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Changing patterns of *Clonorchis sinensis* infections in Kyongbuk, Korea

Chong-Yoon JOO[1]*, Myung-Sook CHUNG[1], Sun-Jin KIM[1] and Chin-Moo KANG[2]

Department of Parasitology[1] and Department of Pediatrics[2], Keimyung University School of Medicine, 194 Tongsan-dong, Taegu, 700-712, Korea

Abstract: Studies were conducted from May, 1993 to April, 1995 to determine the changing patterns of infection by the liver fluke, *Clonorchis sinensis*, among residents and fish hosts in Kyongbuk Province. The infection rate among residents was 7.7% by stool examination. The rate in males (11.3%) was significantly higher than females (4.1%). Positive rate of intradermal test was 27.6% in the same population. The special type of a simple catalytic model was applied for the analysis of intradermal positive reactors by age and sex, and the equation was $y = 0.4776\ (1 - e^{-0.0375t})$ for males and, $y = 0.2085\ (1 - e^{-0.0138t})$ for females. Analysis of stool examination data by two-stage catalytic model revealed $y = 0.025\ (e^{-0.0047t} - e^{-0.0235t})$. The annual *Clonorchis* infection rate was 4.7 per 1,000 susceptibles and the annual loss rate was 23.5 per 1,000 infected. The frequency distribution by the eggs per gram (EPG) was calculated as well as the cumulative percentages of positives. The regression equations were $y = 0.929 + 1.506 \log x$ for males and, $y = 0.473 + 1.767 \log x$ for females. Of the 25 fish species, 7 species were infected with *Clonorchis* metacercariae. Infection rates varied by the species, and ranged from 2.8% in *Puntungia herzi* to 30.0% in *Pseudorasbora parva*. Average number of the matacercariae per gram of flesh was 58.1 in *P. parva*, followed by 10.2 in *Gnathopogon atromaculatus*, 7.0 in *Saurogobio dabryi*, and 3.0 in *Paracheilognathus rhombea*. The present study indicates that clonorchiasis in Kyongbuk Province is less prevalent than that of several decades ago.

Key words: prevalance, clonorchiasis, *Clonorchis sinensis*, catalytic model, epidemiology, Kyongbuk Province

INTRODUCTION

Human clonorchiasis has been known from the early twentieth century as an endemic parasitic disease in Korea, especially along the Nakdong-gang (River) and its tributaries. Considerable data relating to the endemic foci along the river were reported by many parasitologists after Matsumoto (1915) recorded first. In the 1950s, epidemiological studies on *C. sinensis* were made in an attempt to determine the prevalence in the intermediate and final hosts. Walton and Chyu (1959) reported 2,066 positive reactors among 9,771 individuals by intradermal test. Based on the data, 4.5 million inhabitants were estimated infected in Korea.

Since the beginning of the Saemaul movement in the early 1970s, the Korean Government instituted plans for control of human parasitic diseases by mass treatment, extensive public health education and sanitary agricultural practice. The control measure

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*Corresponding author

resulted in a gradual decrease in human helminthic infections and in the number of larval trematodes as well as a decrease in the distribution of the intermediate hosts. However, recent reports revealed that *Clonorchis* infection remains still high, especially in the some villages which locate near rivers, lakes and small ponds (Joo and Hong, 1991; Chung *et al.*, 1991; Lee, 1993; Hyun and Joo, 1994).

The present study was conducted to understand the changing pattern of the epidemiology and control of human clonorchiasis in Kyongbuk Province by comparing with some early data.

MATERIALS AND METHODS

Geographical features of surveyed areas

Kyongbuk Province is located in the southeastern part of the Korean peninsula, covering an area of 19,700 square kilometers. This Province can be divided into the western hills, the eastern coastal hills and the central lowland along valley of the Nakdong-gang (River) and its tributaries (Fig. 1). Seventy two villages and 8 primary schools near the river were included in the study.

