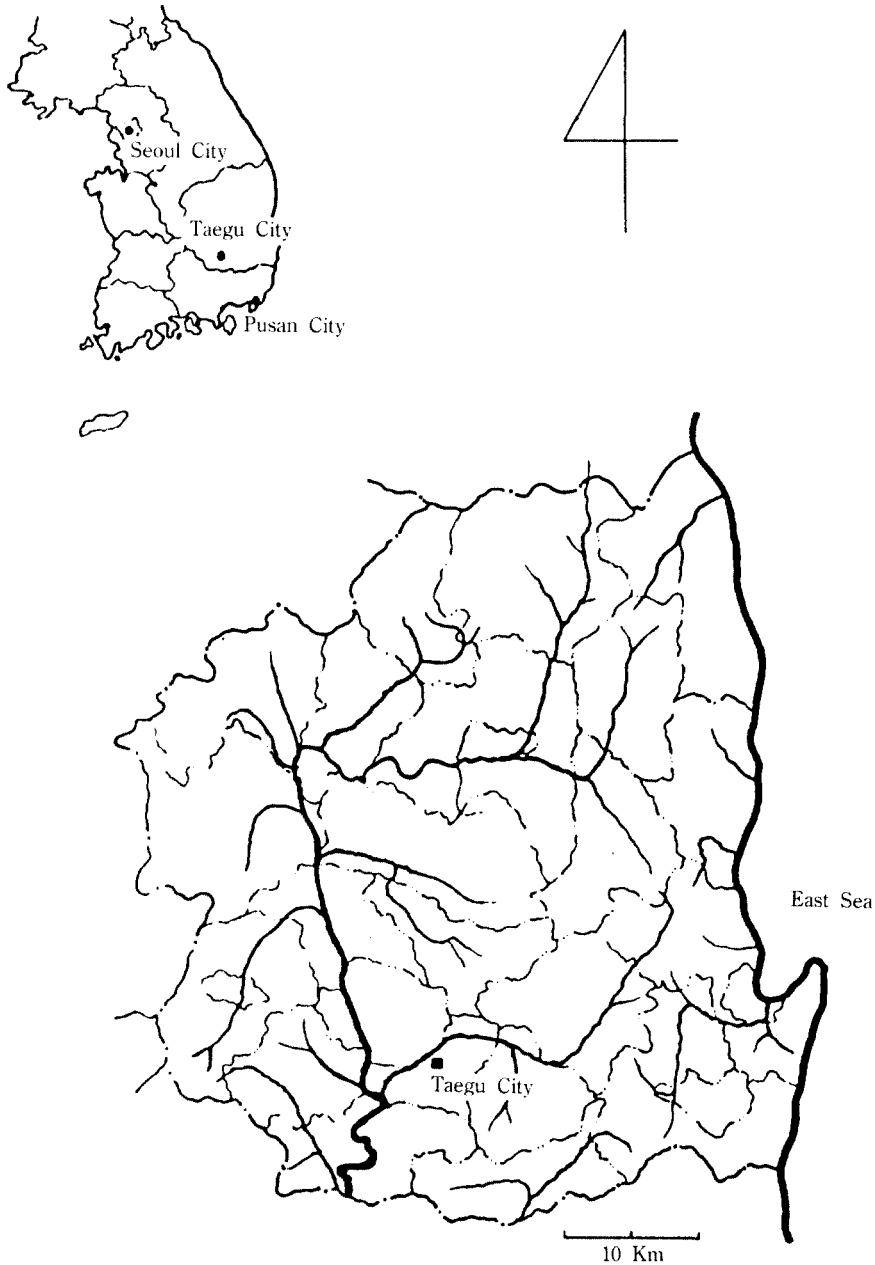

Fig. 1. Map of Kyungpook Province, Korea. Black Bold lines show the rivers surveyed.

