啓明醫大論文集 第19券 第1號
Keimyung Med J
Vol. 19. No. 1. June. 2000

Changing Patterns of *Clonorchis sinensis* Infections in Yeongcheon, Kyungpook Province, Korea*

Sun-Byung Kang, M.D. and Chong-Yoon Joo, M.D.

Department of Parasitology, School of Medicine, Keimyung University
Taegu 700-310, Korea

=Abstract=

Nishimura (1943) indicated that a serious endemic focus of *Clonorchis sinensis* is located in the vicinity of Yeongcheon. The changing patterns of the liver fluke, the infection rates and intensity for *Clonorchis* metacercariae in the fish hosts and the prevalence of *Clonorchis sinensis* among the residents in Yeongcheon, Kyungpook Province, Korea were studied during a period from May, 1996 to April, 1997, and compared with the data reported previously in the same area.

Twelve species of examined 19 fresh water fish speaes were infected with the encysted larvae of *Clonorchis sinensis*, their infection rates varied greatly in different fish. The infection rates of 5 species of fish with *Clonorchis* metacercariae were higher than the results in 1980, while the rates were lower in 2 species, *Pseudorasbora parva* and *Coreoperca herzi*. The metacercarial intensity of *Clonorchis sinensis* in 4 species of fish appeared lower than those reported in 1968 and in 1980, whereas their intensity of infection was found higher in 2 species, *Paracheilognathus rhombea* and *Gnathopogon atromaculatus*. and rather stationary in *Coreoperca herzi*. The prevalence of *Clonorchis sinensis* among the residents in Yeongcheon was relatively high, being found to be 5.6% with an infection rate of 8.9% in males and 2.4% in females. The difference of infection rates between males and females is found to be statistically significant ($t > 2$).

For the analysis of age prevalence patterns of *Clonorchis* positives applied the two-stage catalytic model, and the equations were $Y=1.75\ (e^{-0.011t} - e^{-0.026t})$, $a > b$ in 1964 and $Y= 0.1316\ (e^{-0.005t} - e^{-0.043t})$, $a < b$ in this study. The force of infection was much higher in 1964; 26 per 1,000 susceptibles, compared to 5 per 1,000 susceptibles in this study. On the other hand, the loss of positivity was 11 per annum per 1,000 *Clonorchis* positives in 1964, however, it was much higher in present study, where it was 43 per 1,000 positive cases.

For the analysis of intensity of infection, the frequency distribution by the *Clonorchis* egg

*A dissertation submitted to the Committee of the Graduate School of Keimyung University in partial fulfillment of the requirement for the degree of Doctor of Medical Science, and presented at the spring meeting (1997) of the Korean Society for Parasitology.

counts was calculated as well as the cumulative percentage to the total number of positive cases, the regression equation in this study was Y = 1.925+1.01 log X. These figures indicates that most cases of *Clonorchis* positives were found to be mild infections. This study indicates that clonorchiasis among residents in Yeongcheon is less prevalent than several decades ago and continues to decline.

Key words : *Clonorchis sinensis*, Clonorchiasis, Yeongcheon, Kyungpook Province, Catalytic curve, prevalence, metacercaria, Catalytic model.

Introduction

Yeongcheon in Kyungpook Province has been known as one of the notorious endemic areas of clonorchiasis in Korea. The initial report on the existence of autochthonous cases of liver fluke infection was first made by Matsumoto (1915) by detecting *Clonorchis* eggs among schoolchidren in the vicinity of Taegu.

Nishimura (1943) studied the incidence of *C. sinensis* and other intestinal parasitic infections among the residents in Taegu and Yeongcheon and reported that an endemic focus of the fluke existed in the vicinity of Yeongcheon. He also found fresh-water fishes from the River Kumho which metacercariae liberated the vector snails with *C. sinensis* cercariae. The human infection rates of clonorchiasis was 41.1% of the residents in the area.

After the World War II, the survey results of vector snails with *Clonorchis* cercariae from the basin of the River Kumho had been reported (Lee & Kim (1958), Choi *et al.* (1975), and Chung *et al.* (1980). As for the fish hosts of *Clonorchis* infection, Lee & Kim (1958) found *Clonorchis* metacercaria from *Pseudorasbora parva*, *Pseudogobio esocinus*, *Gnathopogon atromaculatus* and *Pungtungia herzi* caught in the River Kumho.

Many studies have been made on the infection rates and intensity of *Clonorchis* metacercaria in different fish groups in Kyungpook Province (Kim, 1961; Shin, 1964; Lee, 1968; Choi *et al.*, 1976; Lee *et al.*, 1979; Hwang & Choi, 1980; Joo *et al.*, 1983; Joo, 1984; Chung *et al.*, 1991; Joo & Hong, 1991; Lee *et al.*, 1992; Kwak, 1994; Kim, 1995 & Lee *et al.*, 1996). The human incidence in the vicinity of the River Kumho has been decreased gradually.

The incidence of *C. sinensis* among the residents in Yeongcheon was 41.1% (Nishimu-ra, 1943). It showed to 35.3% in 1959 (Walton & Chyu, 1959), and 29.8% in 1971 (Choi *et al.*, 1971)

Since the beginning of the Saemaul movement in the third five-year Economic Development plan, the Korean government has made plans to control human parasitic diseases, and had carried out a mass treatment of egg positive cases in combination with extensive public health education to the residents and an improvement of environment. These operations resulted in a marked decrease in human cases of soil-transmitted

helminthic diseases. However, the recent works by Joo & Hong (1991), Hyun & Joo (1994), Kwak (1994), Kim (1995), and Lee *et al.* (1996) suggested that clonorchiasis still remained highly prevalent, especially in some villages in the vicinity of the Rivers and their tributaries.

This study has proceeded as a part of our investigations on epidemiology and control of human clonorchiasis, to estimate the recent patterns of *C. sinensis* infection among residents in Yeongcheon, Also this study investigated infection of fresh-water fish with *Clonorchis* larvae, and compared the results with those of previous studies in the same area.

Materials and Methods

Geographical conditions of surveyed areas : Yeongcheon is situated in the south-eastern part of Kyungpook Province at 36'58" degree north latitudes, having an area of 919.19 square kilometers, and is bordered to the north by Cheongsong-gun, to the west by Kunwie-gun, Taegu and Kyungsan, and to the east by Pohang and Kyungju (Fig. 1).

The Kumho River, about 118 kilometers in

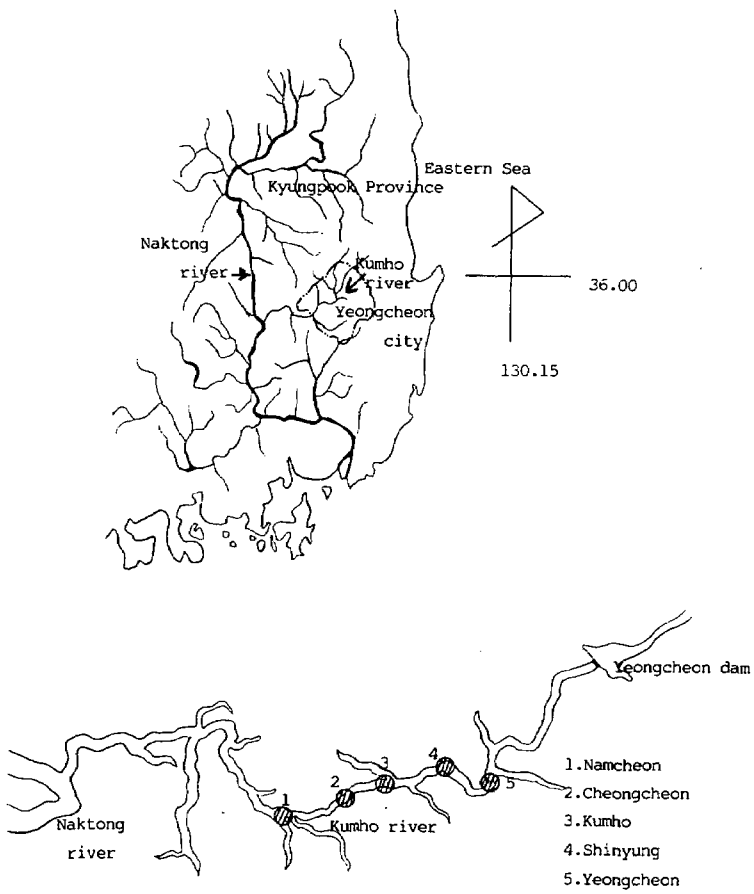

Fig. 1. Map showing the Yeongcheon city and places caught fish habitats(▨)in the River Kumho.

length, has its origin in ranges of the Mt. Kasa and Mt. Seongbub. The main flow of the River runs through Yeongcheon, and joins with the Shinyeong stream running from Mt. Palkong. Finally, it runs through Kyungsan and Taegu and joins with the Naktong River.