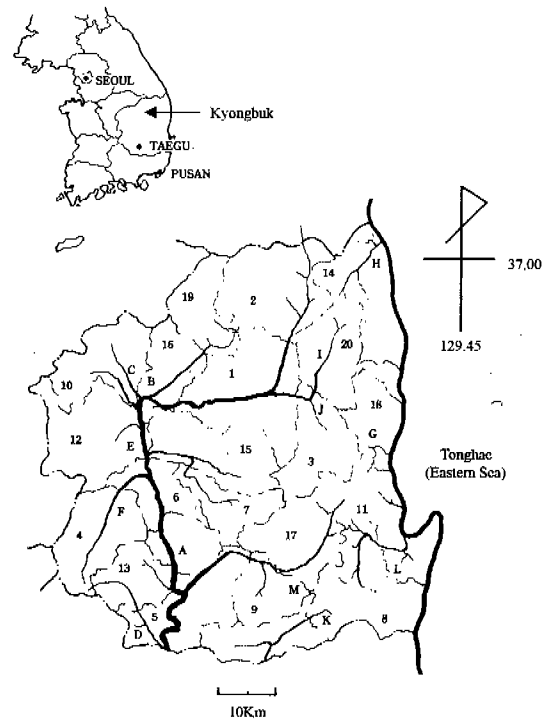

Fig. 1. Map showing the surveyed counties (1-20) and sites of fish collection (A-M) in Kyongbuk, Korea.

Survey of *C. sinensis* infections in residents

To evaluate degree of the prevalence among residents, intradermal test and stool examinations were conducted. Intradermal injections of 0.02 ml of 1:10,000 *Clonorchis* antigen (VBS) were made on the volar surface of the forearm. Wheals of average diameter of 9 mm or more in 30 minutes were considered as positive reactions.

The stool specimens were examined by the MGL technique. When *Clonorchis* eggs were detected, the Stoll s dilution egg-count technique was applied to estimate the intensity of infection.

The quantitative epidemiological analysis

The mathematical parameters were calculated when the observed data of age prevalence were applied to catalytic models of Muench (1959). The special type of a simple catalytic curve was fitted with age prevalence of intradermal positive reactors. To calculate a theoretical transmissibility, i.e., the force and disappearance of infection during the surveyed period, the two stage catalytic curve was applied to age prevalence data of stool examination.

To evaluate the levels of intensity of *C. sinensis* infections, EPG data were converted into a cumulative percentage. Using Bliss s probit table, the cumulative percentage was shown as a regression equation.

The fish host survey

Fresh-water fish were caught to determine the infection rate and the intensity for *Clonorchis* metacercariae. The fish were collected from localities of the Nakdong-gang (River) and its tributaries, streams, lakes and small ponds.

The specific name of the fish was determined using keys described by Chung (1977). One gram of flesh, 100 scales, all fins and the tail

were separated from each fish. The dissected tissues were compressed by two slides and examined under a binocular dissecting microscope (× 45).

Another method of examining intensity of metacercaial burden was used. Metacercariae were isolated by peptic digestion. One gram of flesh was mixed with artificial gastric juice (0.2 ml diluted hydrochloric acid + 0.3 g pepsin/100 ml distilled water), and then incubated at 37-38¡C for 30-40 minutes. After incubation, the mixture was stirred with a glass rod and allowed to stand for 10 minutes to gather the isolated metacercariae in the central portion of the beaker. In the sediment, *Clonorchis* metacercariae were counted under a dissecting microscope (× 100).

RESULTS

Table 1 shows the prevalence of *C. sinensis* among the residents in surveyed areas as revealed by stool examination. A total of 11,181 residents was examined with infection rate of 7.7%. The infection rates were 11.3% for males, and 4.1% for females. Except for in Pohang, the rates in male were higher than in female in all survey areas. The prevalence rates varied from 0.6% to 17.0% by area. In Songju, Andong and Koryong counties, the infection rates were higher, whereas in Pongwha, Kyongju and Yongyang counties the rates were below 4.0%.

The egg positive rates of *C. sinensis* were analysed by sex and age in Table 2. And the rate for groups below 19 years varied from 1.2 to 2.7% for males and from 0 to 2.2% for females.

