

## Epidemiological Studies of Digenetic Trematodes in Yongyang County, Kyungpook Province

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**Abstract:** The present study was undertaken to determine the endemicity of trematode infections in Yongyang County, Kyungpook Province, Korea.

One hundred and seventy-seven out of 955 residents examined were found to be infected with one or more kinds of helminthes. The prevalence rate was 18.5%. Among them, 70 were found to be infected with *Clonorchis sinensis*, 74 with *Metagonimus* sp. and 24 with both flukes. The eggs of Fasciolidae were demonstrated from two specimens. The prevalence rate of clonorchiasis in males was 12.6%, while that in females was 3.6% ( $p < 0.05$ ). The prevalence of metagonimiasis in males was 12.0% and was also significantly higher than 6.1% in females ( $p < 0.05$ ). The intensity of both infections was significantly heavier in males than in females. The prevalence of both flukes was higher in residents of over 30 years of age than in those below that age. No correlation was found between the intensity and the age group.

Among eight species of the fresh-water fish collected at the Panbyon River, *Zacco temmincki* was found to be the most frequently and heavily infested with metacercariae of *Metagonimus* sp., and *Gnathopogon atromaculatus* alone was found to be infested with metacercariae of *Clonorchis sinensis*.

The present results suggest that Yongyang area still remains endemic with *Clonorchis sinensis* and *Metagonimus* sp. infection.

**Key words:** Yongyang Kyungpook, residents, fresh-water fish, *Clonorchis sinensis*, *Metagonimus*, Fasciolidae

### INTRODUCTION

The prevalence of human helminthiasis has been known to be decreasing gradually in Korea (Seo *et al.*, 1969; Kim *et al.*, 1971; Choi *et al.*, 1976; Seo *et al.*, 1981). In particular, infection by soil transmitted nematodes has remarkably decreased. Abstention from use of night soil as a fertilizer in agriculture, and improved standards of living and sanitation may give rise to the reduction of intestinal nematodiasis. Recent surveys, however, revealed that snail transmitted trematodiasis remained highly

prevalent, especially in riverside areas of Korea (Joo, 1980; Kim, 1980; Song, 1982; Bae *et al.*, 1983; Ahn, 1984).

The Naktong River and its tributaries flowing through the Kyungpook and Kyungnam Provinces have been well-known to be highly enzootic with digenetic larval trematodes (Hwang and Choi, 1980; Kang *et al.*, 1984; Cho and Choi, 1984; Sohn *et al.*, 1987; Choi and Koo, 1988; Cho *et al.*, 1990; Choi *et al.*, 1990 a & b). Among the trematodes, *Clonorchis sinensis* and *Metagonimus* sp. are the flukes of great medical importance in Korea. Human clonorchiasis is acquired by eating raw, inadequately cooked or

pickled flesh of fresh-water fish, and metagonimiasis, from fresh- or brackish-water fish.

*Pseudorasbora parva*, the southern top-mouthed minnow, *Gnathopogon atromaculatus*, the Korean shiner and *Pungtungia herzi*, the striped shiner are the most important fish intermediate hosts of *C. sinensis* in Korea. *Zacco temmincki*, the dark chub and *Zacco platypus*, the pale chub are the principal fresh-water fish as the second intermediate host of *Metagonimus* sp. In addition to the chubs, such brackish-water fish as *Plecoglossus altivelis*, the sweetfish and *Tribolodon hakonensis*, the sea-run dace provide the means of human metagonimiasis. Many Korean used to eat the raw flesh of the fresh and brackish-water fish as a delicacy, underestimating the pathogenicity of the flukes and overestimating the efficacy of the anthelmintic, praziquantel.

In Kyungpook Province, Choi *et al.* (1976) reported the prevalence of clonorchiasis to be 19.6%, in 1976 significantly decreased in comparison with 27.7%, previously reported by Shin (1964). The prevalence in Yongyang County was 16.1% in the survey (Choi *et al.*, 1976).

Surveys on trematodiasis, except clonorchiasis, in the vicinity of the Panbyon river have not been performed thoroughly. The river has been famous for its clean water and resort valley. The residents dwelling in the vicinity of the river are used to eating the uncooked flesh of the fresh-water fish and are exposed to the trematodiasis.

The purpose of the present study is to determine the prevalence and intensity of trematodiasis among the residents in Yongyang County, Kyungpook Province, and the infestation status of fresh-water fish by larval trematodes collected in the river Panbyon.

## MATERIALS AND METHODS

**Area surveyed:** Yongyang County is located in the northern part of Kyungpook Province, Korea (Fig. 1). The County has a population

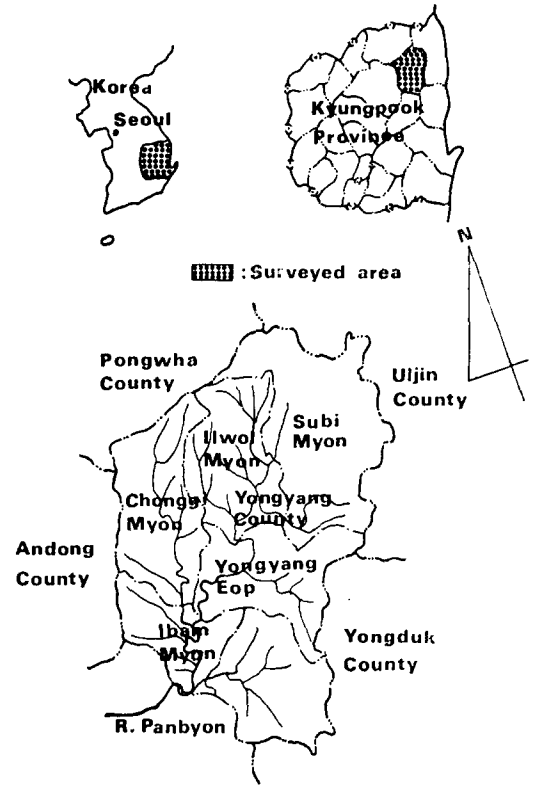


Fig. 1. Map of Yongyang County, Kyungpook Province, showing the river Panbyon and its tributaries.

of approximately 40 thousands. The riverside altitude of the County is about 300 to 400 meters above sea level. The stream of the river Panbyon which is running through the County is quite fast. The river has three tributaries, the rivers Tong, Changun, and Changpa.