There are four rivulets such as Kocheon, Jaho, Bukan and Koheon in the Kumho River basin of Yeongcheon. These four localities in the River were selected as intermediate host survey areas because of the abundance of fresh-water fish found there. The localities are from 30 to 50 meters above sea level and the soil is mainly composed of sand, mud and rock.

Survey on fish intermediate hosts : In order to determine the infection rate and the intensity for *Clonorchis* metacercariae, different fresh-water fish collected in four localities of the Kumho River and its tributaries, were estimated during a period of 1 year from May, 1996. Fresh-water fish were caught by netting and fishing with rod and line.

The fish, after removal of their internal organs in order to prevent autodigestion, were forwarded to the laboratory. The specific name of the fish was determined by the keys described by Chung (1977). One gram of flesh, about 100 scales, all fins and the tail were separated from each fish using a knife, and then each material was compressed between two large slides (50 ×90 ㎜) and was examined for *Clonorchis* metacercariae under a binocular dissecting microscope.

In order to isolate the metacercariae and to estimate the average number of cysts per gram of flesh, a digestion technique was applied : one gram of flesh was mixed with artificial gastric juice (0.2 ㎖ diluted hydrochloric acid and 0.3 g pepsin per 100 ㎖ distilled water), then incubated at 37- 38 ℃ for 30-40 minutes. The mixture was stirred with a glass rod and was allowed to stand for a few minutes to gather isolated cysts in the central portion of the beaker, the *Clonorchis* metacercariae were counted under a binocular microscope.

Some various metacercariae obtained from the fresh-water fish were also immediately fed to golden hamsters. After 2 months, adult worms were collected, flattened between two slides in 70% alcohol, and stained with Semichon's acetocarmine. The stained preparations were studied morphologically for the final identification of trematode species.

Survey of *C. sinensis* infections in residents : In order to evaluate the prevalence of clonorchiasis among the residents in Yeongcheon, the data were collected by utilizing intradermal tests and followed by stool examinations. Intradermal injections, approximately 0.02 ㎖ of 1:10,000 *Clonorchis* antigen (VBS), were applied the volar surface of the forearm. The obtained wheals were measured immediately following the injections, and another measure was taken from 15 to 30 minutes later.

Wheals which had increased an average of 4 mm or more were considered as positive reactions, 3 mm or less were negative, while 3 to 4 mm were recorded as doubtful. The antigen was prepared with lyophilized adult worms as outlined by Yokogawa (1955).

The stool specimens, collected in cartons,

were brought to the laboratory within 2 days after being passed. They were first examined by the MGL technique. If *Clonorchis* eggs were detected, the Stoll's egg-count technique was applied to estimate worm burdens.

Age and sex distribution prevalence of *C. sinensis* infection:In order to estimate the quantitative analysis for age and sex distribution of prevalence, a special type of the simple catalytic curve, which was proposed by Muench (1959), was used. The simple catalytic curve is derived from the following equations:

$$y = 1 - e^{-rt} \text{ or } y = k(1 - e^{-rt})$$

In a special type of the simple catalytic curve, "y" is the fraction of positive result at any time "t". The "r" is the force of infection, which is defined by Muench (1959) as a term of effective contacts per individual per unit of time, which represents a sufficient number to produce infection in susceptibles. The "e" is the base of a natural logarithm. The "k" is a fraction of unit quantity which is subject to change.

The features of transmitting *C. sinensis* infections : In order to estimate the feature of transmitting *C. sinensis* infections among the residents in Yeongcheon, Kyungpook Province, the two-stage catalytic model, which was proposed by Muench (1959), was applied. Since both parameters, such as production and disappearance of positive cases, were considered to be constant over a period long enough to include the oldest age groups in this study, and since the "y" denotes the remainder which, at any age, has been infected and still retains evidence of infection, the following equation can be derived:

$$y = X - Z \quad \cdots\cdots (1)$$

Where "X" denotes the fraction of the population at any age which has become infected, and "Z" represents the portion which has lost all evidence of infection. When constant "a" and "b" are rates at which "X" and "Z" are formed, respectively, the speeds at which two stage reactions : production of positivity "X" and loss of positivity "Z" proceed, are expressed by the following two equations;

$$dx/dt = a(1-x) \text{ or } x = 1 - e^{-at} \quad \cdots\cdots (2)$$

$$\text{and } dz/dt = b(x-z) \text{ or } dz/dt = by \quad \cdots\cdots (3)$$

From equation (1), by differentiation,

$$dy/dt = dx/dt - dz/dt = a(1-x) - b(x-z) \text{ [From Eqs. (2) \& (3)]}$$

$$= ae^{-at} - by \text{ [From Eqs. (2) \& (3)]}$$

This is another simple linear equation, whose general solution is

$$y = \frac{a}{b-a} e^{-at} - Ce^{-bt} \quad \cdots\cdots (4)$$

if $y = 0$ when $t = 0$, it becomes

$$y = \frac{a}{b-a} (e^{-at} - e^{-bt}) \quad \cdots\cdots (5)$$

or, When "a" is larger than "b", it is

$$y = \frac{a}{a-b} (e^{-bt} - e^{-at}) \quad \cdots\cdots (6)$$

and if "a" = "b", it is

$$y = at^{e-at} \quad \cdots\cdots (7)$$

The maximum values of Eqs. (5) or (6) and (7) occur at

$$t = \frac{\ln a - \ln b}{a - b} \text{ or } t = \frac{1}{a} \quad \cdots\cdots (8)$$

When In "a" or In "b" is the natural logarithm of "a" or "b" to the base "e", Muench provided the nomograms in his monograph.

The levels of intensity of *C. sinensis* infections : In order to evaluate the levels of intensity of *C. sinensis* infections, the EPG of clonorchiasis patients was converted into a cumulative percentage and represented as a regression equation using Bliss's probit table. The regression line is represented

by a simple equation of :

$$y = a + b \log X$$

where " y" is probit of cumulative frequency at "X" EPG and "a" and "b" are the constant, "a" corresponds to the percentage of cases with EPG count 1 (zero in logarithm) and "b" is the regression line plotted against the horizontal axis.

The frequency distribution by EPG counts was calculated as well as the fifty per cent level of EPG in a population ($Cs.D_{50}$) was obtained by solving the equation;

$$\log X_{50} = (5 - a)/b$$

Results

The infection rates and intensity for metacercariae of *C. sinensis* in fishes caught in the river Kumho are shown in Table 1. Of 19 fish species, 12 kinds were infected with the

Table 1. Infection rates and densities for *Clonorchis* metacercariae from fresh-water fish collected in some localities of Kumho River (1996-1997)

Scientific name (Family/species)	No. of fish examined	Flesh		Scales		Fins & Tail		Average No. of cyst/ gram of flesh
		No.	%	No.	%	No.	%	
Family Cyprinidae								
Acheilognathus limbata (T et S*)	2	2	100.0	-	-	-	-	3.5
Acheiolgnathus intermedia (T et S)	66	52	78.8	-	-	-	-	14.2
Carassius carassius Linnaeus	40	-	-	-	-	-	-	-
Cobitus lutheri Rendahl	1	1	100.0	-	-	-	-	2.0
Gnathopogon atromaculatus Nichols et Pope	38	3.8	100.0	-	-	25	65.8	79.5
Gobiobotia macrocephalus Mori	2	-	-	-	-	-	-	-
Hemibarbus longirostris (Regan)	1	1	100.0	-	-	-	-	5.0
Paracheilognathus rhombea (T et S)	113	92	81.4	-	-	6	5.3	8.1
Pseudogobio esocinus (T et S)	4	4	100.0	-	-	-	-	9.8
Pseudorasbora parva (T et S)	209	168	80.4	-	-	22	10.5	24.2
Pungtungia herzi Herzenstein	1	1	100.0	-	-	-	-	17.0
Sarcocheilichthys workigae Mori	2	2	100.0	-	-	2	100.0	65.5
Squalidus chankaensis tsuchigae (Jordan et Hubbs)	103	99	96.1	4	3.9	90	87.4	15.8
Zacco platypus (T et S)	24	-	-	-	-	-	-	-
Zacco temmincki (T et S)	15	-	-	-	-	-	-	-
Family Centrachidae								
Lepomis macrochirus Rafinesque	1	-	-	-	-	-	-	-
Family Channidae								
Channa argus (Cantor)	1	-	-	-	-	-	-	-
Family Eleotridae								
Mogurnda obscura (T et S)	2	-	-	-	-	-	-	-
Family Serranidae								
Coreoperca herzi Herzenstein	8	1	12.5	-	-	-	-	1.4