The egg positive rate for males was always higher than that for females in all age groups over 20 years; it was 14.0% in males and 2.0% in females in the 25-29 year age group. The rate subsequently increased to the highest rate of 21.0% for males in the 45-49 year group, and of 7.8% for females in the 40-44 year group. In older males, the rate fluctuated and

Table 1. Prevalence of *Clonorchis sinensis* infections among residents of Kyongbuk by stool examination (1994)

Surveyed districts (county or city)	Male		Female		Total	
	No. of examined	positive rate (%)	No. of examined	positive rate (%)	No. of examined	positive rate (%)
1. Andong	525	21.7	473	7.0	998	14.7
2. Pongwha	317	1.0	314	0.3	631	0.6
3. Chongsong	158	11.4	119	2.5	277	7.6
4. Kimchon	220	8.6	213	2.4	433	5.5
5. Koryong	412	13.8	353	11.1	765	12.6
6. Kumi	271	17.0	267	3.7	538	10.4
7. Kunwie	336	18.8	346	3.5	682	11.0
8. Kyongju	570	4.0	626	2.8	1,186	3.4
9. Kyongsan	190	7.9	181	2.2	371	5.1
10. Munkyong	230	10.0	232	2.2	462	6.1
11. Pohang	161	5.6	221	8.1	382	7.1
12. Sangju	203	8.9	208	4.8	411	6.8
13. Songju	85	21.2	68	11.8	153	17.0
14. Ulchin	229	7.4	243	2.9	472	5.1
15. Wisong	578	12.6	463	4.1	1,041	8.8
16. Yechon	224	17.0	256	0.8	480	8.3
17. Yongchon	207	15.5	212	3.3	419	9.3
18. Yongdok	232	7.8	297	4.0	529	5.7
19. Yongju	218	9.2	256	3.1	474	5.9
20. Yongyang	229	3.9	248	2.4	477	3.1
Total	5,595	11.3	5,586	4.1	11,181	7.7

Table 2. Infection rate of *Clonorchis sinensis* among residents of Kyongbuk by sex and age groups by stool examination (1994)

Age group (year)	Male		Female		Total	
	No. of examined	positive rate (%)	No. of examined	positive rate (%)	No. of examined	positive rate (%)
0- 4	83	1.2	68	0	151	0.7
5- 9	682	1.3	629	1.1	1,311	1.2
10-14	864	1.5	840	0.8	1,704	1.2
15-19	331	2.7	315	2.2	646	2.5
20-24	199	3.0	151	1.3	350	2.3
25-29	129	14.0	155	1.9	284	7.3
30-34	277	15.2	308	3.3	585	8.9
35-39	346	16.5	339	6.2	685	11.4
40-44	360	15.8	360	7.8	720	11.8
45-49	349	20.9	363	5.5	712	13.1
50-54	493	18.7	500	6.0	993	12.3
55-59	526	19.0	543	5.5	1,069	12.2
60-64	390	18.2	418	6.7	808	12.3
65-69	272	17.7	280	5.0	552	11.2
70-74	174	16.1	152	5.9	326	11.4
75-79	83	8.4	112	5.4	195	6.7
80-	37	5.4	53	7.6	90	6.7
Total	5,595	11.3	5,586	4.1	11,181	7.7

abruptly decreased to 5.4% for males over 75 years. In older females, it remained between 5.0-7.0%. In Table 3, the rates of positive intradermal tests are shown. Of 2,300 individuals examined, 27.6% showed positive reactions. The percent of positive reactors increased with age until 45-49 years for males and 50-54 years for females, followed by a gradual decrease.

The special type of a simple catalytic curve was applied to the age prevalence of positive intradermal tests (Fig. 2). The values of the constant, which were estimated from the nomogram for the observed data, led to the equation of simple catalytic curve, $y = 0.4776 (1 - e^{-0.0375t})$ in males and $y = 0.2085 (1 - e^{-0.0138t})$ in females. From these equations, the forces of infection, the effective contacts giving rise to positive skin reaction per 1,000 residents annually, are 37.5 for males and 13.8 for females. The asymptotes are about 47.8% in male and 20.9% in female that estimated values of the limit of possible positive reactions.

The diagrams of two-stage catalytic model, based on age prevalence by egg positive rates of *C. sinensis* infections are shown in Fig. 3. For 1994 data, the two-stage catalytic curve was $y = 0.025 (e^{-0.0047t} - e^{-0.0235t})$. The value of constant a means the rate of contacts effective to produce egg positive cases; the force of new infections. It was 7.4 per annum per 1,000 in 1994 data. The value of the constant b was calculated to be 0.0235, indicating that the rate of disappearance (23.5 per annum per 1,000 infected). The maximum value of y occurred in

$$t = \frac{\ln b - \ln a}{b - a} = \frac{\log b - \log a}{b - a} \times 2.3026$$

$= 85.60$ years.