Table 1. Comparison of species and number of fresh-water fish caught in some localities of Seven Rivers and their tributaries with previously reported data

Scientific name	Korean	No. of fish collected		
		Choi (1976)	Hwang & Choi (1980)	Present authors (1991)
Family cyprinidae				
Acanthorhodeus taenianlis Gunter	큰 납 지 리	13	33	34
Acheilognathus limbata (T et S*)	칼 납 자 루	24	25	—
Carassius carassius Linnaeus	붕 어	302	27	240
Coreoleucicus splendidus Mori	쉬 리	25	—	7
Cyprinus carpio Linnaeus	잉 어	52	—	8
Erythroculter erythropterus (Basilewsky)	강 준 치	23	—	—
Gnathopogon atromaculatus Nichols et Pope	불 개	143	30	200
Hemibarbus labeo (Pallas)	누 치	39	26	58
Hemibarbus longirostris (Regan)	참 마 자	18	—	—
Microphysogobio koreensis Mori	모 래 주 사	17	—	—
Moroco oxycephalus (Bleeker)	버 들 치	18	—	43
Paracheilognathus rhombea(T et S)	납 지 리	34	44	149
Pseudogobio esocinus(T et S)	모 래 모 치	52	15	62
Pseudorasbora parva(T et S)	참 붕 어	78	35	64
Pungtungia herzi Herzenstein	돌 고 기	130	16	212
Rhodeus ocellatus(Kner)	흰 줄 납 줄 개	—	—	30
Sarcocheilichthys sinensis Bleeker	참 중 고 기	41	—	15
Saurogobio dabryi Bleeker	두 우 쟁 이	—	—	152
Zacco platypus(T et S)	피 래 미	268	59	356
Zacco temmincki(T et S)	갈 견 이	—	—	234
Family Anabntidae				
Macropodus chinensis(Bloch)	버 들 붕 어	—	15	13
Family Bagridae				
Coreobagrus brevicorpus Mori	꼬 치 동 자 개	—	11	40
Family Centrachidae				
Lepiomis macrochirus Rafinesque	파 란 볼 우 럭	—		28
Family Channidae				
Channa argus(Cantor)	가 물 치	—	—	3
Family Cichlidae				
Tilapia massambica Peters	태 래 어	—	—	3
Femaily Eleotridae				
Mogurnda obscura(T et S)	동 사 리	35	—	—
Family Gasterosteidae				
Gasterosteus aculeatus aculeatus(Linnaeus)	큰 가 시 고 기	—	—	57
Family Gobiidae				
Sicyopterus japonicus Tanaka	열 동 갑 문 절	22	—	—
Family Serranidae				
Coreoperca herzi Herzenstein	꺾 지	61	6	22
Family Siluridae				
Parasilurus asotus Linnaeus	메 기	—	—	8

* T et S: Temminck et Schlegel.

2. The fish host survey: Fresh-water fish were caught in the rivers and their tributaries by netting and fishing with rod and line. The fish, after removal of their intestinal contents to prevent autodigestion, were forwarded to our 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 *C. sinensis*, the flesh, scales, all fins and tail were taken from each individual using a knife, compressed between two large slides(50×90mm) and examined for the presence of *Clonorchis* metacercariae under a binocular dissecting microscope.

In order to isolate the larval trematodes and to estimate the average number of cysts per gram of flesh, the digestion technique was also applied: One gram of flesh, mixed with artificial gastric juice. The juice constisted of 0.2 g of diluted hydrochloric acid and 0.3 g pepsin per 100ml of distilled water. The beakers containing the mixture were incubated under the temperature 37-38 C for 30-40 minutes.

The cysts from the fresh-water fish were also immediately fed to golden hamsters, and adult worms were obtained from hamsters after 2 months, flattened between two slides in 70 per cent alcohol, and stained with Semichon's acetocarmine.

The stained preparations were studied morphologically for the final identification of *C. sinensis*.

Table 2. Infection rates and density of *Clonorchis* metacercariae from freshwater fish caught in the Rivers and their tributaries in 1991

Species	No. of fish examined	Flesh		Scales		Fins & Tail		Average No. of metacercaria per g of flesh
		No.	%	No.	%	No.	%	
A. taenianalis	34	3	8.8	–	–	–	–	1.3
C. carassius	240	–	–	–	–	–	–	–
C. splendidus	7	–	–	–	–	–	–	–
C. carpio	8	–	–	–	–	–	–	–
G. atromaculatus	200	71	35.5	3	1.5	–	–	33.6
H. labeo	58	12	20.7	–	–	–	–	–
H. longirostris	49	3	6.1	–	–	–	–	1.7
M. oxycephalus	43	–	–	–	–	–	–	–
P. rhombea	149	48	32.2	–	–	–	–	–
P. esocinus	62	35	56.5	–	–	–	–	2.9
P. parva	64	44	68.8	2	1.6	–	–	12.2
P. herzi	212	100	47.2	–	–	–	–	9.3
R. ocellatus	30	–	–	–	–	–	–	–
S. sinensis	15	2	13.3	1	6.7	1	6.7	2.0
S. dabryi	152	39	25.7	–	–	–	–	5.0
Z. platypus	356	–	–	–	–	–	–	–
Z. temmincki	234	–	–	–	–	–	–	–
M. chinensis	13	–	–	–	–	–	–	–
C. brevicorpus	40	5	12.5	–	–	–	–	1.4
L. macrochirus	28	–	–	–	–	–	–	–
C. argus	3	–	–	–	–	–	–	–
T. massambica	3	–	–	–	–	–	–	–
G. aculeatus aculeatus	57	–	–	–	–	–	–	–
C. herzi	22	3	13.6	–	–	–	–	2.0
P. asotus	8	–	–	–	–	–	–	–