* T et S : Temminck et Schlegel.

encysted larvae of *C. sinensis*. The most frequently infected fish were *Acheilognathus limbata, Cobitus lutheri, Gnathopogon atromaculatus, Hemibarbus longirostris, Pseudogobio esocinus, Pungtungia herzi*, and *Sarcocheilichthys workigae*, with positive rates of 100.0%, followed by *Squalidus chankaensis tsuchigae* with 96.1%, *Paracheilognathus rhombea* with 81.4%, *Pseudorasbora parva* with 80.4%, and *Acheiolgnathus intermedia* with 78.8%. The less frequently infected fish was *Coreoperca herzi* with 12.5%. No *Clonorchis* metacercaria was found in flesh, scales, fins and tail of the remaining 7 species of fish.

The metacercarial intensity in fish was also low as a whole. Of these, *G. atromaculatus* was most heavily infected with the encysted larvae and the average number of cysts was 79.5 cysts, and *S. workigae* was next infected with an average of 65.5 cysts. *P. parva, P. herzi, S. chankaensis tsuchigae* and *A. intermedia* were moderately infected, with an average varying from 14.2 to 24.2 cysts. However, *A. limbata, C. lutheri, C. herzi* and *H. longirostris* were less heavily infected, with averages of 3.5, 2.0, 1.4, and 5.0 cysts, respectively.

The data presented in Table 2 are to compare the 1997 results of the infection rate of *C. sinensis* metacercariae in fresh-water fish in the Kumho river with previously reported data. In fact, the infection rates for *C. sinensis* cysts varied greatly in different fish in this study (1997) and in the previously reported data. Of the fish examined in this study, the encysted larvae of *C. sinensis* were found in 12 species of fish; of the 209 *P. parva* examined in 1997, 80.4% of the fish were infected with *Clonorchis* larvae, while 94.3% of 35 fish examined in 1980, 53.9% of 63 fish examined in 1969, and 45.5% of 77 fish in 1961 were infected. The infection rate for *Clonorchis* metacercariae in the flesh of *P. esocinus* in 1968 was found to be 50.0%, whereas the rates in 1988 and 1997 were elevated to 66.7% and 100.0%, respectively. Similarly, an increase in the rate of infection in 5 species of fish, *G. atromaculatus, A. limbata, H. longirostris, P. herzi, and P. rhombea*, occurred between 1961 and 1997. But contrast, a reduction in the rate of infection in the *C. herzi* was encountered.

The reported infection intensity for *Clonorchis* metacercariae in the fresh-water fish caught in the Kumho river in 1968 and in 1980 are compared with the data in 1997 and listed in Table 3. In previously reported data, *P. parva* was the most heavily infected and the average number of the cysts per gram of flesh were 34.3 in 1968, and 41.8 in 1980, respectively, whereas, in this study *G. atromaculatus* was the most heavily infected with an average of 79.5, followed by S. *workigae* with 65.5, and *P. parva* with 24.2.

The metacercarial intensity of *C. sinensis* in the flesh of fish decreased in 4 species of fish, *A. limbata, P. parva, P. esocinus*, and *P. herzi*. On the other hand, an elevation in the intensity in the 2 species, *P. rhombea* and *G. atromaculatus* were observed. No fluctuation in the intensity of infection in one species, *C. herzi*, was observed.

Table 4 shows the prevalence of *C. sinensis* infections among the residents in Yeongcheon, Korea. A total of 1,463 residents were tested, and the prevalence rate was found to be 5.60%. The sex-specific rate of infections was significantly higher in

Table 2. Comparison of infection rates for *Clonorchis* metacercariae from fresh-water fish collected in some localities of Kumho River with previously reported data

Scientific name (Family/species)	Nishimura (1943)	Kim (1961)	Lee (1968)	Hwang & Choi (1980)	Authors (1997)
Family Cyprinidae					
A · taenianalis Gunter	-	186(16.7)**	-	33(33.6)	-
A · limbata (T et S*)	-	-	-	25(60.0)	2(100.0)
A · signifer Berg	-	357(18.2)	-	-	-
A · yamatsutae Mori	-	236(17.4)	-	-	-
A · intermedia (T et S)	-	-	-	-	66(78.8)
C · carassius Linnaeus	15(0)	128(19.5)	31(19.7)	27(0)	40(0)
C · lutheri Rendahl		-	-	-	1(100.0)
C · brevicauda Gunter	4(50.0)	25(8.0)	8(25.0)	-	-
C · carpio Linnaeus	-	15(6.7)	4(25.0)	-	-
G · atromaculatus Nichols et Pope	9(100.0)	290(30.0)	-	30(70.0)	38(100.0)
G · macrocephalus Mori	-	-	-	-	2(0)
H · labeo (Pallas)	-	13(7.7)	-	26(42.3)	-
H · longirostris (Regan)	36(27.8)	14(7.1)	6(0)	-	1(100.0)
M · koreensis Mori	-	71(22.5)	-	-	-
P · rhombea (T et S)	81(65.4)	-	-	44(29.5)	113(81.4)
P · esocinus (T et S)	-	126(10.3)	20(50.0)	15(66.7)	4(100.0)
P · parva (T et S)	19(100.0)	77(45.5)	63(53.9)	35(94.3)	209(80.4)
P · herzi Herzenstein	19(52.6)	121(71.1)	26(50.0)	16(87.5)	1(100.0)
S · sinensis Bleeker	-	227(74.0)	23(69.6)	-	-
S · workigae Mori	-	-	-	-	2(100.0)
S · *chankaensis tsuchigae* (Jordan et Hubbs)	-	-	-	-	103(96.1)
Z · platypus (T et S)	46(4.3)	2(0)	3(0)	59(0)	24(0)
Z · temmincki (T et S)	-	-	-	-	15(0)
Family Anabantidae					
M · chinensis (Block)	-	-	-	15(40.0)	-
Family Bagridae					
C · brevicorpus Mori	-	103(7.8)	-	11(63.6)	-
Family Centrachidae					
L · macrochirus Rafinesque	-	-	-	-	1(0)
Family Channidae					
C · argus (Cantor)	-	-	-	-	1(0)
Family Eleotridae					
M · obscura (T et S)	-	-	-	-	2(0)
Family Serranidae					
C · herzi Herzenstein	-	-	-	6(16.7)	8(12.5)

* T et S : Temminck et Schlegel.

** The number in the parenthesis means percentage.

Table 3. Comparison of infection densities for *Clonorchis* metacercariae from fresh-water fish collected in some localities of Kumho River with previously reported data

Scientific name (Family/species)	No. of fish examined			Average No. of cysts/gram of flesh		
	Lee (1968)	Hwang & Choi (1980)	Authors (1997)	Lee (1968)	Hwang & Choi (1980)	Authors (1997)
Family Cyprinidae						
A · taenianalis Gunter	24	33	-	6.0	7.6	-
A · limbata (TetS*)	26	25	2	6.0	13.3	3.5
A · intermedia (TetS)	-	-	66	-	-	14.2
C · carassius Linnaeus	60	27	40	0	0	0
C · lutheri Rendahl	-	-	1	-	-	2.0
C · carpio Linnaeus	52	-	-	0	-	-
G · atromaculatus Nichols et Pope	58	30	38	6.5	18.9	79.5
G · macrocephalus Mori	-	-	2	-	-	0
H · labeo (Pallas)	39	26	-	7.7	6.9	-
H · longirostris (Regan)	-	-	1	-	-	5.0
P · rhombea (Tet S)	-	44	113	-	1.7	8.1
P · esocinus (Tet S)	50	15	4	11.2	20.9	9.8
P · parva (Tet S)	56	35	209	34.3	41.8	24.2
P · herzi Herzenstein	61	16	1	14.8	27.1	17.0
S · sinensis Bleeker	36	-	-	15.1	-	-
S · workigae Mori	-	-	2	-	-	65.5
S · chankaensis tsuchigae (Jordan *et Hubbs*)	-	-	103	-	-	15.8
Z · platypus (T et S)	-	-	24	-	-	0
Z · temmincki (T et S)	-	-	15	-	-	0
FamilyAnabantidae						
M · chinensis (Block)	-	15	-	-	8.0	-
FamilyBagridae						
C · brevicorpus Mori	24	11	-	0	2.7	-
Family Centrachidae						
L · macrochirus Rafinesque	-	-	1	-	-	0
Family Channidae						
C · argus (Cantor)	-	-	1	-	-	0
Family Eleotridae						
M · obscura (T et S)	-	-	2	-	-	0
Family Serranidae						
C · herzi Herzenstein	-	6	8	-	0.9	1.4

* TetS:Temminck et Schlegel.