**Semi-quantitative formalin-ether sedimentation technique:** A modification of formalin-ether centrifugal sedimentation technique (Ritchie, 1948) was applied. In a centrifuge tube, 15 ml graduated, approximately 0.5 g of feces was crushed in 10 ml of water, and stirred into a suspension. The suspension was filtered through two sheets of surgical gauze held over a glass funnel. The filtered suspension was centrifuged for 5 minutes at about 2,000rpm and the supernatant fluid was decanted. Seven ml of 10% formalin was added to the sediment and the sediment was allowed to stand for 10 minutes

for fixation. Three ml of ether was added, and the tube was stoppered and shaken vigorously for 30 seconds. After being centrifuged for 5 minutes at about 2,000rpm, ether, a plug of debris and formalin were discarded. Ten % formalin was added onto the sediment to be the final volume of approximately 0.5 ml. A drop (approximately 0.02 ml) of the suspension was transferred to a slide by a pasteur pipette, covered with a coverglass, and the number of individual helminthic eggs in the entire preparation were counted.

**Stoll's diluted egg-counting method**(Stoll, 1923): A 15 ml, graduated tube was filled with 14 ml of 0.1N sodium hydroxide (NaOH) and feces was added with a wooden applicator to bring the contents to the 15 ml mark. The tube was stoppered and shaken vigorously. After standing for 24 hours, the tube was shaken again and exactly 0.15 ml of the suspension was taken with a special pipette. The pipette was emptied on to 6 or 7 slides. The sample was covered with coverglass and the number of individual helminthic eggs were counted in the entire preparation. The count was multiplied by 100.

**Correction of egg count for consistency of fecal specimen:** Egg count was corrected by multiplying as follows hard formed,  $\times 1$ ; mushy-formed,  $\times 2$ ; mushy-diarrheic,  $\times 3$ ; diarrheic,  $\times 4$ .

**Determination of intensity of infection by Stoll's egg counting method:** The cases of which EpG count were below 1,000 were regarded as light clonorchiasis, those with a count between 1,000 and 9,900 as moderate, and those with a count over 10,000 as heavy clonorchiasis. In *Metagonimus* sp. infection, the cases of the count below 500 were regarded as light, those with a count between 500 and 1,000 as moderate, and those with a count over 1,000 as heavy infection.

**Slide-glass compression method and artificial digestion method:** Flesh of the fresh-water fish was compressed between two large (70 $\times$ 90 mm) slide-glasses and examined for the presence of metacercariae. The flesh containing

digenetic larval trematodes was mixed with an appropriate volume of the artificial gastric juice. The mixture was allowed to stand for 2~4 hours and the larvae were isolated from digested debris under a dissecting microscope. The species of the larvae isolated were identified according to the method of Komiya and Tajimi (1941). The formula of the artificial gastric juice was as follows: diluted HCl 3.0 g, pepsin 0.3 g and distilled water 100.0 cc.

**Questionnaire:** Simple questions were asked to the residents in the County in order to assess the level of knowledge on digenetic trematodiasis. The questions were as follows.

Have you ever eaten raw fresh-water fish?

How frequently have you eaten the raw fish?

In which season did you eat the fish the most frequently?

Do you know the possibility that you can be infected with distomate flukes by ingesting the raw flesh?

If you have eaten the flesh even though you know the possibility, what is the reason?

**Chemotherapy:** The residents infected with *C. sinensis* were given praziquantel with the dose of 25 mg per kg of body weight twice a day, and those with *Metagonimus* sp. were 30 mg per kg once.

**Statistical analysis of results:** The results were analysed with  $\chi^2$  test, paired t-test and multiple regression.

## RESULTS

Table 1 presents the prevalence of helminthic infection among 955 residents of Yongyang County, Kyungpook Province. One hundred and seventy-seven (18.5%) of residents were found to be infected with one or more kinds of helminthes.

Among single species infection, the prevalence of metagonimiasis was the highest, being 7.7%, and the of clonorchiasis was the second, 7.3%. The prevalence of fascioliasis, hookworm infection and trichuriasis was low being 0.2, 0.5 and 0.1%, respectively. Twenty five residents

**Table 1.** Prevalence of helminthic infection among 955 residents of Yongyang county, Kyung-pook Province, Korea(1990)

Helminthes	No. infected	Prevalence (%)
<i>Clonorchis sinensis</i>	70	7.3
<i>Metagonimus</i> sp.	74	7.7
<i>Fasciola</i> sp.*	2	0.2
Hookworm	5	0.5
<i>Trichuris trichiura</i>	1	0.1
Double infection <i>C. sinensis</i> & <i>Metagonimus</i> sp.	24	2.5
<i>C. sinensis</i> & <i>T. trichiura</i>	1	0.1
Total	177	18.5

\*One of which was regarded as a false infection.