Results

A total of 2,087 of fresh-water fish of 25 species belong to Family Cyprinidae, Anabantidae, Bagridae, Centrachidae, Channidae, Eleotridae, Gasterosteidae, Gobiidae, Serranidae, and Siluridae were collected from seven rivers and their tributaries, several small ponds and swamps of Kyungpook Province in1990-1991. The individual numbers and species of fresh-water fish caught are compared with previously reported data and listed in Table 1. Of these, the crussian carp(*C. carassius*), the Korean shiner(*G. atromaculatus*), the flat bitterling(*P. rhombea*), the striped shiner(*P. rhombea*), the striped shiner(*P. herzi*), the pale chub(*Z. platypus*), and the dark chub(*Z. temminchi*) are the most frequently collected species of fish.

Five species, *C. splendidus, C. carpio, M. chinensis, C. argus,* and *P. asotus* are known to be the common species of the rivers, but in this survey they are less frequently collected. *S. dabryi* and *G. aculeatus aculeatus* are first collected, and *T. massambica* is found in breeding ponds. In the present survey *E. erythropterus, M. koreensis, M. obscura,* and *S. japonica* are not found.

Table 3. Comparison of the infection rates for *Clonorchis* metacercariae from fresh-water fish with previously reported data

Species	Choi(1976)		Hwang & Choi(1980)		Present authors	
	No.	%	No.	%	No.	%
A. taenianalis	13	7.7	33	36.4	34	8.8
A. limbata	24	4.2	2.5	60.0	–	–
C. carassius	302	–	27	–	240	–
C. splendidus	25	–	–	–	7	–
C. carpio	52	–	–	–	8	–
E. erythropterus	23	13.0	–	–	–	–
G. atromaculatus	143	47.6	30	38.5	200	35.5
H. labeo	39	87.2	26	42.3	58	20.7
H. longirostris	18	–	–	–	49	6.1
M. koreensis	17	–	–	–	–	–
M. oxycephalus	18	–	–	–	43	–
P. rhombea	34	5.9	44	29.5	149	32.2
P. esocinus	52	90.4	15	66.7	62	56.5
P. parva	78	92.3	35	94.3	64	68.8
P. herzi	130	60.8	16	87.5	212	47.2
R. ocellatus	–	–	–	–	30	–
S. sinensis	41	87.8	–	–	15	13.3
S. dabryi	–	–	–	–	152	25.7
Z. platypus	268	–	59	–	356	–
Z. temmincki	–	–	–	–	234	–
C. brevicorpus	–	–	11	63.6	40	12.5
C. argus	–	–	–	–	3	–
M. obscura	35	–	–	–	–	–
T. massambica	–	–	–	–	3	–
S. japonicus	22	–	–	–	–	–
G. aculeatus aculeatus	–	–	–	–	57	–
C. herzi	61	–	6	16.7	22	13.6
P. asotus	–	–	–	–	8	–
M. chinensis	–	–	15	40.0	13	–

Table 2 shows the infection rates and intensity for *Clonorchis* metacercaria according to the species of fresh-water fish. Of 25 species of fish examined, 12 kinds were infected with encysted larvae of *C. sinensis*. *P. parva* was the most highly infected with the positive rates of 68.8 per cent, followed by *P. esocinus* with 56.5 per cent, *P. herzi* with 47.2 per cent, and *G. atromaculatus* with 35.5 per cent.

The less frequently infected fish were *A. taenianalis* and *H. longirostris*, 8.8 per cent and 6.1 per cent, respectively. No *Clonorchis* metacercaria was found in the flesh, scales, fins, and tail of the remaining 13 kinds of fish collected in this survey.