Table 4. Prevalence of *Clonorchis sinensis* infections among residents in Yeongcheon, Korea (1996-1997)

Age group (Year)	Male		Female		Total	
	No. tested	%	No. tested	%	No. tested	%
0 - 4	7	0	8	0	15	0
5 - 9	99	1.0	93	0	192	0.5
10 - 14	144	1.4	142	0	286	0.7
15 - 19	11	0	13	0	24	0
20 - 24	12	16.7	4	0	16	12.5
25 - 29	11	9.1	11	9.1	22	9.1
30 - 34	29	17.2	73	1.4	102	5.9
35 - 39	79	10.1	84	3.6	163	6.8
40 - 44	80	7.5	50	6.0	130	6.9
45 - 49	51	13.7	38	10.5	89	12.4
50 - 59	100	18.0	113	2.7	213	9.9
60 - 69	66	18.2	98	2.0	164	18.5
70 -	32	6.3	15	6.7	47	6.4
Total	721	8.9	742	2.5	1,463	5.6

males than in females. The age-specific rate of infections varied from 0 to 18.18% in males and 0 to 10.53% in females, and the highest infection rate occurred in the 60-69 year age group in males and 45-49 year age group in females, respectively.

The overall prevalence of *C. sinensis* among schoolchildren and residents in

Table 5. Comparison of *Clonorchis* infections in Yeongcheon in 1997 with previously reported data

Source	Group tested	No. tested	Prevalence(%)	Method
Matsumoto (1915)	Residents	349	18.6	Stool examination
Nishimura (1943)	Residents	331	41.1	Stool examination
Lee & Kim (1958)	School children	247	16.4	Floatation technique
Walton & Chyu (1959)	Public officials	325	34.3	Intradermal test
Lee et al. (1960)	School children & residents	2,438	23.7	Intradermal test
Shin (1964)	School children & residents	4,298	30.1	Intradermal test
Choi et al. (1976)	School children & residents	5,232	22.8	Stool examination & Intradermal test
Authors (1997)	School children & residents	1,463	5.6	Stool examination & Intradermal test

Yeongcheon in 1997 are compared with previously reported data and listed in Table 5. Of the 331 residents examined in 1943, 41.1% of the residents were infected with *C. sinensis*, whereas, 30.1% of 4,298 residents examined in 1964, 22.8% of 5,232 residents in 1976, and only 5.6% of 1,463 residents examined in 1997 were found to be infected. Although there was considerable variation in the prevalence of clonorchiasis among the residents in Yeongcheon, the present results indicated a marked decrease in the prevalence of *Clonorchis* infections compared with earlier reports available.

The comparative data of *Clonorchis* positives by sex and age groups for application

Table 6. Fraction of *Clonorchis* positives, by age and sex in Yeongcheon in 1964 and 1997, for the arrangement of catalytic curve, special type, $Y=k(1-e^{-rt})$

Age	t	Shin(1964)				Authors(1997)			
		Male		Female		Male		Female	
		y	$k(1-e^{-rt})$	y	$k(1-e^{-rt})$	y	$k(1-e^{-rt})$	y	$k(1-e^{-rt})$
0 - 4	2.5	0.0529	0.0787	0.0472	0.0489	0	0.0205	0	0.0065
5 - 9	7.7	0.0650	0.2136	0.0981	0.1284	0	0.0603	0	0.0216
10 - 14	12.5	0.1936	0.3220	0.1028	0.1882	0	0.0989	0	0.0347
15 - 19	17.5	0.2993	0.4101	0.2480	0.2331	0	0.1364	0	0.0495
20 - 24	22.5	0.5126	0.4808	0.3282	0.2670	0.2500	0.1725	0	0.0624
25 - 29	27.5	0.5086	0.5379	0.2945	0.2924	0.3333	0.2079	0.1419	0.0772
30 - 34	32.5	0.7441	0.5839	0.2857	0.3115	0.5000	0.2416	0.2000	0.0896
35 - 39	37.5	0.8783	0.6211	0.4350	0.3258	0.3333	0.2745	0.2308	0.1043
40 - 44	42.5	0.8729	0.6510	0.5000	0.3367	0.3158	0.3067	0.1500	0.1169
45 - 49	47.5	0.8333	0.6751	0.4054	0.3448	0.3636	0.3372	0.1667	0.1311
50 - 59	55.0	0.6181	0.7029	0.2786	0.3534	0.3667	0.3818	0.1600	0.1520
60 -	65.0	0.5676	0.7283	0.3125	0.3604	0.3864	0.4378	0.1429	0.1778
$\sum A$		36.66		19.39		18.01		7.48	
$\sum tA$		1546.6671		796.6863		824.0051		347.7751	
$\bar{t}$		42.1895		41.0673		45.7501		46.4878	
$\sum' A$		52.37		27.71		25.73		10.680	
t'		60.27		58.66		65.35		66.41	
r'		0.03		0.04		0.0045		0.0009	
$\sum' K=1A$		67.5		75.0		20.00		4.9	
k		0.7758		0.3695		1.2865		2.181	
r		0.043		0.057		0.0064		0.0013	

Remark : Each age group is 5 or 10 years wide. The sums of items in the *y* columns must therefore be multiplied by 5 or 10 to get $\sum A$. So must the sums of products of items in *y* columns by those in *t* columns to get $\sum tA$. The quantity of *k* is the ratio of observed $\sum A$ to the value expected(if *k* were 1) for the value of r' determined from $\bar{t}$' (r:estimated rate).