(2.6) examined were found to be parasitized by two kinds of helminthes, twenty-four infected doubly with *C. sinensis* and *Metagonimus* sp. and only one infected with *C. sinensis* and

whipworms.

Table 2 shows the sex and age group related prevalence of clonorchiasis among 95 residents including 25 doubly infected. Clonorchiasis was found to be significantly more prevalent in males, 12.6% than in females, 3.6% ( $p < 0.05$ ). The residents of age over 30 years were more prevalent than those under 30. The highest prevalence in males was 17.4% in 60~69 years' age group, whereas in females the highest prevalence was in 20~29 years' age group, being 8.0%. No one of either sex among 10~19 years' age group was found to be infected.

The prevalence of metagonimiasis among 98 residents was significantly higher in males, 12.0%, than in females, 6.1% ( $p < 0.05$ ) (Table 3). The residents over 30 years of age were more infected than those below that age. The prevalence in males was the highest in 60~69

**Table 2.** Prevalence of *Clonorchis sinensis* infection in Yongyang county by sex and age groups(1990)

Age group	Male			Female			Total		
	No. exam.	No. inf.	% inf.	No. exam.	No. inf.	% inf.	No. exam.	No. inf.	% inf.
0~9	19	1	5.3	21	0	0	40	1	2.5
10~19	26	0	0	20	0	0	46	0	0
20~29	63	2	3.2	25	2	8.0	88	4	4.5
30~39	158	22	13.9	63	1	1.6	221	23	10.4
40~49	168	25	14.9	56	3	5.4	224	28	12.5
50~59	178	25	14.0	61	4	6.6	239	29	12.1
60~69	46	8	17.4	29	0	0	75	8	10.7
70~	17	2	11.8	5	0	0	22	2	9.1
Total	675	85	12.6	280	10	3.6	955	95	9.9

**Table 3.** Prevalence of *Metagonimus* sp. infection in Yongyang county by sex and age groups(1990)

Age group	Male			Female			Total		
	No. exam.	No. inf.	% inf.	No. exam.	No. inf.	% inf.	No. exam.	No. inf.	% inf.
0~9	19	1	5.3	21	0	0	40	1	2.5
10~19	26	0	0	20	0	0	46	0	0
20~29	63	3	4.8	25	3	12.0	88	6	6.8
30~39	158	23	14.6	63	7	11.1	221	30	13.6
40~49	168	21	12.5	56	2	3.6	224	23	10.3
50~59	178	20	11.2	61	3	4.9	239	23	9.6
60~69	46	11	23.9	29	1	3.4	75	12	16.0
70~	17	2	11.8	5	1	20.0	22	3	13.6
Total	675	81	12.0	280	17	6.1	955	98	10.3

**Table 4.** Sex and age groups related to intensity of infection with *C. sinensis* based on Stoll's egg counting method among residents(1990)

Age group	Male			Female			Total		
	No. inf.	Sum EpG*	Mean EpG	No. inf.	Sum EpG	Mean EpG	No. inf.	Sum EpG	Mean EpG
0~9	1	200	200	0	0	0	1	200	200
10~19	0	0	0	0	0	0	0	0	0
20~29	2	19,000	9,500	2	300	150	4	19,300	4,825
30~39	22	41,500	1,886	1	1,000	1,000	23	42,500	1,848
40~49	25	58,300	2,332	3	1,300	433	28	59,600	2,129
50~59	25	159,000	6,360	4	7,200	1,800	29	166,200	5,731
60~69	8	12,900	1,612	0	0	0	8	12,900	1,613
70~	2	8,000	4,000	0	0	0	2	8,000	4,000
Total	85	298,900	3,516	10	9,800	980	95	308,700	3,249

\* EpG means number of eggs per gram of feces.

**Table 5.** Sex and age groups related to intensity of infection with *Metagonimus* sp. based on Stoll's egg counting method among residents(1990)

Age group	Male			Female			Total		
	No. inf.	Sum EpG	Mean EpG	No. inf.	Sum EpG	Mean EpG	No. inf.	Sum EpG	Mean EpG
0~9	1	200	200	0	0	0	1	200	200
10~19	0	0	0	0	0	0	0	0	0
20~29	3	5,800	1,933	3	900	300	6	6,700	1,117
30~39	23	25,300	1,100	7	1,100	157	30	26,400	880
40~49	21	36,900	1,757	2	700	350	23	37,600	1,635
50~59	20	20,800	1,040	3	1,200	400	23	22,000	957
60~69	11	8,400	764	1	100	100	12	8,500	708
70~	2	300	150	1	100	100	3	400	133
Total	81	97,700	1,206	17	4,100	241	98	101,800	1,039

years' age group, being 23.9%, whereas in female the highest was in the over 70 years' age group, being 20.0%. No one of either sex among 10~19 years' age group was found to be infected.

Table 4 presents sex and age group related intensity of clonorchiasis based on the Stoll's egg counting method. The intensity was heavier in males than in females. The mean number of the eggs per gram of feces in males was 3,516 while that in females was 980. No close association was found between the intensity and the age group. At any rate, the highest EpG was encountered in the 50~59 years' age group without regard to sex.

Table 5 presents sex and age group related intensity of metagonimiasis based on the Stoll's egg counting method. The intensity was found to be heavier in males than in females. The mean number of the eggs per gram of feces in males was 1,206 while that in females was 241. No close association was found between the intensity and age group. The highest EpG was encountered in 40~49 years' age group, with the mean of 1,635.