The metacercarial density of *C. sinensis* in fish, however, expressed in average number of encysted larvae per gram of flesh, was low as a whole. Of these, *G. atromaculatus* was the most heavily infected with the larvae and the average number of cysts being 36.6, *P. parva* was next with an average of 12.2 cysts. *H. labeo*, *P. herzi*, *S. dabryi* and *P. esocinus* were moderately infected with an average number varying from 2.9 to 9.3 cysts.

A. taenianalis, *H. longirostris*, *P. rhombea*, and *C. brevicorpus* were less heavily infected with an average of 1.3, 1.7, 1.8 and 1.4 cysts, respectively.

The data presented in Table 3 are compared the 1991 results of the infection rates of *Clonorchis* metacercariae in fresh-water fish with those of Choi(1976) and Hwang and Choi(1980). Of the fish examined in 1991, the encysted larvae of *C. sinensis* were found

Table 4. Comparison of the infection rates for *Clonorchis* metacercariae on scales, fins and tail with previously reported data

Species	Lee(1968)		Hwang & Choi(1980)		Present authors	
	No.	%	No.	%	No.	%
A. taenianalis	50	–	33	–	34	–
A. limbata	50	–	25	–	–	–
C. carassius	60	–	27	–	240	–
C. splendidus	–	–	–	–	7	–
C. carpio	52	–	–	–	8	–
G. atromaculatus	58	–	30	6.7	200	1.5
H. labeo	39	–	26	–	58	–
H. longirostris	–	–	–	–	49	–
M. oxycephalus	–	–	–	–	43	–
P. rhombea	–	–	44	2.3	149	–
P. esocinus	50	2.0	15	–	62	–
P. parva	56	1.8	35.	–	64	1.6
P. herzi	61	3.3	16	–	212	–
S. sinensis	36	38.9	–	–	15	6.7
R. ocellatus	–	–	–	–	30	–
S. dabryi	–	–	–	–	152	–
Z. platypus	33	–	59	–	356	–
Z. temmincki	–	–	–	–	234	–
C. brevicorpus	24	–	11	–	40	–
C. argus	–	–	–	–	3	–
T. massambica	–	–	–	–	3	–
G. aculeatus aculeatus	–	–	–	–	57	–
C. herzi	–	–	6	–	22	–
P. asotus	–	–	–	–	13	–
M. chinensis	–	–	15	–	–	–

in 12 fish species: Of the 64 *P. parva* examined in 1991, 68.8 per cent of the fish were infected with *C. sinensis*, while 92.3 per cent of 78 fish examined in 1976 and 94.8 per cent of 35 fish examined in 1980 were infected. Similarly, reduction in the infection rate in the seven species of fish, *G. atromaculatus, H. labeo, P. esocinus, P. herzi, S. sinensis, C. brevicorpus* and *C. herzi* occurred in the period from 1976 to 1991. On the contrary, an increase in the infection rate in the one species of fish, *P. rhombea*, was encountered.

The infection rates for encysted larvae found on the scales, fins and tail of fresh-water fish in 1991 were summarized in Table 4 and briefly compared with those in 1968 and in 1980. There was considerable variation in the infection rates of fish according to their species. In the case of *S. sinensis*, 38.9 per cent of 36 fish examined in 1968 were found infected with *C. sinensis*, whereas, 6.7 per cent of 15 fish examined in 1991 wer infected. A reduction in the

Table 5. Comparison of infection density for *Clonorchis* metacercariae from fresh-water fish with previously reported data