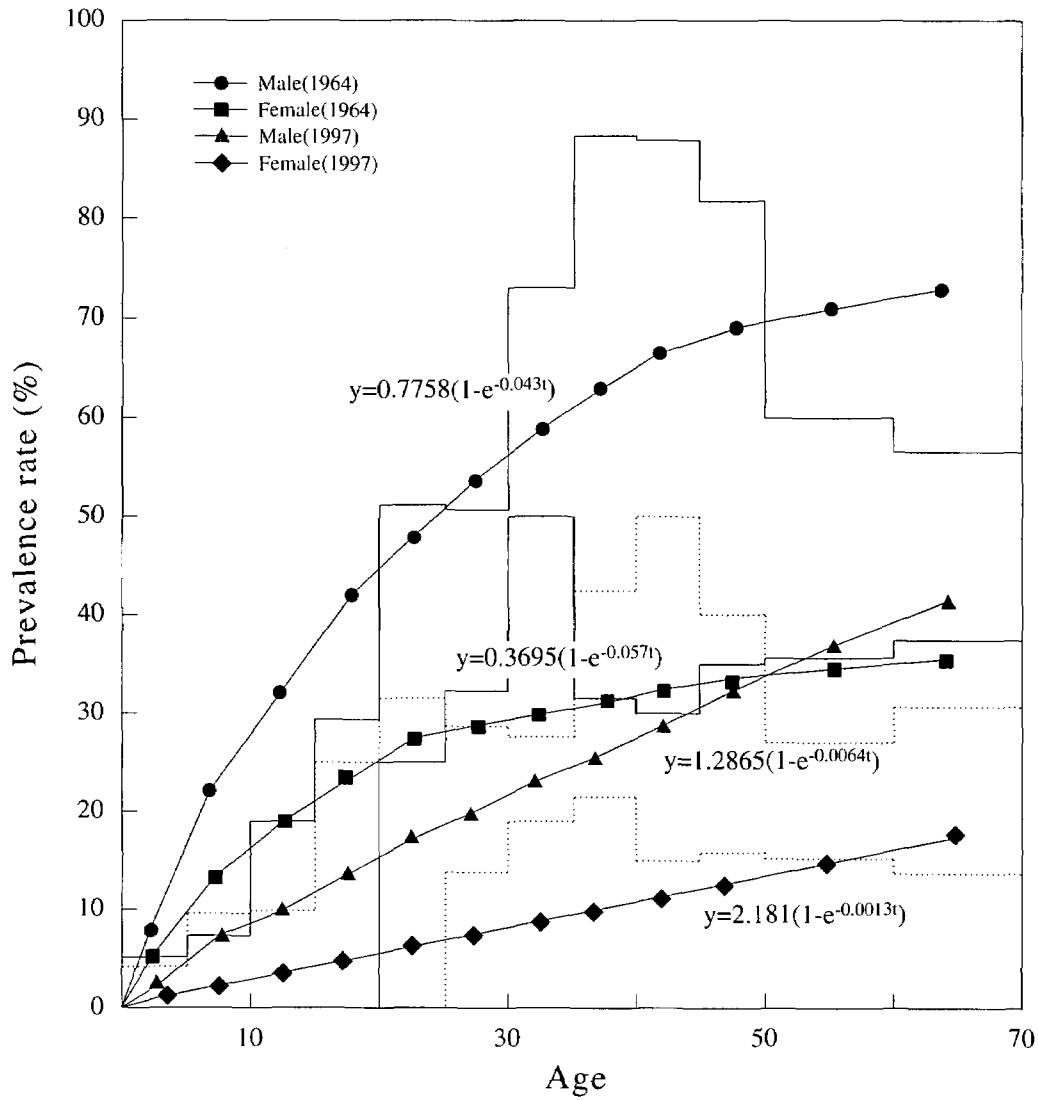

fig. 2. Simple catalyic curves and histograms showing fraction of *Clonorchis* positives in Yeongchun Kyungpook Province by age from 0 to 70 years.

of the special types of a simple catalytic curve are listed in Table 6 and illustrated in Fig. 2. The values of the constant estimated from the nomogram for the observed data, lead to the equation, of the male's simple catalytic curves were $y = 0.7758 (1 - e^{-0.043t})$ in 1964, and $y = 1.2865 (1 - e^{-0.0064t})$ in 1997. And also female's were $y = 0.3695 (1 - e^{-0.057t})$ in 1964, and $y = 2.181 (1 - e^{-0.0013t})$ in 1997. The differences were so great that the curve for males was much higher than that for females.

The data of the two-stage catalytic model to the age prevalence of *C. sinensis* among

Table 7. Comparative data of two-stage catalytic model to age prevalence of clonorchiasis among residents in Yeongcheon in 1964 and 1997

Age	t	Shin(1964)		Authors(1997)	
		y	$\frac{a}{a-b}(e^{-bt}-e^{-at})$	y	$\frac{a}{a-b}(e^{-bt}-e^{-at})$
0-4	2.5	0.051	0.0627	0	0.0118
5-9	7.5	0.080	0.1712	0.005	0.0314
10-14	12.5	0.147	0.2599	0.007	0.0467
15-19	17.5	0.276	0.3318	0	0.0586
20-24	22.5	0.425	0.3892	0.125	0.0676
25-29	27.5	0.389	0.4344	0.091	0.0744
30-34	32.5	0.490	0.4685	0.059	0.0793
35-39	37.5	0.641	0.4937	0.068	0.0829
40-44	42.5	0.613	0.5114	0.069	0.0853
45-49	47.5	0.625	0.5226	0.124	0.0867
50-59	55.0	0.713	0.5296	0.099	0.0876
60-69	65.0	0.337	0.5257	0.085	0.0870
70-	75.0	0.337	0.5084	0.064	0.0852
$\sum A$		32.555		5.442	
$\sum tA$		1480.7375		254.38	
$\bar{t}$		45.49		46.74	
$\sum' A$		40.6937		6.8025	
$\bar{t}'$		56.8552		58.4298	
a'		0.021		0.004	
a		0.026		0.005	
b'		0.009		0.034	
b		0.011		0.043	
$\frac{a}{a-b}$		1.75		0.1316	

Remark : Each age group is 5 or 10 years wide. The sums of item in the y columns must therefore be multiplied by 5 or 10 to get $\sum A$.
So must the sums of products of items in the y columns by those in t columns to get $\sum tA$.

the residents in Yeongcheon in 1997 are compared with the data in 1964 and listed in Table 7, and illustrated in Fig. 3.

In 1997, the infection rate of *C. sinensis* was found to be as high as 5.60%, the value of constant "a" was found to be 0.005. In other words, the force of infection was 5 per annum per 1,000 susceptible persons.

However, the value of constant "b" was found to be 0.043, showing that the rate of disappearance from the positive to negative during the observed period was per annum 43 per 1,000 *Clonorchis* positive cases.

Therefore, $y = 0.1316\ (e^{-0.005t} - e^{-0.043t})$, and the maximum value of "y" occurred at

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

$= 56.6258$ years.

But contrast, the two stage catalytic curve in 1964 was $y = 1.75\ (e^{-0.011t} - e^{-0.026t})$, the value of constant "a" was found to be 0.026,

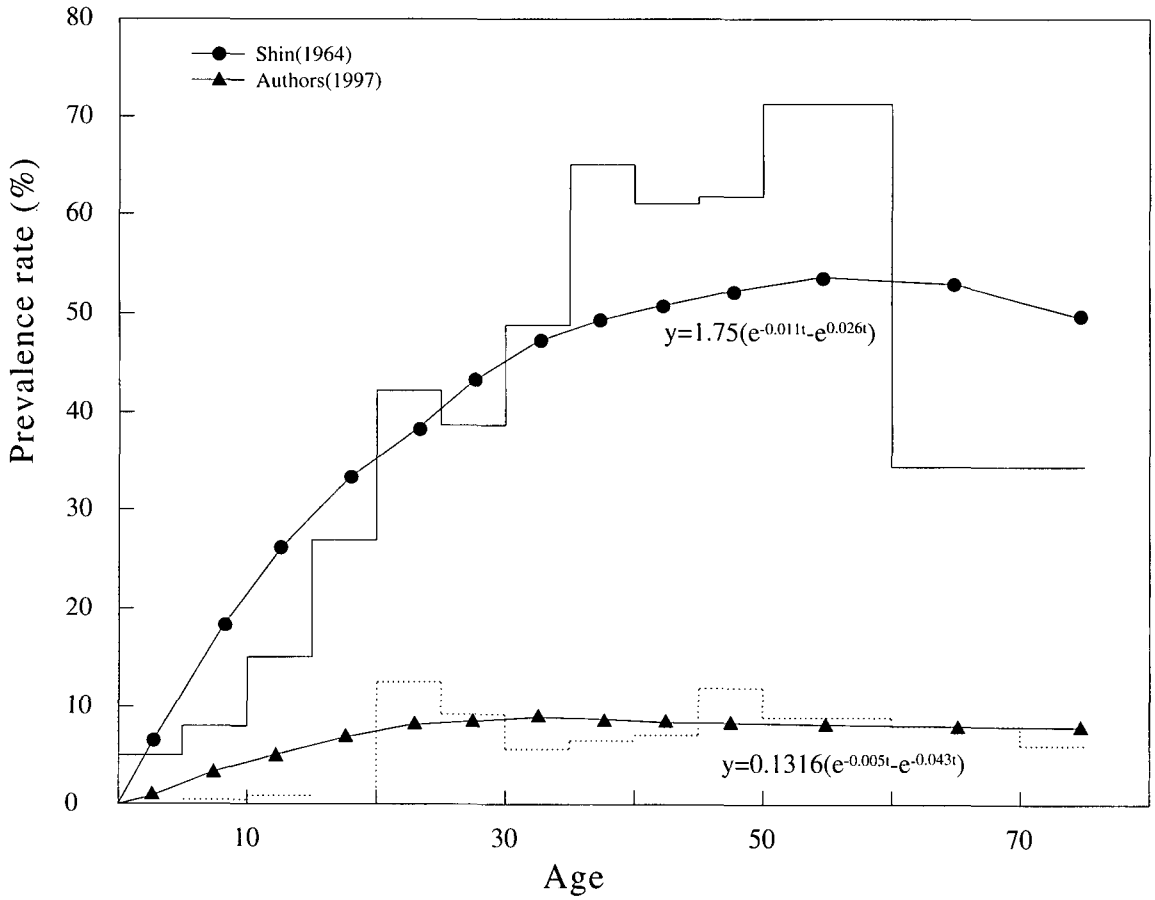

fig. 3. Two-stage catalytic curve and histogram showing fraction of *Clonorchis* positives in Yeongchun Kyungpook province in 1964 and 1997.

that being the rate of *Clonorchis* infection. However, the value of constant "b" was observed to be 0.011, showing that the rate of disappearance from the positive to negative during the observed period was only 11 annum per 1,000 cases with clonorchiasis. In this study, the overall prevalence rate for clonorchiasis in Yeongcheon was much lower than that in 1964 : the former was 5.6% and the latter, 30.1%. These results indicate that the force of *Clonorchis* infections was much lower in 1997 than in 1964.