Table 6 and Fig. 2 shows the distribution frequency by intensity of clonorchiasis according to sex and age group. Thirty nine (45.9%) of 85 males were regarded to be lightly infected, 38(44.7%) moderately infected, and 8(9.4%),

**Table 6.** Distribution of intensity of infection with *C. sinensis* among residents by sex and age groups

Age group	Male			Female			Total(%)		
	Light*	Moderate#	Heavy <sup>o</sup>	Light	Moderate	Heavy	Light	Moderate	Heavy
0~9	1	0	0	0	0	0	1(100)	0	0
10~19	0	0	0	0	0	0	0	0	0
20~29	1	0	1	2	0	0	3(75.0)	0	1(25.0)
30~39	11	9	2	0	1	0	11(47.8)	10(43.5)	2( 8.7)
40~49	9	14	2	2	1	0	11(39.3)	15(53.6)	2( 7.1)
50~59	12	10	3	1	3	0	13(44.8)	13(44.8)	3(10.2)
60~69	4	4	0	0	0	0	4(50.0)	4(50.0)	0
70~	1	1	0	0	0	0	1(50.0)	1(50.0)	0
Total	39	38	8	5	5	0	44	43	8
Percent	45.9	44.7	9.4	50.0	50.0	0	46.3	45.3	8.4

\*Light: EpG count between 100 and 900.

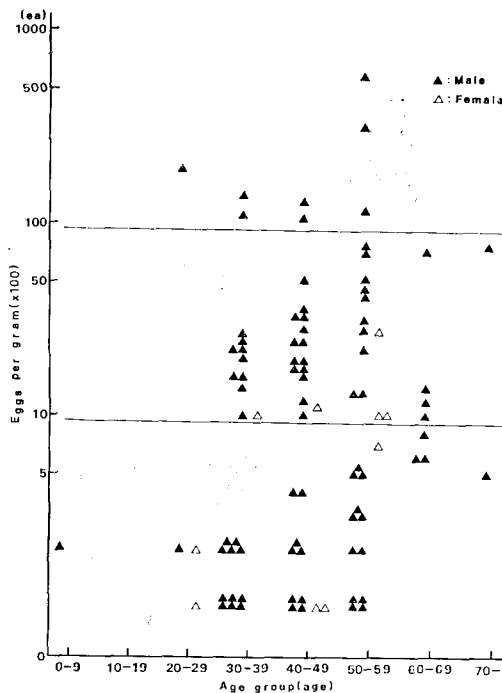
#Moderate: EpG count between 1,000 and 9,900.

<sup>o</sup>Heavy: EpG count over 10,000.

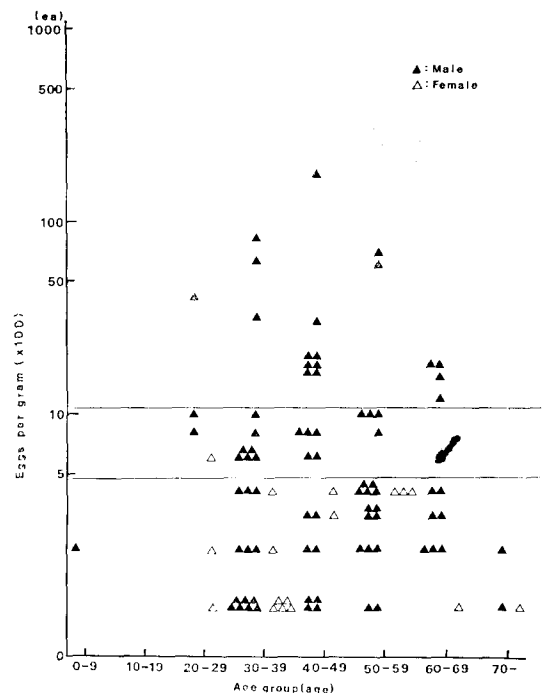
aged between 20 and 59, in heavily infected. Five (50.0%) out of 10 females were regarded as lightly infected, the the other five in moderately infected.

Table 7 and Fig. 3 shows frequency distribution by intensity of metagonimiasis according

to sex and age group. Forty-four (54.3%) out of 81 infected males were regarded to be lightly infected, 18 (22.2%) moderately infected, and 19 (23.5%), aged between 20 and 69, in heavily infected. Sixteen (94.1%) out of 17 infected females were regarded as lightly infected, and



**Fig. 2.** Intensity of infection with *C. sinensis* by sex and age groups.



**Fig. 3.** Intensity of infection with *Metagonimus* sp. by sex age groups.

**Table 7.** Distribution of intensity of infection with *Metagonimus* sp. among residents by sex and age groups

Age group	No. males			No. females			No. total(%)		
	Light*	Moderat#	Heavy <sup>o</sup>	Light	Moderate	Heavy	Light	Moderate	Heavy
0~ 9	1	0	0	0	0	0	1(100)	0	0
10~19	0	0	0	0	0	0	0	0	0
20~29	0	2	1	2	1	0	2(33.3)	3(50.0)	1(16.7)
30~39	13	7	3	7	0	0	20(66.7)	7(23.3)	3(10.0)
40~49	8	5	8	2	0	0	10(43.5)	5(21.7)	8(34.8)
50~59	14	4	2	3	0	0	17(73.9)	4(17.4)	2( 8.7)
60~69	7	0	4	1	0	0	8(66.7)	0	4(33.3)
70~	2	0	0	1	0	0	3(100)	0	0
Total No.	45	18	18	16	1	0	61	19	18
Proportion (%)	55.6	22.2	22.2	94.1	5.9	0	61.2	19.4	18.4

\*Light: EpG count between 100 and 500.

#Moderate: EpG count between 600 and 1,000.

<sup>o</sup>Heavy: EpG count over 1,000.