In 1964 data, the egg positive rate was 27.7%. The calculated value of the constant a was 0.0264 and b was 0.0214. Therefore, $y = 5.28 (e^{-0.0214t} - e^{-0.0264t})$, and the maximum value of y occurred in 42.0 years.

Table 4 shows the distribution pattern of cases when analysed by intensity of infection. The intensity of infection, expressed as eggs per gram (EPG) of feces, was divided into 1-999, 1,000-9,999, 10,000-29,999, and over

Table 3. Frequency distribution of intradermal positive reactors to *Clonorchis sinensis* antigen among residents of Kyongbuk by sex and age groups (1994)

Age group (year)	Male		Female		Total	
	No. of examined	positive rate (%)	No. of examined	positive rate (%)	No. of examined	positive rate (%)
0- 4	13	0	14	0	27	0
5- 9	22	4.6	18	0	40	2.5
10-14	28	7.1	24	4.2	52	5.8
15-19	10	10.0	12	8.3	22	9.1
20-24	30	26.7	19	5.3	49	18.4
25-29	27	44.4	37	5.4	64	21.9
30-34	62	41.9	86	14.0	148	25.7
35-39	107	39.3	103	12.6	210	26.2
40-44	137	49.6	137	13.1	274	31.4
45-49	117	52.1	106	19.8	223	36.8
50-54	155	51.0	157	21.0	312	35.9
55-59	140	47.1	176	11.4	316	27.2
60-64	109	40.4	148	14.9	257	25.7
65-69	82	42.7	77	9.1	159	26.4
70-74	49	36.7	43	16.3	92	27.2
75-	23	26.1	32	21.9	55	23.6
Total	1,111	42.2	1,189	13.9	2,300	27.6

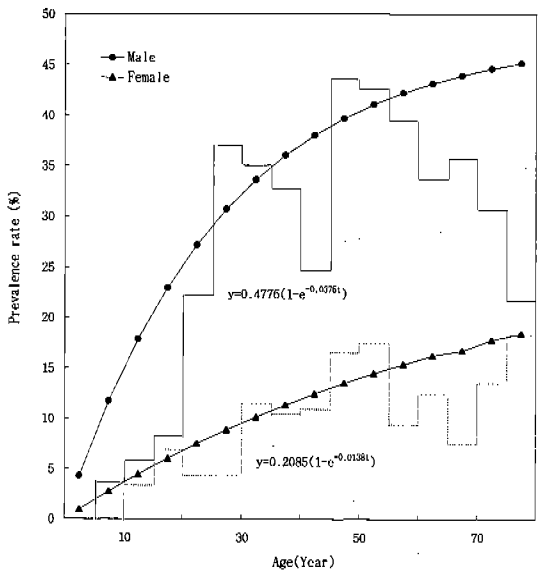

Fig. 2. Simple catalytic curves and histograms showing fraction of *Clonorchis* intradermal positives in Kyongbuk by age.

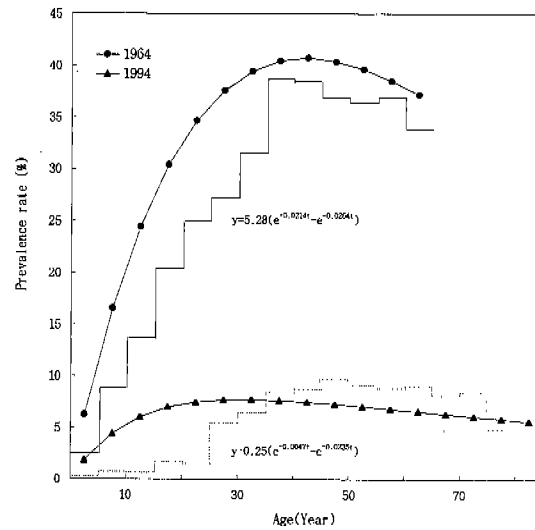

Fig. 3. Two-stage catalytic curves and histograms showing fraction of *Clonorchis* egg positives in Kyongbuk in 1964 and 1994.

30,000. The EPG was less than 999 in 247 males (73.3%) and 112 females (76.7%); 1,000-9,999 in 82 males (24.3%) and 34 females (23.3%).