In Table 9, the comparative data of intensity for *Clonorchis* infections among the residents in Yeongchon, Kyungpook Province in 1976, 1994, and 1997 are summarized. The intensity of infection, expressed in eggs per gram of feces, was divided into 500 egg intervals in the first and second classes, and followed by 1,000 and 10,000 egg intervals for convenience of explanation.

The data in 1976 was less than 10,000 in 453 cases or 66.98%, and more than 100,000 in 24 cases or 1.49%, whereas, the

Table 8. Comparison of intensity of *Clonorchis sinensis* infections among residents in Yeongcheon, Korea in 1976, 1994 and 1997, revealed by Stoll's egg counts

	Choi et al. (1976)		Hyun & Joo(1994)		Authors(1997)	
X(EPG)	Freq*	Cum. %**	Freq	Cum. %	Freq.	Cum.%
- 500	-	-	189	62.59	35	51.47
- 1,000	-	-	46	77.80	3	55.88
- 2,000	-	-	29	87.40	1	57.35
- 3,000	-	-	5	89.06	2	60.29
- 4,000	-	-	6	91.05	1	61.76
- 5,000	626	38.86	4	92.37	4	67.65
- 6,000	-	-	3	93.36	0	67.65
- 7,000	-	-	5	95.02	4	73.53
- 8,000	-	-	1	95.35	2	76.47
- 9,000	-	-	2	96.01	3	80.88
- 10,000	453	66.98	1	96.34	1	82.35
- 20,000	145	75.98	7	98.21	8	94.12
- 30,000	71	80.38	2	99.31	1	95.59
- 40,000	44	83.16	1	99.64	1	97.06
- 50,000	60	86.84	1	99.97	1	98.53
- 60,000	47	89.76	-	-	1	100.00
- 70,000	49	92.80	-	-	-	-
- 80,000	38	95.16	-	-	-	-
- 90,000	27	96.83	-	-	-	-
- 100,000	27	98.51	-	-	-	-
100,000 and over	24	100.00	-	-	-	-
No. examined	11,710		1,555		1,463	
No. positive	1,611		302		82	
Percent positive	19.6		19.4		5.60	
Constant "a"	5.85		2.72		3.08	
Constant "b"	1.52		1.14		1.01	
C.s D_{50}	7.14		2.00		1.91	

number of eggs per gram of feces in 1992 was less than 1,000 in 235 cases or 77.80%, 1,001 - 10,000 in 56 cases or 18.54%, and more than 10,001 in 11 cases or 4.9%. In this study, 38 cases or 55.88% of the 68 *Clonorchis* positive were found to be light infected (EPG count less than 1,000), 18 cases or 26.47% were moderately infected (EPG count between 1,001 to 10,000), and 12 cases or 17.65% were heavily infected. The largest number was recorded to be 54,000 in a 41- year old male in Kokyung myun, Yeongcheon.

The regression lines of cumulative percentage of *C. sinensis* positives against EPG intensity in the log-probit scale are illustrated in Fig. 4.

In a total of 68 positives examined in this

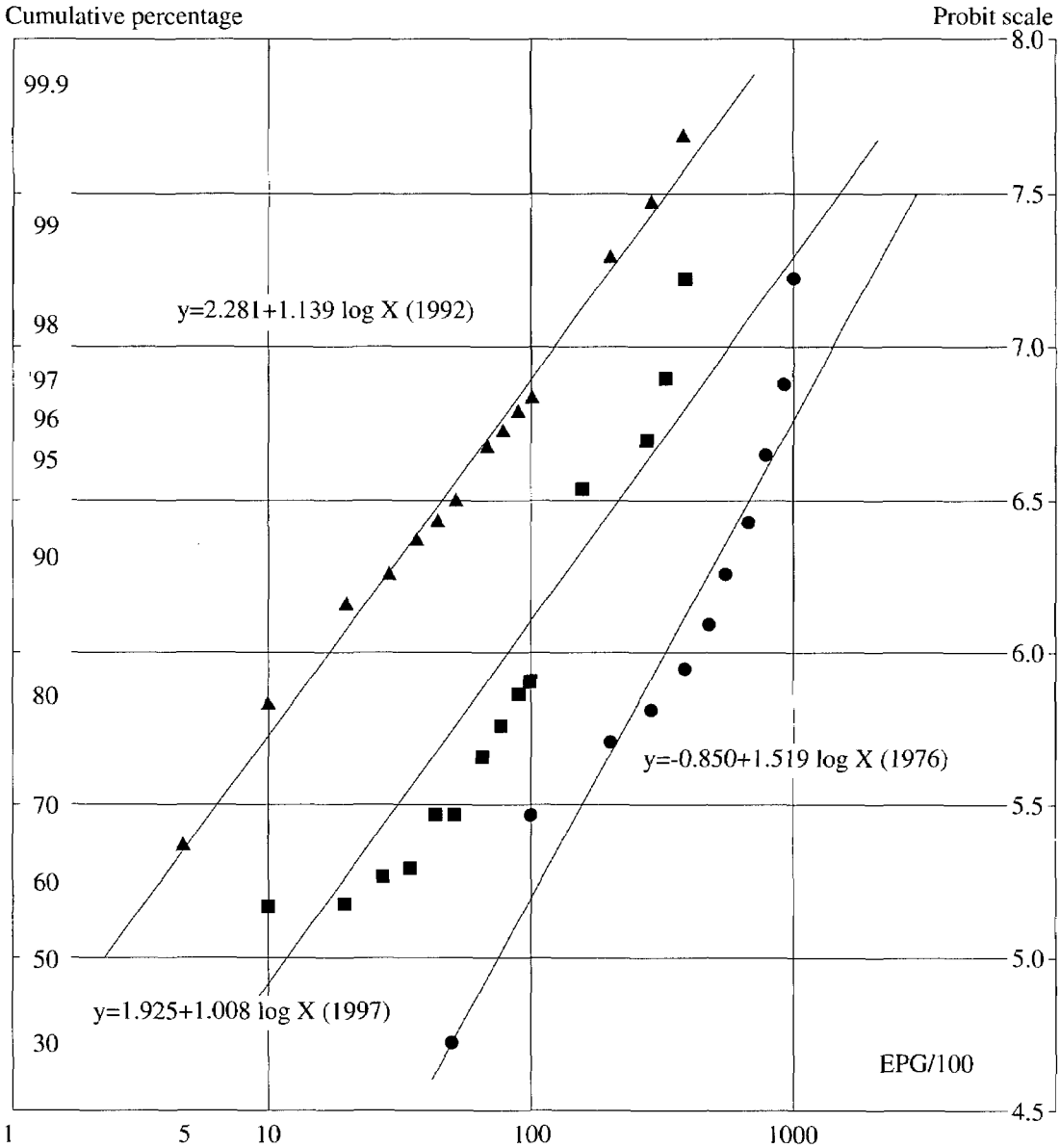

fig. 4. Regression lines of cumulative percentage of *C. sinensis* egg positive cases against EPG intensity in log-probit scale in Yeongchun Kyungpook Province.

study, the regression equation was y = 1.925 + 1.01 log X. The intensity of *C. sinensis* infection, expressed as the fifty per cent level of EPG among the residents (C.s D_{50}), was 3.05.

In the previously reported intensity of *Clonorchis* infection, Choi *et al* (1976)'s regression equation was y = 0.850 + 1.52

log X, and Hyun and Joo (1992)'s was y = 2.281 + 1.139 log X. The values of C.s.D_{50} for the former was 3.85 and the latter, 2.39.