**Table 8.** Prevalence and intensity of infection with *C. sinensis* according to administrative districts of Yongyang county(1990)

District (Myon)	No. examined*			No. <i>C. sinensis</i> positive**(%)			Total EpG	Mean EpG
	Male	Female	Total	Male	Female	Total		
Yongyang	198	68	266	28(14.1)	5(7.4)	33(12.4)	74,600	2,261
Ilwol	38	11	49	11(28.9)	1(9.1)	12(24.5)	36,700	3,058
Subi	145	86	231	4( 2.8)	0(0)	4( 1.7)	8,200	2,050
Ibam	172	87	259	33(19.2)	3(3.4)	36(13.9)	181,300	5,036
Chonggi	122	28	150	9( 7.4)	1(3.5)	10( 6.7)	7,900	790
Total	675	280	955	85(12.6)	10(3.6)	95( 9.9)	308,700	3,249

\*Number of residents examined.

\*\*Number of residents infected with *C. sinensis*.

**Table 9.** Prevalence and intensity of infection with *Metagonimus* sp. according to the administrative districts of Yongyang county(1990)

District (Myon)	No. examined*			No. <i>Metagonimus</i> sp. positive**(%)			Total EpG	Mean EpG
	Male	Female	Total	Male	Female	Total		
Yongyang	198	68	266	17( 8.6)	1( 1.5)	18( 6.8)	17,000	944
Ilwol	38	11	49	4(10.5)	1( 9.1)	5(10.2)	2,400	480
Subi	145	86	231	24(16.6)	10(11.6)	34(14.7)	39,200	1,153
Ibam	172	87	259	23(13.4)	5( 5.7)	28(10.8)	26,900	928
Chonggi	122	28	150	13(10.7)	0(0)	13( 8.7)	16,300	1,254
Total	675	280	955	81(12.0)	17( 6.1)	98(10.3)	101,800	1,039

\*Number of residents examined.

\*\*Number of residents infected with *Metagonimus* species.

the only one(5.9%) moderately infected.

Remarkable differences were found in the

prevalence and intensity of the infections from

district to district(Tables 8 & 9). Residents in

**Table 10.** Fresh water fish collected in the Panbyon river, Yongyang County(1990)

Species	Common name	Korean name	Length (cm)	Weight(g)
<i>Coreoperca herzi</i> Herzenstein	Perch	꺽 지	7.2~21.4	6.3~140.0
<i>Coreoleuciscus splendidus</i> Mori	Korean chub	쉬 리	7.9~10.9	3.6~ 11.0
<i>Gnathopogon atromaculatus</i> N et P*	Korean shiner	문 개	7.0~ 9.2	2.6~ 4.6
<i>Microphysogobio koreensis</i> Mori	Sandy fish	모래 주사	8.1~ 9.0	4.3~ 6.2
<i>Odontobutis obscura</i> (T et S**)	Dark sleeper	동 사 리	7.5~10.5	5.0~ 12.5
<i>Pungtungia herzi</i> Herzenstein	Striped shiner	뽕 고 기	7.3~14.3	3.2~ 31.2
<i>Zacco platypus</i> (T et S)	Pale chub	피 래 미	6.3~ 8.0	2.0~ 4.5
<i>Zacco temmincki</i> (T et S)	Dark chub	갈 기 니	5.9~14.5	2.4~ 36.0

\*N et P means Nichols et Pope.

\*\*T et S means Temminck et Schlegel.

**Table 11.** Incidence and intensity of infestation with *C. sinensis* and *Metagonimus* sp. metacercariae in fresh-water fish collected in the river Panbyon(1990)

Species	No. fish exam.	No. (%) infested		Mean No. Mc/g*	
		<i>C. sinensis</i>	<i>Metagonimus</i>	<i>C. sinensis</i>	<i>Metagonimus</i>
<i>Coreoperca herzi</i>	90	0	0	0	0
<i>Coreoleuciscus splendidus</i>	51	0	0	0	0
<i>Gnathopogon atromaculatus</i>	43	10(23.3)	0	2.1	0
<i>Microphysogobio koreensis</i>	65	0	0	0	0
<i>Odontobutis obscura</i>	74	0	5(6.8)	0	0.2
<i>Pungtungia herzi</i>	140	0	0	0	0
<i>Zacco platypus</i>	56	0	31(55.4)	0	1.3
<i>Zacco temmincki</i>	275	0	158(57.5)	0	12.4

\*Mc/g means number of metacercariae per gram of flesh.

Subi Myon revealed the highest prevalence and mean EpG count for metagonimiasis, but the lowest prevalence and relatively low mean EpG count for clonorchiasis. Those in Ilwol and Ibam Myons, revealing relatively high mean EpG count for clonorchiasis, showed low EpG count for metagonimiasis. The mean EpG count for clonorchiasis was lowest while that for metagonimiasis was highest in the residents in Chonggi Myon. The residents in Yongyang Eop showed intermediary EpG count for both fluke infection.

Eight kinds of fresh-water fish were collected in the river Panbyon (Table 10). The most commonly collected species was *Zacco temmincki*, followed by *Pungtungia herzi*, *Coreoperca herzi*, the perch, *Odontobutis obscura*, the dark sleeper, *Microphysogobio koreensis*, the sandy fish, *Zacco platypus*, *Coreoleuciscus splendidus*, the Korean

chub, and *Gnathopogon atromaculatus*, the Korean shiner.