Table 5 represents the case distribution by intensity of *Clonorchis* infections when analysed by sex and age. Two hundred forty-

Table 4. Intensity of *Clonorchis sinensis* infection by Stoll s egg-count technique among residents in Kyongbuk (1994)

Range of EPG (intensity)	Male		Female		Total	
	No. of infected	Proportion (%)	No. of infected	Proportion (%)	No. of infected	Proportion (%)
1-999	247	73.3	112	76.7	359	74.3
1,000-9,999	82	24.3	34	23.3	116	24.0
10,000-29,999	5	1.5	—	—	5	1.0
30,000-	3	0.9	—	—	3	0.6
Total	337	100	146	100	483	99.9

Table 5. Numerical distribution of intensity of *Clonorchis* infection among residents by sex and age groups (1994)

Age group (year)	Male				Female				Total			
	L[a]	M[a]	H[a]	Mean	L	M	H	Mean	L	M	H	Mean
0- 4	1	0	0	100	0	0	0	0	1	0	0	0
5- 9	3	0	0	400	2	0	0	150	5	0	0	300
10-14	5	0	0	460	4	1	0	400	9	1	0	430
15-19	2	2	0	3,575	3	1	0	1,000	5	3	0	2,288
20-24	3	2	0	2,200	0	1	0	1,700	3	3	0	2,133
25-29	5	0	0	460	3	0	0	433	8	0	0	450
30-34	17	10	0	1,148	5	1	0	900	22	11	0	1,103
35-39	18	9	1	1,850	7	4	0	964	25	13	1	1,600
40-44	32	14	2	2,806	11	7	0	1,061	43	21	2	2,330
45-49	23	7	3	3,464	13	1	0	414	36	8	3	2,555
50-54	45	8	0	930	18	3	0	529	63	11	0	818
55-59	34	7	2	1,435	14	9	0	1,013	48	16	2	1,288
60-64	25	11	0	1,647	12	5	0	965	37	16	0	1,202
65-69	20	5	0	924	13	0	0	362	33	5	0	732
70-74	11	5	0	906	3	1	0	700	14	6	0	865
75-79	3	2	0	2,260	3	0	0	767	6	2	0	1,700
80-	0	0	0	0	1	0	0	600	1	0	0	600
Total	247	82	8	1,728	112	34	0	763	359	116	8	1,436

[a]L, light infection, EPG count less than 1,000; M, moderate infection, EPG count between 1,001 and 10,000; H, heavy infection, EPG count over 10,001.

seven males (73.3%) and 112 females (76.7%) were observed lightly infected. Eight males (2.4%) between the age of 35 and 59 years had heavy infections. The mean EPG in 483 cases was 1,436. Mean EPG in males (1,728) was higher than in females (763).

The cumulative percentage of *Clonorchis* egg positive cases by EPG are shown in the log-probit scale (Fig. 4). Of 483 cases examined, the regression equation was y = 0.804 + 1.579 log x. The intensity of *C. sinensis* infections ($Cs.D_{50}$) was 2.657. The regression equation was y = 0.929 + 1.506 log x in males and y = 0.473 + 1.767 log x in females. $Cs.D_{50}$ for males and females were 2.703 and 2.562, respectively.

Twenty-three species of fresh-water fish and two species of brackish-water fish were collected from the Nakdong-gang (River) and its tributaries, streams or small ponds (Fig. 1).

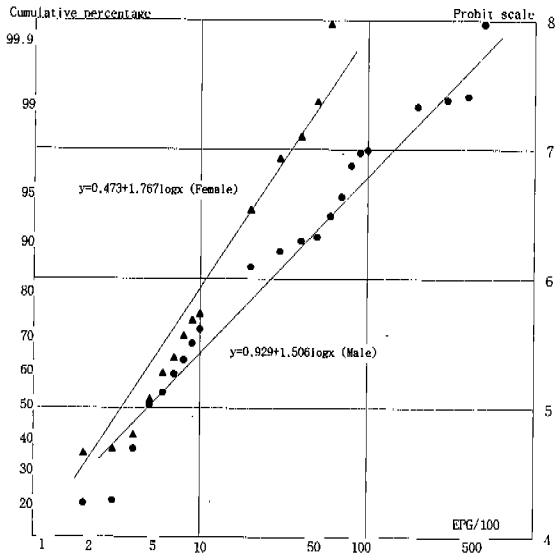

Fig. 4. Regression lines of the cumulative percentage of *C. sinensis* egg positive cases against EPG intensity in log-probit scale for residents of Kyongbuk.