Species	No. of fish examined			Average No. of larvae per gram of flesh		
	Choi (1976)	Hwang & Choi (1980)	Present authors (1991)	Choi (1976)	Hwang & Choi (1980)	Present authors (1991)
A. taenianalis	13	33	34	2.7	7.6	1.3
A. limbata	24	25	—	1.5	13.3	—
C. carassius	302	27	240	—	—	—
C. splendidus	25	—	7	—	—	—
C. carpio	52	—	8	—	—	—
E. erythropterus	23	—	—	2.4	—	—
G. atromaculatus	143	30	200	15.1	18.9	33.6
H. labeo	39	26	58	10.3	6.9	4.8
H. longirostris	18	—	49	—	—	1.7
M. koreensis	17	—	—	—	—	—
M. oxycephalus	18	—	43	—	—	—
P. rhombea	34	44	149	3.3	1.7	1.8
P. esocinus	52	15	62	18.6	20.9	2.9
P. parva	78	35	64	51.4	41.8	12.2
P. herzi	130	16	212	14.2	27.1	9.3
S. sinensis	41	—	15	19.5	—	2.0
R. ocellatus	—	—	30	—	—	—
S. dabryi	—	—	152	—	—	5.0
Z. platypus	268	59	356	—	—	—
Z. temmincki	—	—	234	—	—	—
C. brevicorpus	—	11	40	—	2.7	1.4
C. argus	—	—	3	—	—	—
M. obscura	35	—	—	—	—	—
S. japonicus	22	—	—	—	—	—
T. massambica	—	—	3	—	—	—
C. herzi	61	6	22	—	0.9	2.0
P. asotus	—	—	8	—	—	—
M. chinensis	—	15	13	—	8.0	—
G. aculeatus aculeatus	—	—	57	—	—	—

rate of infection in four species of fish was recognized.

The infection densities for *Clonorchis* metacercariae in the flesh of fresh-water fish in 1991 are compared with previously reported data and listed in Table 5.

In fact, the metacercarial burden of *C. sinensis* in fish greatly varied in different fish in 1976, in 1980 and in the present study. In the metacercarial density of *C. sinensis* in fish in the period from 1976 to 1991 it decreased in seven species, *A. taenianalis, H. labeo, P. esocinus, P. parva, P. herzi, S. sinensis* and *C. brevicorpus.*

On the other hand, an elevation in the density in the 2 species, *G. atromaculatus,* and *C. herzi* was observed.

In the previously reported data, *P. parva* was the most heavily infected and the average number of the cysts per gram of flesh was 51.4 in 1976 and 41.8 in 1980, whereas, in this survey *G. atromaculatus* was the most heavily infected with an average of 33.6 cysts.

Discussion

Since describing the establishment of *C. sinensis* infections into the definitive hosts including human beings by taking orally the mature *Clonorchis* metacercariae with raw fresh-water fish(Kobayashi, 1910 & 1912; Mukoyama, 1922), the biological, ecological and morphological studies on the fish intermediate hosts have been carried out by many investigators in Japan, China, Korea and othe countries.

The first report of clonorchiasis in Korea was made by Matsumoto(1915), who found the *Clonorchis* eggs from the stools among the in-and-outpatients in Taegu Charity hospital located in Kyungpook Province. Kobayashi(1924) made a survey of the second intermediate host naturally infected with *Clonorchis* metacercaria in six locations in Korea and demonstrated that seven species of fresh-water fish belonging to the Family Cyprinidae were the intermediate host of *C. sinensis* in the endemic areas of southern Korea.

Subsequently many studies of the second intermediate hosts of *C. sinensis* were performed by many investigators in Korea. A list of the recorded and recognized species of the fish hosts of the liver fluke is given in Table 6. As shown in Table 6, it is clear that most fish served as the second intermediate hosts of *C. sinensis* belonging to the Family Cyprinidae, except those to the Families Bagridae, Serranidae, Siluridae, and Channidae, etc.

Nishimura(1943) found *Clonorchis* metacercaria in *Zacco platypus* from Yeongcheon, Korea, and recorded it as the intermediate host of the liver fluke. But according to the records of many investigators they were never found in this fish (Lee, 1968; Choi, 1976; Lee et al. 1979; Hwang and Choi, 1980; Joo, 1980; Kim and Choi, 1981; Joo, 1984; Hong, 1990). Judging from the above results it is uncertain whether this fish served as fish host of the liver fluke and it must be studied further.

The fish host, *C. carassius* was first reported as the second intermediate host of *C. sinensis* by Kobayashi(1912), who made a survey of the fish hosts in Miyagi, Shiga, and Okayama Prefecture, Japan. Subsequently many studies of the encysted larvae of the liver fluke in this fish were carried out by numerous investigators in Korea, Japan, and the other countries. Miki(1922) reported that many *Clonorchis* metacercariae were found in *P. parva,* whereas no metacercaria was found in *C. carassius* and *C. carpio.*

Quite recently Rhee et al. (1982) studied the clavate cells of epidermis in *C. carpio nudus* with reference to its defense activity to *C. sinensis,* and reported that a large number of clavate cells were found in the epidermis of *P. asotus, C. carpio,* and *C. carassius* which were not suitable as fish hosts for *C. sinensis,* while clavate cells were not found in *P. parva.* Further work along this line is needed.