*C. sinensis* metacercaria was demonstrated from the flesh of *G. atromaculatus* alone, with the rate of 23.3% and the intensity of 2.1 cysts per gram of the flesh. On the other hand, *Metagonimus* sp. metacercaria was detected from the flesh of *Z. temmincki*, *Z. platypus* and *O. obscura*. The incidence and intensity were the highest in *Z. temmincki*, 57.5% and 12.4 cysts per gram, followed by *Z. platypus*, 55.4% and 1.3 cysts and *O. obscura*, 6.8% and 0.2 cysts (Table 11).

Table 12 and figure 4 show the incidence and intensity of infestation with *C. sinensis* metacercaria from *G. atromaculatus* by locality. The metacercaria failed to be demonstrated from the fish caught at Subi area. The rates from fish

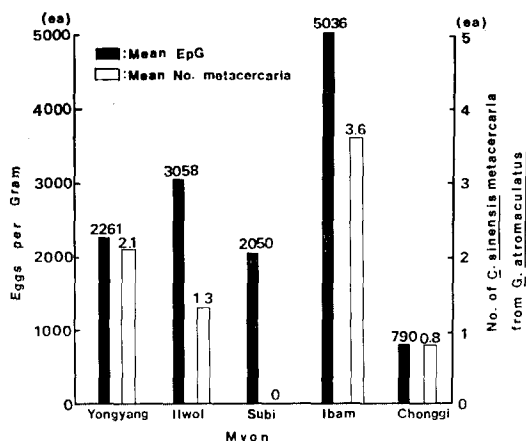


**Table 12.** Rate and intensity of infestation with *C. sinensis* metacercariae from *G. atromaculatus* by locality

Locality	No.(%) fish		Mean No. Mc/g
	exam.	inf.	
Yongyang	19	3(15.8)	2.1
Ilwol	4	1(25.0)	1.3
Subi	1	0	0
Ibam	13	4(30.8)	3.6
Chonggi	6	2(33.3)	0.8
Total	43	10(23.3)	2.1

**Table 13.** Rate and intensity of infestation with *Metagonimus* sp. metacercariae from *Z. temmincki* by locality

Locality	No.(%) fish		Mean No. Mc/g
	exam.	inf.	
Yongyang	33	26(78.8)	8.2
Ilwol	20	5(25.0)	0.3
Subi	106	106(100)	30.0
Ibam	83	51(46.4)	1.1
Chonggi	33	8(24.2)	0.4
Total	275	158(57.5)	12.4

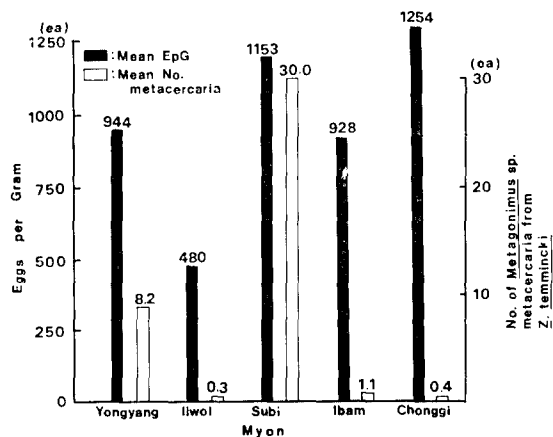


**Fig. 4.** Association of intensity of *C. sinensis* infection in residents with infestation of fish host by area.

collected in the other areas were between 15.8 and 33.3%. The intensity ranged from 0.8 to 3.6 cysts per gram of the fish flesh.

Table 13 and Fig. 5 show the incidence and intensity of infestation with *Metagonimus* sp. metacercariae from *Z. temmincki* by locality. The incidence was the highest in the fish caught at Subi area, 100%, followed by Youngyang area, 78.8%, Ibam area, 46.4%, Ilwol area, 25.0%, and Chonggi area, 24.2%. The intensity was also the highest in the fish collected in Subi area, 30.0 cysts, followed by Yongyang area, 8.2 cysts, and Ibam area, 1.1 cysts per gram of flesh. The intensity in Chonggi and Ilwol areas was low, 0.4 and 0.3 cysts, respectively.

Fig. 6 shows a significantly close association of semi-quantitative formalin-ether sedimentation



**Fig. 5.** Association of intensity of *Metagonimus* sp. infection in residents with infestation of fish host by area.

method with Stoll's dilutional egg counting method ( $p < 0.001$ ).

## DISCUSSION

In Kyungpook Province, the infection rate of clonorchiasis in residents, in general, has been thought to be high based on the high infestation rates and intensity of metacercariae in freshwater fish and the residents' habit of eating raw fish as a delicacy(Choi *et al.*, 1976). In contrast, *Metagonimus* sp. infection has not been known to be prevalent in the Province except in coastal areas(Seo *et al.*, 1981) in which *Plecoglossus altivelis*, the sweetfish are abundant. Prevalence of helminthiasis was, in the present study, 18.5% among residents examined,