Of these, *C. carassius*, *Z. platypus*, *Z. temmincki*, *P. herzi* and *G. atromaculatus* are the most frequently collected. Common freshwater fish such as *C. splendidus*, *C. carpio*, *H. labeo*, *S. czerskii* and *M. chinensis*, are less frequently met in the present survey. No *E. erythropterus*, *M. koreensis* and *S. japonica* were collected.

Table 6 lists the infection rates and intensities of *Clonorchis* metacercariae. Seven of 25 species examined were infected in their flesh. *P. parva* was the most frequeatly infected (30.0%), followed by *P. rhombea* (14.3%), *G. atromaculatus* (13.8%) *P. esocinus* (10.5%), *S. dabryi* (10.5%), *H. longirostris* (7.1%) and *P. herzi* (2.8%).

The intensity of *C. sinensis* metacercariae, expressed as the average number per gram of flesh, was variable. *P. parva* was the most heavily infected (average number of cysts 58.1). *G. atromaculatus* and *S. dabryi* were moderately infected with an average number of 10.2 and 7.0, respectively. *H. longirostris*, *P. herzi*, *P. rhombea* and *P. esocinus* were low infected with an average number of 1.5, 2.5, 3.6, and 1.5, respectively.

DISCUSSION

Although markedly changed, the results of this study indicate that clonorchiasis is still one of the most important parasitic diseases in many parts of Kyongbuk Province. Egg positive rate was as high as 7.7% and the positive rate by intradermal tests was 27.6% in this study. The data of intradermal tests were comparable with those of previous reports in the province; 27.9% by Shin (1964) and 19.6% by Choi *et al.* (1976). However, egg positive rate was markedly lowered. In addition to the changing rates, it should be kept in mind that the present survey population are representing population of Kyongbuk differently from those of the earlier studies. The subjected population of Shin (1964) and Choi *et al.* (1976) represented a majority of contemporary rural population in Kyongbuk. Sample areas of the present study come from almost same areas as the earlier studies, where fresh-water fish could be collected. In other words, the sample areas in this study were confined in ecologically preserved areas. Problem is that during the past 20 years the population have shifted from rural to urban areas, and that ecology in many previous rural areas has been damaged. Therefore the subjected people in the present survey represent less proportion of whole Kyongbuk. If we include the people living in the ecologically labile areas such as urban areas, the rates would be certainly lower. Few data of intradermal tests are available especially in a large scale survey in general population in Kyongbuk Province. However, stool examination data in Taegu and Kyongbuk Province in the fifth national parasite survey (1992) revealed 0.2% and 2.7% of egg positive rates, respectively. The result of the present study, together with that of the national survey, suggest that the clonorchiasis is slowly changing its endemicity in the ecologically preserved areas. In the ecologically labile areas, people are presumed to get the infection by going to the endemic foci for fishing *etc.*

As Chung *et al.* (1980) had shown, the density of the vector snail of *Clonorchis sinensis* and cercarial infection in the snail have been gradually reduced in Kyongbuk

Table 6. Infection rate and intensity of *Clonorchis* metacercariae in fresh-water fish collected from Kyongbuk, Korea (1994)

Species of fish	No. of fish examined	No. of positive[a]	Positive rate (%)	Average No. of metacercariae/g of flesh
Carassius carassius	301	0	—	0
Coreoleucicus splendidus	5	0	—	0
Cyprinus carpio	2	0	—	0
Culter brevicauda	20	0	—	0
Hemibarbus labeo	2	0	—	0
H. logirostris	28	2	7.1	1.5 (1-2)
Gnathopogon atromaculatus	87	12	13.8	10.2 (1-32)
Pseudorasbora parva	30	0	30.0	58.1 (3-155)
Pungtungia herzi	143	4	2.8	2.5 (1-5)
Moroco oxycephalus	36	0	—	0
Zacco platypus	309	0	—	0
Z. temmincki	210	0	—	0
Acheilognathus intermedia	21	-	—	0
Paracheiognathis rhombea	35	5	14.3	3.6 (2-9)
Pseudogobio esocinus	19	2	10.5	1.5 (1-2)
Saurogobio dabryi	38	4	10.5	7.0 (1-17)
Sarcocheilichthys czerskii	3	0	—	0
Parasilurus asotus	18	0	—	0
Coreoperca herzi	62	0	—	0
Mogurnda obscura	77	0	—	0
Coreobagrus brevicorpus	31	0	—	0
Lepiomis macrochirus	7	0	—	0
Macropodus chinensis	6	0	—	0
Plecoglossus altivelis	52	0	—	0
Mugil cephalus	7	0	—	0

[a]The metacercariae were recovered only from flesh, not from fin and scale.