Lee(1956) found *Clonorchis* metacercaria in *Channa argus* collected in the River Naktong. Later no report of this fish as the second intermediate host was recorded. It is uncertain whether this fish is incriminated as the fish host of *C. sinensis.* Chun (1962) found the encysted larvae of *C. sinensis* in *Zacco temmincki.* No workers recorded this fish as such later.

Table 6. The reported second intermediate hosts of *Clonorchis sinensis* in Korea

Family & Species	Korean	Author	Locality
Family Cyprinidae			
Abbotina rivularis (Basilewsky)	버들매치	Kobayashi(1923)	Hampyung
Acanthohodeus taenianalis (Gunter)	큰납지리	Lee(1956)	Naktong River
Acanthohodeus gracilis Regan	가시납지리	Kobayashi(1924)	Hampyung
Acheilognathus limbata (T et S)*	칼납자루	Choi(1976)	Naktong River
Acheilognathus signifer Berg	묵납자루	Kim(1961)	Kumho River
Acheilognathus yamatsute Mori	줄납자루	Kim(1961)	Kumho River
Carassius carassius(Linnaeus)	붕어	Nishimura(1943)	Yeongcheon
Culter brevicauda Gunther	백조어	Nishimura(1938)	Yeongcheon
Erythroculter erythropterus (Basiewsky)	강준치	Nishimura(1938)	Taegu
Gnathopogon atromaculatus (Nichols et Pope)	몰개	Kobayashi(1924)	Yeongdungpo
Gnathopogon striatus (Regan)	줄몰개	Kobayashi(1924)	Yeongdungpo
Hemibarbus longirostris (Regan)	참마자	Nishimura(1938)	Yeongcheon
Hemibarbus labeo (Pallas)	누치	Lee(1956)	Naktong River
Microphysogobio koreensis Mori	모래주사	Kim(1961)	Kumho River
Pseudogobio esocinus (T et S)	모래무지	Lee(1956)	Naktong River
Paracheilognathus rhombea (T et S)	납지리	Kobayashi(1928)	Naktong River
Pseudoperilampus notatus (Bleeker)	떡납줄갱이	Lee et al.(1958)	Kumho River
Pseudorasbora parva (T et S)	참붕어	Kobayashi(1924)	Yeongdungpo
Pungtungia herzi Herzenstein	돌고기	Nishimura(1938)	Taegu
Rhodeus ocelleatus (Kner)	흰줄납줄개	Shin(1964)	Naktong River
Sarcocheilichthys czerskii (Berg)	중고기	Kobayashi(1928)	Yeongdungpo
Sarcocheilichthys sinensis (Bleeker)	참중고기	Kobayashi(1928)	Yeongdungpo
Saurogobio dabryi Bleeker	두우쟁이	Joo & Hong(1990)	Ahnseong River
Zacco platypus (T et S)	피래미	Nishimura(1938)	Yeongcheon
Zacco temmincki (T et S)	갈견이	Chun (1962)	Naktong River
Cyprinus carpio Linnaeus	잉어	Lee & Kim(1958)	Naktong River
Family Anabantidae			
Macropodus chinensis (Bloch)	버들붕어	Lee (1956)	Naktong River
Family Bagridae			
Coreobagrus bervicorpus Mori	꼬치동자개	Kim(1961)	Kumho River
Family Channidae			
Channa argus (Cantor)	가물치	Nishimura(1938)	Yeongcheon
Family Serranidae			
Coreoperca herzi Herzenstein	꺾지	Nishimura(1938)	Yeongcheon
Family Siluridae			
Parasilurus asotus (Linnaeus)	메기	Nishimura(1938)	Yeongcheon
Family Eleotridae			
Mogurnda obscura (T et S)	동사리	Shin(1964)	Naktong River

*T et S: Temminck et Schlegel

Saurogobio dabryi was first recorded as the intermediate host of *C. sinensis* by Kubo and Makino (1941) in Manchuria, China. In Korea no report of this fish as the second intermediate host was recorded. In this study the infection rate for *C. sinensis* in 152 *S. dabryi* was 25.7 per cent, and the average number of its metacercaria per gram of flesh was 5.0 cysts. It is clear that this fish played the second

intermediate host as chief vector for the fluke in Korea.