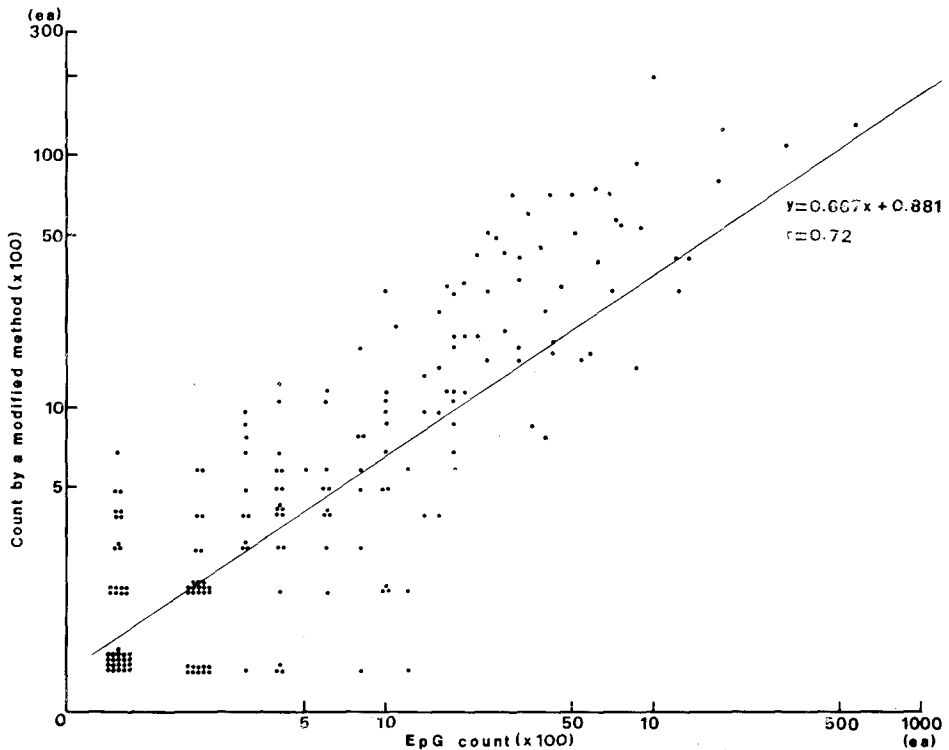


Fig. 6. Relationships between EpG count by Stoll's method and count by a modified method.

Among the helminthiasis, clonorchiasis (7.3%) and metagonimiasis (7.7%) were prevalent in the surveyed area. On the other hand, such soil-transmitted nematodiasis as ascariasis, trichuriasis, and hookworm infection were very low in their prevalences (0.7%). The reason for this is that periodic mass treatment as well as abstention from use on night soil fertilizer have reduced the incidence of the nematodiasis. Recently, in fact, it has been very difficult to demonstrate nematode eggs or larvae from vegetables (Choi *et al.*, 1990d). However, the prevalence of trematodiasis (17.9%) was found to remain high although the rate was found to have decreased compared with those reported by Choi *et al.* (1976).

Choi *et al.* (1976) carried out a survey on clonorchiasis in 6 Counties including Youngyang, Kyungpook Province. In that survey, the prevalence was 16.1% in 1,724 residents. The rates

in Yongchon, Uisong, Andong, Chongsong, and Sangju Counties were reported to be 22.8, 30.0, 7.1, 8.6, and 18.2%, respectively. Choi (1978) reported 13.4% in Seongju County. Seo *et al.* (1981) reported that the prevalence of metagonimiasis in Andong, Kumi, and Chilgok area of Kyungpook Province ranged from 0 to 0.5%. The rate, 10.3%, of the present study is significantly higher than those of Nakdong riverside areas, 1.7% in average (Seo *et al.*, 1981).

As a matter of fact, among the residents examined, the number below 20 years' of age was 86 (9.0%) whereas those among population of Yongyang area is about 10,000 (25%). The incidences in these age groups were significantly low compared with the other age groups. The number of females examined also was much lower than the males, although the sex ratio in the County is 1:1. For these reasons, the real prevalences of clonorchiasis and metagonimiasis may

be a little lower than the results of the present study.

Lee *et al.* (1984) made an attempt to determine differential keys on the morphology of heterophyid eggs. Eggs of *Pygidiopsis summa* and those *Stellantchasmus falcatus* were distinguished with ease from those of *Metagonimus yokogawai*, *Heterophyes nocens* and *Heterophyopsis continua*. The latter three overlapped one another in the size. The eggs from even a species of heterophyid trematode varied in size and shape. In this reason, the specific diagnosis of heterophyid infection should be determined by the identification of adult flukes obtained after chemotherapy and purgation. However, it is extremely difficult to obtain and identify the adult flukes in mass survey. In the present survey, poor cooperation of the residents failed to identify the adult flukes of heterophyids although almost all of heterophyid eggs regarded as ones of *M. yokogawai*.

The helminthic eggs regarded as ones of *Fasciola* sp. were demonstrated from two residents, one regarded as a false infection caused by ingestion of raw liver of cattle, and the other as hepatic fascioliasis.

Among trematodiasis in the County, *Metagonimus* sp. infection was slightly more prevalent than the liver fluke infection, although the Panbyon River is an upper-stream tributary of the Nakdong River which has been known to be more enzootic with *C. sinensis* rather than *Metagonimus* sp. (Hwang and Choi, 1980; Kang *et al.*, 1984; Cho and Choi, 1984; Sohn *et al.*, 1987; Choi and Koo, 1988; Cho *et al.*, 1990; Choi *et al.*, 1990a & b). This seemed to be caused by the altitude of the surveyed areas. Since the areas surveyed were of high altitude, 300~400 meters or more above sea level. The Panbyon River is running fast, and no *Pseudorasbora parva* and only a few *G. atromaculatus* were collected from the river. Demonstration of *C. sinensis* metacercariae from *P. herzi*, if collected relatively commonly, failed. *Z. temmincki*, collected the most commonly, was frequently and heavily infested by *Metagonimus* sp. metacercar-

iae. In particular, the residents of the upper stream basin, Subi Myon, were found to be infected more frequently with *Metagonimus* sp. than those of the lower stream basin, Yongyang Eop and Chonggi Myon. No close association was observed between the infestation rate of the fresh-water fish with the metacercariae and the prevalence of the infections in residents by area, and between the intensity of the infestation and that of infections by area (Figs. 4 & 5).