Province together with habitat reduction. The main cause of these reductions is water pollution by industrial and household wastes. Other causes are sprayed insecticides and pesticides for cultivating new breed of rice (Joo and Hong, 1991) and land reclamation.

In addition to the vector snail reduction, the changing attitute of people toward eating raw and undercooked fish has been regarded as another factor in the changing endemicity (Lee, 1993; Hyun and Joo, 1994). However, the declining speed of infection is slow as shown in this study. Popular use of praziquantel for treating clonorchiasis is certainly another cause of lowering endemicity.

As analysed in Fig. 2, every 37.5 male or 13.8 female inhabitants in the survey areas turned to intradermal positives every year per 1,000 population. The sex-related difference of *Clonorchis* infection has long been well known in Korean population especially in adults (Joo, 1980 & 1984b; Chung *et al.*, 1991; Joo and Hong, 1991; Lee, 1993; Hyun and Joo, 1994). We have shown the difference by applying the parameter, the force of effective infection of Muench (1959).

In clonorchiasis, age prevalence data in the endemic areas have been analysed by two-stage catalytic model of Muench (1959) using stool examination data (Song *et al.*, 1979; Song *et al.*, 1983; Rim, 1986; Lee, 1993; Hyun and Joo, 1994; Kwak, 1994). In the present study, the force of transmission was 4.7 per 1,000 susceptibles causing egg passing infections while 23.5 per 1,000 infected turned to the free from infection every year. When compared with the calculated parameters from data of Shin (1964), the force of transmission

was reduced from 21.4 per 1,000 susceptibles in 1964 to 4.7 in this study. This parameter indicates the changing patterns of during the past 30 years.

Since Kang (1972) applied probit analysis for the cumulative frequency data of EPG in *Clonorchis* infected population, the analysis has been repeated in different endemic areas (Rim, 1986; Lee, 1993; Hyun and Joo, 1994; Kwak, 1994). In the present analysis, the regression equation was $y = 0.804 + 1.579 \log x$. Fifty percent level of EPG was 2.657. These data of worm burden estimation revealed that the frequency of heavy infections are not uncommon in the endemic areas of Kyongbuk (Table 4).

Number of fish species distributing in an area, number of infected fish species with *C. sinensis* metacercariae and their infection rate and burden are parameters determining the degree of ecological damage and the potentiality of *C. sinensis* transmission to final hosts including human. In the present survey, 25 species of fresh-water fish were identified. Of them, 7 species were found infected with *C. sinensis* metacercariae. When compared with previously reported data in Kyongbuk (Shin, 1964; Choi *et al.*, 1976; Hwang and Choi, 1980; Joo, 1984a; Lee *et al.*, 1992), all of the above parameters concerning fresh-water fish and metacercarial infections are similar except for the infection rate in the fish. In wide areas in Kyongbuk, the ecology, suitable for *Clonorchis* transmission, is well preserved as shown in this study. Whether this good environment for the sake of *Clonorchis* will shrink or widen should be observed in the future. For a continuous declining of human clonorchiasis in the well preserved ecology, the programs of health education and praziquantel treatment are necessary to be amplified.

REFERENCES

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

Choi DW, Ahn DH, Choy CH, Kim SS (1976) *Clonorchis sinensis* in Kyungpook Province, Korea 3. Changing pattern of *Clonorchis sinensis* infection among inhabitants. *Korean J Parasitol* **14:** 117-122.

Chung BJ, Joo CY, Choi DW (1980) Seasonal variation of snail population of *Parafossarulus manchouricus* and larval trematode infection in river Kumho, Kyungpook Province, Korea. *Korean J Parasitol* **18:** 54-64.

Chung DI, Kim TI, Lee KR, Choi DW (1991) Epidemiological studies of digenetic trematodes in Yongyang county, Kyungpook Province. *Korean J Parasitol* **29:** 325-338.

Chung MK (1977) The fishes of Korea. Ilchi Publ Co Seoul.

Hwang JT, Choi DW (1980) Changing patterns of infestation with larval trematodes from resh-water fish in River Kumho, Kyungpook Province, Korea. *Kyongbuk Univ Med J* **21:** 460-475.