In earlier studies of *C. sinensis* in Kyungpook Province, Lee and Kim(1958) made a survey of the first and second intermediate host of *C. sinensis* in the vicinity of the River Kumho between Taegu and Yeongcheon areas, and reported that vector snails were found in Kumho district. They also found *Clonorchis* metacercariae in several fresh-water fish such as *P. parva, G. atromaculatus, P. herzi,* and *P. esocinus* from these water areas.

As for the survey of *Clonorchis* infection in the second intermediate host, Lee(1968) examined the metacercaria in various species of fresh-water fish in the same River surveyed by Lee and Kim(1958) reported that 50 or 89.3 per cent among 56 *P. parva,* 61 or 100.0 per cent among 61 *P. herzi* and 49 or 98.0 per cent among 50 *P. esocinus* were infected with *Clonorchis* metacercaria, but 60 *C. carassius,* 31 *Z. platypus* and 52 *C. carpio* were found negative for it. He also stated the *P. parva* was the most heavily infected and the average number of metacer-caria per gram of flesh was 34.3.

Choi(1975 & 1976) made surveys on the intermediate hosts of *C. sinensis,* and reported that vector snails were found in 10 locations along the River Naktong and its tributaries. Considerably higher population density of snails was observed in Dongchon area of the River Kumho in the eastern part of Taegu city. Of the fish examined, *P. parva* was the most frequently infected fish, being found in 92.3 per cent, followed by *P. esocinus, S. sinensis* and *H. labeo* with the rate of 90.4 per cent, 87.8 per cent and 87.2 per cent, in decreasing oder. In the metacercarial burden, *P. parva, S. sinensis, P. esocinus* and *P. herzi* harboured a large number of cysts, whereas, *P. rhombea, A. limbata* and *A. taenianalis* were infected with only a few cysts. Similar finding were obtained by Lee et al. (1979), Hwang and Choi(1980), and Joo(1984).

Hong(1990) carried out surveys recently on *C. sinensis* in the vicinity of the River Ahnseong, and found that 10 of 17 species of fish harboured the *Clonorchis* metacercariae. The most frequently infected was *P. parva* with a rate of 85.4 per cent, the less frequently infected was *A. taenianalis* with 12.5 per cent, and the intermediate one was *S. dabryi.* The human incidence of clonorchiasis there amounted to 11.0 per cent of 902 residents in the area.

In the present study, 25 species of fresh-water fish belonging to the Families of Cyprinidae, Anabantidae, Bagridae, Centrachidae, Channidae, Cichlidae, Eleotridae, Gasterosteidae, Gobiidae, Serranidae, and Siluridae were collected in several localities of seven rivers and their tributaries, in which 12 species of the fish, *A. taenianalis, G. atromaculatus, H. labeo, H. logirostris, P. rhombea, P. esocinus, P. parva, P. herzi, S. sinensis, S. dabryi, C. brevicorpus, and C. herzi* harboured the encysted larvae of *C. sinensis.* The results of this study are similar to those reported by Lee(1968), Choi(1976), Hwang and Choi(1980), and Hong(1990). However, they differ considerably in the number of Family and species collected, i. e., 2 Families and 9 species reported by Lee(1968), 4 Families and 11 species by Hwang and Choi(1980), and 5 Families and 17 species by Hong(1990).

These differences may be due to the collection techniques, geographical variations or general changes in the population distribution of various fish species and climatic variations.

In the fish intermediate host survey of *C. sinensis* by many workers in Korea, Japan, China, and other countries, it was found that *P. parva, P. esocinus, P. herzi, G. atromaculatus* and *H. labeo,* etc. belonging to the Family Cyprinidae were most heavily infected with *Clonorchis* metacercariae. Of these, *P. parva* played the role as main vector for the liver fluke.

In this study, *P. parva, P. esocinus, P. herzi, and G. atromaculatus* were heavily infected with the encysted larvae of *C. sinensis.* Their rates ranged from 35.5 per cent to 68.8 per cent. *H. longirostris, S. sinensis, A. taenianalis, C. brevicorpus,* and *C. herzi* were less frequently infected with rates for the cysts of the fluke being less than 15.0 per cent.

The rates and intensity of infection with *Clonorchis* metacercaria in the 12 species of fish varied markedly from fish to fish. The average number of the cysts was from 1.3 in *A. taenianalis* to 33.6 in *G. atromaculatus.*

The results in this study are in agreement with the data obtained by Choi(1976) in the River Kumho, by Choi(1978) in the River Taeka, and by Hong(1990) in the River Ahnseong, but the degree of infection with *Clonorchis* metacercaria is much lower those reported by Lee(1968), and Hwang and Choi(1980).