The infestation rate and the intensity of the fish hosts with *C. sinensis* metacercariae was much lower than with *Metagonimus* sp. metacercariae, although the infection rate of clonorchiasis in the residents, however, was as high as that of metagonimiasis. Moreover, the intensity of clonorchiasis (mean EpG, 3,249) was higher than that of metagonimiasis (mean EpG, 1,039). The longer infection period and the high egg-laying fecundity of *C. sinensis* in human hosts may contribute to the discrepancy.

Prevalences and intensity of clonorchiasis and metagonimiasis in males was found to be significantly higher and heavier than those in females ( $p < 0.05$ ). It seemed to be caused by more chances by the males to ingest raw fresh-water fish and by more disregard of the infections rather than by ignorance of the possibility to be infected by the flukes. The prevalences of both infections were lower in groups below 30 years than in those over 30 years. These results coincided with those reported previously (Kim *et al.*, 1971; Choi *et al.*, 1976; Seo *et al.*, 1981).

The fecundity of *C. sinensis* in human hosts has not been known accurately. That of *Metagonimus* sp. is also vague. Seo *et al.* (1981) suggested that the number of eggs per gram of feces per *M. yokogawai* counted after worm expulsion with anthelmintics varied from 4.0 to 18.2, and the number of eggs per day per *M. yokogawai* from 1,293 to 1,727. On the other hand, Ahn *et al.* (1981) reported that the number per day was estimated 35 to 45. The fecundity of flukes, in general, may be influenced by several factors, that is, number of flukes in

habitat, the species of host, the longevity of parasitism, and so on. The present author, for convenience's sake, divided the intensity of infection into 3 groups, light, moderate and heavy. Over 80% of residents were found to be infected slightly or moderately. For this reason, the infection rate may vary a little according to the sensitivity of the method applied in the surveys.

As the results of the questionnaires asked to the residents, 119 out of 210 residents (56.7%), answered that they had eaten raw fresh-water fish. Among those, ninety-one, 76.5% of fish-eaters, knew the possibility that they could be infected with distomate flukes by ingesting the raw fish. There were three major reasons given for eating the raw fish even though they knew the possibility of distomate infection. Forty-four answered that they thought the pathogenicity of the flukes to be very low. Twenty-seven answered excellent efficacy of praziquantel and 18 answered that they thought the fish caught at the river, free of the flukes because of its clear water. The remaining two gave miscellaneous reasons.

The semi-quantitative formalin-ether sedimentation method, in place of Stoll's dilutional egg counting method, was found to be also available in determination of the intensity of infection (Fig. 4), particularly in light or moderate infection. Compared with Stoll's method, the semi-quantitative determining the presence of the fluke eggs and the number on a slide glass simultaneously and within a short time, would be more applicable in mass survey of helminthiasis.

These results suggest that trematodiasis is still prevalent in Yongyang County, Kyungpook Province, and the prevalence may be much higher in the mid-stream area of the river Nakdong where fresh-water fish were found to be heavily infested with digenetic larval trematodes.

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### 慶北 英陽地域 吸蟲類 疫學調查

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慶北 英陽地域 住民들의 吸蟲類 感染實態와 第2 中間宿主 淡水魚의 吸蟲類 被囊幼蟲의 寄生狀을 糾明하기 爲 疫學調查를 施行하였다. 蟲卵檢査는 半定量的 formalin-ether 集卵法에 依據하였고 吸蟲類 蟲卵陽性者는 Stoll 氏 蟲卵計算法으로 感染程度를 推定하였다. 吸蟲類 被囊幼蟲의 寄生狀은 슬라이드 글라스 壓迫法과 人工消化法으로 調查하였다.

被檢者 955名中 18.5%(177名)에서 蠕蟲卵이 檢出되었고 그 中 吸蟲類 蟲卵은 肝吸蟲 單獨感染者 7.3%(70名), 異形吸蟲類 單獨感染者 7.7%(74名), 肝吸蟲과 異形吸蟲類 二重感染者 2.5%(24名), 肝吸蟲과 鞭蟲 二重感染者 0.1%(1名), 및 肝蛭 偽感染者 0.1%(1名)으로 17.9%(171名)에서 檢出할 수 있었다.

性別 肝吸蟲 感染은 男性 675名중 12.6%(85名), 女性 280名중 3.6%(10名)으로 男性에서 有意적으로 높았다. 異形吸蟲類 感染 역시 男性 675名中 12.0%(81名), 女性 280名中 6.1%(17名)으로 男性에서 有意적으로 높았다. 感染程度도 兩 吸蟲 모두 男性에서 女性보다 높았다. 年齡別로는 30歲 以上群에서 30歲 未滿群보다 심한 感染程度를 나타내었다. 10~19歲群에서는 兩 吸蟲類의 感染者가 없었다. 感染程度와 年齡사이에는 有意한 相關을 認定할 수 없었다.

半邊川에서 採集된 8種의 淡水魚中 橫川吸蟲 被囊幼蟲의 寄生率과 그 程度는 各各 갈거니에서 57.5%, 12.4個로 가장 높았고 동사리에서 6.8%, 0.2個로 가장 낮았으며 피래미에서 55.4%, 1.3개로 중간을 나타내었다. 肝吸蟲 被囊幼蟲은 물개에서만 寄生率 23.3%, 그 寄生程度 2.1個로 나타났다.

以上の 成績으로 미루어 보아 慶北 英陽地域은 肝吸蟲과 異形吸蟲類의 漫延地임을 알 수 있었다.

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