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

Joo CY (1980) Epidemiological studies of *Clonorchis sinensis* in vicinity of River Taewha, Kyongnam Province, Korea. *Korean J Parasitol* **18:** 199-214.

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

Joo CY (1984b) Recent patterns of intestinal helminth infections among the residents in Taegu City, Korea. *Korean J Parasitol* **22:** 109-155.

Joo CY, Hong YA (1991) Epidemiological studies of *Clonorchis sinensis* in the vicinity of River Ahnseong, Kyungpook Province, Korea. *Jpn J Parasitol* **40:** 542-552.

Kang SY (1972) An epidemiological analysis of the clonorchiasis in an area of North Choong Chong Do (= province). *Korean J Publ Hlth* **9**(1): 105-112.

Kwak KW (1994) Epidemiological studies of *Clonorchis sinensis* in the vicinity of Cheongdo River, Kyungpook, Korea. Theses Graduate School Keimyung Univ, 1-41.

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

Lee SH (1993) Epidemiological studies of

Clonorchis sinensis in the coastal areas of Kyungpook, Korea. Theses Graduate School Keimyung Univ, 1-27.

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

Muench HO (1959) Catalytic models in epidemiology (Monograph). Harvard Univ Press.

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

Rim HJ (1986) The current pathobiology and chemotherapy of clonorchiasis. *Korean J Parasitol* **24**(Suppl.): 1-131.

Shin DS (1964) Epidemiological studies of *Clonorchis sinensis* prevailed in the people of Kyungpook Province *Korean J parasitol* **2:** 1-13 (in Korean)..

Song KW, Kang SY, Lee SH (1979) A mathematical approach to the mode of transmission of clonorchiasis in the inhabitants of Naktong and Han river basin. *Korean J Parasitol* **17:** 114-120 (in Korean).

Song IC, Lee JS, Rim HJ (1983) Epidemiological studies on the distribution of *Clonorchis sinensis* infection in Korea. *Korean Univ Med J* **20:** 165-190 (in Korean).

Walton BC, Chyu I (1959) A survey of the prevalence of clonorchiasis and paragonimiasis in the Republic of Korea by the use of intradermal tests. *Bull Wld Hlth Org* **21:** 721-726.

=초록=

경북지역에 있어서 간흡충 감염상의 변화

주종윤[1], 정명숙[1], 김선진[2], 강진무[2]

계명대학교 의과대학 기생충학교실[1], 소아과학교실[2]

경북지역에 있어서 간흡충 감염상의 변화를 1993년 5월부터 1995년 4월까지 주민을 대상으로 간흡충 항원피내반응과 충란검사를 함과 아울러 제2중간숙주인 담수어에서의 본 충 피낭유충 기생상을 조사하였다. 주민들에 있어서 간흡충 감염률은 7.7%로 비교적 높았으며, 남성에서 11.3%, 여성에서 4.1%로 유의적 차를 인정할 수 있었다. Catalytic model의 특이형을 적용하였던 바, 관측치로부터 얻어진 이론곡선은 남성에서 $y = 0.4776(1 - e^{-0.0375t})$, 여성에서 $y = 0.2085(1 - e^{-0.0138t})$이었다. Muench의 two-stage catalytic model로 연령별 감염률을 추정하여, $y = 0.025(e^{-0.0047t} - e^{-0.0235t})$, 즉, 매년 간흡충 감염자는 주민 1,000명에 대해 4.7명의 비율로 산출되며, 감염자 1,000명 중 23.5명의 비율로 음성으로 전환되고 있음을 알 수 있었다. 간흡충 감염자에 있어서 EPG의 cumulative percentage와 Bliss의 probit table를 이용하여 회귀방정식을 계산하였던 바, 남자에서 $y = 0.929 + 1.506 \log x$, 여자에서 $y = 0.473 + 1.767 \log x$이었다. 채집된 9과 25종의 어류 중 7종에서 간흡충 피낭유충을 검출할 수 있었으며, 평균 감염량이 참붕어에서는 58.1개로 가장 많았고, 다음은 10.2개인 몰개였으며, 납지리 및 두우쟁이에서는 각각 3.6 및 7.0개이었다. 이상의 성적으로 미루어 보아 경북 지역의 간흡충증은 수십년전에 비해 적게 유행되고 있으며 계속 감소하고 있음을 확인하였다.

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