The main factors contributing to the lower infection rates and intensity of *C. sinensis* in fish than earlier reports are considered to be the pesticidal and artificial effects on the water, which are inhibitary on the survival of larval trematodes, and can enhance destruction of natural environment such as causing the water level to drop, and regulating the construction of many concrete septa across the river to store water for irrigation of the rice fields, especially the ecology of the river.

Such considerations were also recognized by Choi (1976), Joo(1980 and 1988), and Hong(1990).

In fact, there are many newly established factories, apartments, and rice fields in the vicinity of the rivers and massive drainage of waste products into the rivers, together with intense spraying of pesticides on the farms and fields in the vicinity which may result in the destruction of the natural environment of the rivers.

As also indicated by Joo(1988), it was shown in this study that the intensity of *Clonorchis* metacercariae in fish hosts has been decreasing recently. It is suggested that destruction of the natural environment of the rivers may have affected the infection rates for the larval trematodes in fish.

Summary

Recent patterns of infection with *Clonorchis* metacercaria in fresh-water fish were studied in Kyungpook Province during the period from September 1990 through August 1991, and compared with previously reported data in the same Province.

Of 25 species of fish examined, 12 species were infected with the encysted larvae of *C. sinensis*. their rates varied greatly in different fish and ranged from 6.1 per cent in *Hemibarbus longirostris* to 68.8 per cent in *Pseudorasbora parva*.

The infection rates of 7 species of fish with *Clonorchis* metacercariae were lower than the results in 1976 and in 1980, while the rate was higher in one species, *Paracheilognathus rhombea*, and rather stationary in *Coreoperca herzi* and *Acanthohodeus taenianalis*.

The intensity of infection in several species of fish appeared higher than those reported in 1976 and in 1980, whereas their intensity of infection were found lower in 7 species, *Acanthohodeus taenianalis, Hemibarbus labeo, Pseudogobio esocinus, Pseudorasbora parva, Pungtungia herzi, Sarcocheilichthys sinensis*, and *Coreobagrus brevicorpus*.

It was found that the rate of infection in fresh-water fish with *Clonorchis sinensis* was still relatively high, and the metacercarial burden in the fish varied greatly in different fish in 1976, 1980 and in this study.

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= 국문초록 =

경북에서 채집된 담수어에 있어서 간흡충 피낭유충 기생상의 변화

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1990년 9월부터 1991년 8월까지 경북도내 강과 그 지류에서 투망과 낚시등으로 담수어를 채집하여 어체 부위별로 간흡충 피낭유충 기생상을 조사하였다. 한편 얻은 결과를 崔(1976)와 황 및 최(1980)의 조사성적과 비교하였다.

경북도내 강과 지류에서 채집된 어류는 10科 25종이었으며, 이 중 12종, 큰납지리, 몰개, 누치, 참마자, 납지리, 모래모치, 참붕어, 돌고기, 참중고기, 두우쟁이, 꼬치 동자개 및 꺽지, 에서는 간흡충 피낭유충을 검출할 수 있었다.

8종의 어류, 몰개, 누치, 모래모치, 참붕어, 돌고기, 참중고기, 꼬치동자개 및 꺽지, 에서는 1976년 및 1980년의 조사성적에 비하여 그 기생율이 낮았으며, 1종의 어류, 납지리에서는 그 율이 높았다. 참마자와 두우쟁이는 1976년 및 1980년에는 간흡충 피낭유충을 검출할 수 없었는데 비하여 이번조사에서는 검출할 수 있었으며 그 율은 각각 6.1%, 25.7%였다.

감염정도에 있어서는 1976년 및 1980년에 비해 2종의 어류, 몰개와 꺽지, 에서는 어육 1g당 피낭유충 수가 많았으며, 7종의 어류, 큰납지리, 누치, 모래모치, 참붕어, 돌고기, 참중고기 및 꼬치동자개, 에서는 적었다.

이상의 성적으로 미루어보아 경북도내에서 채집된 어류에 있어서 간흡충 피낭유충 기생율은 아직도 높았으나, 그 기생정도는 1980년에 비해 어종별로 심한 변동을 나타내고 있음을 알 수 있었다.