Discussion

Nishimura (1943) stated that a serious endemic focus of *C. sinensis* was located in the vicinity of Yeongcheon, Kyungpook Province, Korea. He also discovered the encysted larvae of *C. sinensis* from several kinds of fresh-water fish including *P. parva* collected from the Kumho river, and demonstrated that fresh-water fish belonging to the Family Cyprinidae served as the second intermediate host of *C. sinensis*. Little factual work on *C. sinensis* in Korea was performed before the end of the Korean War, and some studies on the prevalence of the liver fluke infection and other intestinal helminthes among the residents and fish intermediate hosts were conducted by Japanese and/or American military personnel in Korea. After the Korean War, many investigators have made studies on the incidence of clonorchiasis among the residents in Yeongcheon (Lee & Kim, 1958; Walton & Chyu, 1959; Lee *et al.*, 1960; Shin, 1964; Choi *et al.*, 1971; Choi *et al.*, 1973; Joo & Baik, 1986), and on the infection rates and density for *Clonorchis* metacercariae from the fish intermediate hosts collected in the vicinity of the Kumho river (Lee & Kim, 1958; Kim, 1961; Shin, 1964; Lee, 1968; Choi, 1976; Park, 1978; Hwang & Choi, 1980). As a result of previous studies, the prevalence rates of *C. sinensis* among the residents in Yeongcheon were found to be variant, ranging from 16.4% to 41.1%, and the rates continued to decline during last five decades. In addition, it has been demonstrated that approximately 24 fish species belonging to Families Cyprinidae, Bagridae, and Serranidae play the important role in transmitting the liver fluke.

The results in the present study show that the prevalence of *C. sinensis* in 1,463 residents was 5.6% and many fish intermediate hosts are present in the Kumho river and its tributaries.

In the survey of fresh-water fish in Kyungpook Province, with a consideration of their importance as the second intermediate host of *C. sinensis*, Nishimura (1943) found for the first *Clonorchis* cysts in some species of fresh-water fish, and he also reported that *G. atromaculatus* was the most frequently infected fish, with an infection rate of 100.0%. A study of Lee & Kim (1958) found the *Clonorchis* metacercariae in 9 of 10 species of fresh-water fish collected in the vicinity of the Kumho river, which was followed by Lee (1968) who surveyed these again in more details and within a wider area. Choi (1976) in a comprehensive survey for *C. sinensis* found that 10 of 21 species of fresh-water fish were infected with *Clonorchis* larvae, and reported that *P. parva* was the most frequently infected fish, being found with 93.2%, followed by *P. esocinus, S. sinensis, H. labeo,* and *P. herzi* with rates of 90.4%, 87.8%, 87.2%, and 60.8%, in decreasing order.

Hwang & Choi (1980) in a comparative study on infection rates of larval trematodes in fresh-water fish collected in the Kumho

river, with the results reported by Lee (1968), reported that *P. parva* was the most heavily infected, the average number of *Clonorchis* larvae per gram of flesh, being found with 41.8 cysts. Four species of fish, such as *P. herzi, P. esocinus, G. atromaculatus, and A. limbata*, were moderately infected, the average number varying from 27.1 to 13.3 cysts, and the remaining 8 species of fish were infected with a few cysts only. Similar results in the Kumho river were obtained by Choi (1976), and by Park (1978) showed that fish were abundant in the river and high rates and intensity of larval trematodes infection were observed in various fish examined.

From the studies on the infection with *Clonorchis* cysts from fresh-water fish caught in the some rivers, small ponds and swamps, in comparison with the previously reported data in the same area (Lee, 1968; Choi, 1976; Hwang & Choi, 1980), Lee *et al* (1992) showed that the infection rates and intensity of *Clonorchis* larvae varied markedly from fish to fish. A lower rates of infection were reported by Kim (1995) in the same Province, where 2.8-30.0% of the seven species of fresh-water fishes collected in some localities were infected with the encysted larvae of *C. sinensis*. In the present study, 19 species of fresh-water fishes were collected, of which 12 species such as *A. limbata, A. intermedia C. lutheri, G. atromaculatus, H. longirostris, P. rhombea, P. esocinus, P. parva, P. herzi, S. workigae, S. chankaensis tsuchigae*, and *C. herzi*, harboured the metacercaria of *C. sinensis* and the infection rates for *Clonorchis* larvae varied markedly from fish to fish.

The intensity of *Clonorchis* infections, the average number of cysts per gram of flesh, varied from 1.4 cysts in *C. herzi* to 79.5 cysts in *G. atromaculatus*, and were similar to those reported by Joo (1984) and Kim (1996) in the River Hyungsan, by Lee & Joo (1995) in the river Taega, and by Hwang and Choi (1980) in the River Kumho. These findings support the assumption that the scarcity of fish and the variant infection rates and intensity of larval trematodes in the fish hosts may be due to pesticidal and artificial effects on the water, which would be inhibitory to the survival of the larval trematodes. Quite recently, a long drought all-year round and destruction of the natural environment by constructing dams and ponds in the upper stream, by 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 paddies, may have affected the ecology of fish and other aquatic life.

In fact, it is apparent that 11 of 19 species of fish are now almost impossible to collect the desired number in the river Kumho.

The findings in this study, dealing with schoolchildren and residents in Yeongcheon, Kyungpook Province, indicated that clonorchiasis is less prevalent than it was several decades. From the data presented in Table 5. Nishimura (1943) found 41.1% of *C. sinensis* egg positive cases by stool examination from 331 examinees in Yeongcheon. Walton and Chyu (1959) reported 34.3% of *C. sinensis* infections by intradermal test from 325 public officials, and Choi *et al* (1976)

also reported that the overall prevalence rate for clonorchiasis was reduced from 27.7% to 19.6% in a period of 10 years.

The present data showed some decrease in prevalence rates compared with the above mentioned reports. The decrease of *C. sinensis* infections was considered to be due to the improvement of the socio-economic situation and public health education as well as an anti-*Clonorchis* campaign.

There was a significant difference between the infection rates of males and females. The former was 8.9% and the latter, 2.4% (Table 4).

These results are identical with some reports from Kyungpook Province, and suggest that this is probably related to undesirable traditional habits of males.

In fact, Korean males have a custom of eating raw fish, soaked simply in vinegar or red-pepper mash, as an appetizer when drinking rice-wine and/or distilled spirits at social meetings. Since males frequently participate in such meetings, they are more susceptible to getting infected than females.

As shown in Tables 6-8 for a quantitative analysis in the epidemiological changes of clonorchiasis among the residents in Yeongcheon over the 30 years, a special type of simple catalytic model was applied to the age and sex prevalence rates. The results of these catalytic curves are shown in Fig. 2. In previously reported data (Shin, 1964), the simple catalytic curve for males was $Y = 0.7758(1 - e^{-0.043t})$, and for females, $Y = 0.3695\ (1 - e^{-0.057t})$. The rates of the both sexes were almost parallel and higher rates were revealed in all age groups. However, 30 years later, as shown in this study (1997), that for males was $Y = 1.2865\ (1 - e^{-0.0064t})$ and for females, $Y = 2.181\ (1 - e^{-0.0013t})$; the rate for females was usually lower than that for males in all adult age groups. The present results showed a marked decrease in the prevalence of *C. sinensis* infections compared with those of Shin (1964).

This reduction was prominent in younger age groups but less marked in the aged groups. This seems to be due to several factors, such as persistent education for public health, the reduction of the source of infection by treatment, along with cultural, dietary and economic changes.

In the present study, there was a drop off in the prevalence rate from 0.7% in the 10-14 age group to zero in the group of 15-19 year olds, but increased to 12.5% as its peak in the 20-24 age group. Such an irregular prevalence rate was thought not to be a natural trend. This fluctuation might be due to the inclusion of the age group for students and military service, thus bringing uneven components in the sample taken for survey.

In the earlier studies for the quantitative analysis on the epidemiological changes of *C. sinensis* infections in the endemic areas of Korea, Song *et al* (1979) made a mathematical approach to the mode of transmission of clonorchiasis among the residents in the vicinities of the Naktong and Han Rivers. They estimated that the two-stage catalytic model fitted well with the prevalence rates according to age groups in the egg positive cases in Kimhae and Koyang county, and also commented that the mode

of transmission of clonorchiasis in Kimhae city presented a more rapid pattern of infection than those of other endemic areas in Korea. The results reported by Rim (1986) are identical with the data obtained by other investigators (Song *et al.*, 1983; Hyun & Joo, 1994; Kwak, 1994; Kim. 1995; & Lee *et al.*, 1996) who observed that the theoretically obtained two-stage catalytic curve fitted well with the observed data that the catalytic model was found useful in understanding the feature of transmission of clonorchiasis. In the present study, the equation of the two-stage catalytic model was $Y = 0.1316 (1 - e^{-0.005t} - e^{-0.043t})$, a = 0.005, b = 0.043. The a-value, the production of positivity, was found to be 0.005 showing that the rate of production of positivity was per annum 5 per 1,000 susceptibles. However, the b-value, the loss of positivity, was observed to be as high as 0.043, which means the rate of change of the positives to negative was per annum 43 per 1,000 *Clonorchis* infective cases. This figure in general is similar to the data obtained by Kim (1995), though it is different from the results reported by Shin (1964), Kim (1974), Song *et al* (1979), Hyun & Joo (1994), and Kwak (1994).

As shown in Table 7, the *Clonorchis* positive rate in Yeongcheon reported by Shin (1964) was observed to be 30.1%, the a-value was found to be 0.026 and the b-value, 0.011 and the calculation lead to the equation; $Y = 1.75 (e^{-0.011t} - e^{-0.026t})$ in 1964. The force of infection (a-value) was much lower in this study, 5 per 1,000 susceptibles, compared with 26 per 1,000 susceptibles in 1964. On the other hand, the loss of positivity (b-value) was 11 per annum per 1,000 *Clonorchis* positive cases in 1964, however, it was much higher in the present study, where it was 43 per 1,000 positive cases. The present results in general indicate that clonorchiasis in Yeongcheon is less prevalent than it was several decades ago.

On the basis of previously reported data and our own figures, it was clear that the age-specific rate of *C. sinensis* increased gradually from the first year of life upto about 40 years of age, and then reached a maximum in the age groups of 40-49 or 50-59 years, as was illustrated by the formula of the two-stage catalytic model (Fig. 3).

In this study approximately 51.5% of the 68 positive cases with clonorchiasis had less than 500 eggs per gram of feces. These figures indicate that in most cases of clonorchiasis were found to be lightly infected. Such a lower intensity of *Clonorchis* infections can hardly be explained, but a marked improvement of socio-economic status, effectiveness of public health education and a campaign to control human parasitic diseases during the past several decades can be seen as important factors for decreasing the infections. Such considerations were also recognized by Hyun & Joo (1994), Kwak (1994), Kim (1995), and Lee *et al* (1996).

As for the intensity by age group, especially in the older age groups rather higher than younger ones, particularly in males, a trend of increasing intensity was seen, though the figures were uneven. A study of Rim *et al* (1973) commented that such an increase in intensity was considered to be caused by an

accumulation of adult worms through repeated infections. Kim (1974), on the other hand, reported that the higher intensity of infection in males rather than females was statistically significant in the high endemic locality but not in the low endemic locality.

The mathematical approach was attempted by some investigators (Kang, 1972; Rim. 1986; Hyun & Joo, 1994; Kwak, 1994; Kim, 1995; Lee *et al.*, 1996) in order to identify the intensity and endemicity of clonorchiasis.

The frequency distribution of *Clonorchis* positive cases in a population of the surveyed areas is roughly logarithmic normal and thus the regression line is represented by a simple equation of $Y = a + b \log X$.

Rim (1986) reported that the regression equations originating from Kimhae county was $Y = 3.44 + 1.20 \log X$, $Cs.D_{50} = 19.95$, and in Euisung county, in the upper stream area of the Naktong river, was $Y = 3.76 + 1.42 \log X$, $Cs.D_{50} = 7.47$. Quite recently Lee *et al* (1996) carried out a study on *Clonorchis* infections among the residents in the coastal areas of Kyungpook Province, and reported that the regression equation was $Y = 1.07 + 1.50 \log X$, $Cs.D_{50} = 2.76$. In the present study, the regression equation was found to be $Y = 3.08 + 1.01 \log X$, $Cs.D_{50} = 1.91$. Our results show lower intensity than those reported by Kang (1972), Song *et al*, (1983) & Rim (1986), but these figures are similar to the findings of Hyun & Joo (1994), Kwak (1994), Kim (1995) and Lee *et al* (1996), in that a relatively low degree of intensity of *Clonorchis* infections appeared in some localities of Korea.

As shown in these findings, it is quite conceivable that the small-sized fishes with *Clonorchis* cysts are apparently neglected by the residents for raw consumption, but are eaten mostly as preserved food after being boiled in soybean sauce.

According to a questionnaire of the residents with clonorchiasis, they eat large-sized fishes, such as *Carassius carassius, C. carpio*, and *C. carpio nudus*, in a raw state, cutting them in slices and mixing them with vinegar or soybean paste. This assumption is supported by the fact that our results marked a lower level of intensity with $Cs. D_{50} = 1.91$. It is supposed that some cases of heavy infections would occur if the infections originate from the eating of small-sized fishes which usually harbour many *Clonorchis* cysts.

References

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

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

Choi DW, Chung BJ, Ahn DH, Lee DM : *Clonorchis sinensis* in Kyungpook Province, Korea 1. Distribution and demonstration ofthe cercaria of *Clonorchis sinensis* from snail, *Parafossarulus manchouricus* Bourgigant. *Korean J Parasit* 1975;13:

133-138.

Choi DW, Joo CY, Park SD, Kim JW : Changing pattern of *Clonorchis sinensis* infection among school children in the Kumho basin,Kyungpook Province, Korea. *Korean J Parasit* 1973;11:26-32

Choi DW, Park SD, Ahn DH, Kim YM : Intestinal parasites survey of Kyungpook National University hospital patients. *Korean J Parasit* 1971;9:47-54

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

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

Chung MK : *The Fishes of Korea,* Seoul, Ilchi Publ co., 1977, pp1-727.

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

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

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

Joo CY, Baik DH : Prevalence of intestinal helminth infections in Kyungpook Province, Korea. *New Med J* 1986;29: 1083-1092.

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

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

Kang SY : Epidemiological analysis of the *Clonorchis* in an area of north chungchong-do (Province). *Korean J Publ Hlth* 1972;9:105-112.

Kim DC : Ecological studies of *Clonorchis sinensis* : Endemicity and propagation of clonorchiasis in high and low endemic areas in Korea. *Yonsei Reports Trop Med* 1974;5:3-44.

Kim JK(1961) : Rate of infection of *Clonorchis sinensis* in various of second intermediate hosts and their seasonal variations in the Dongchon area of river Kumho (in Korean). *New Med J* 1961;4:1221-1223.

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

Kim SR : Changing patterns of infection with digenetic larval trematodes from freshwater fish in river Hyungsan, Kyungpook, Korea. *Theses Graduate School Keimyung Univ* 1997;1-37.

Kwak KW : Epidemiological studies of *Clonrchis sinensis* in the vicinity of

Cheongdo river, Kyungpook, Korea. *Theses Graduate School Keimyung Univ* 1994;1-41.

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

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

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

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

Lee SK, Lee KG, Choi DW, Kong ST, Chun NG, Shin YD : Incidence of intestinal helminths among the inhabitants of Kyungpook Province (in Korean). *Theses collection of Kyungpook Univ* 1960;4:185-198.

Lee SH, Ahn SH, JOO CY : Epidemi-ological studies of *Clonorchis sinensis* in the coastal areas of Kyungpook Korea. *Keimyung Med J* 1996;15:303-326.

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

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

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

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

Park TC : Infestation pattern of *Clonorchis sinensis* metacercaria from six kinds of fresh-water fish in Yeongcheon (in Korean). *Korean Central J Med* 1978;24:387-389

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

Rim HJ, Lee SK, Seo BS : Studies on the epidemiology and clinical aspects of clonorchiasis in Korea (in Korean). *New Med J* 1973;16:69-79.

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

Song KW, Kang SY, Lee SH : A mathematical approach to the mode of transmission of Clonorchiasis in the inhabitants of Naktong and Han river basin (in Korean). *Korean J Parasit* 1979;7:114-120.

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

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

Yokogawa M : Intradermal test for paragonimiasis I and II (in Japanese). *Jpn J*

Parasit 1955;4:276-281 and 282-289.