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Study on *Metagonimus yokogawai* (Katsurada, 1912) in Korea

Ⅲ. Epidemiological observation of human *Metagonimus* infection in Hadong area, South Kyongsang Do.

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It has been well known that the genus *Metagonimus* infections were distributed in Korean populations soon after the description of new species on the *Metagonimus yokogawai* by Katsurada (1912). On the basis of the stool examination many earlier investigators have described 0.1-21.3 perecnt as prevalence rates of *Metagonimus yokogawai* among Koreans. And in almost all of the reports the prevalence rates were around 1 percent(Mine, 1916; Kobayashi et Kon, 1917; Kojima et Ko, 1919; Yabe et al., 1923; Hara et Himeno, 1924; Furuyama, 1927; Oda, 1929; Hunter et al., 1949; Lesser, 1956; Lee et al., 1960; Lee et al, 1966; Seo et al., 1969; Park et al, 1969). But it would be more reasonable to mention that these authors observed the heterophyidae ova from stool specimens rather than the ova of *Metagonimus yokgawai*, because it is not apparent whether the only species of *Metagonimus yokogawai* has been found in Korea and also because it could be distinguished from other heterophyidae ova only with great difficulty. According to Seo et al. (1969), they have surveyed on the intestinal helminths infections in Koreans and reported

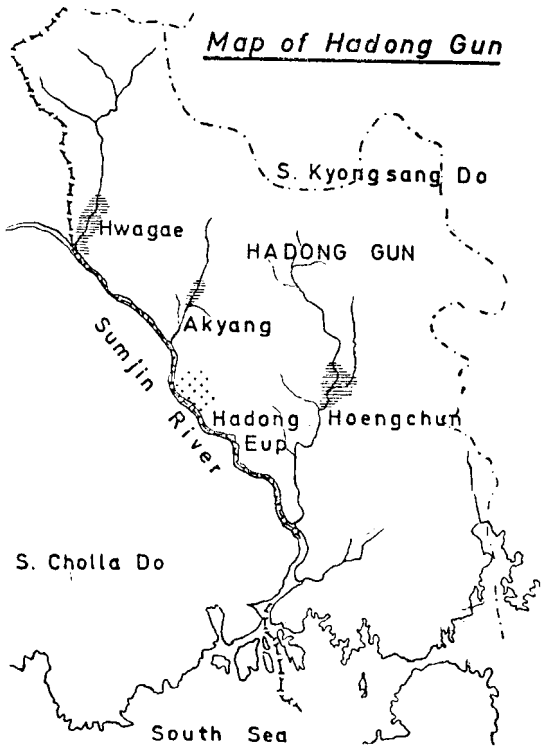

Fig. 1. The map showing the surveyed areas. The shaded areas were the places where sweetfishes (*Plecoglossus altlivelis*) were readily available in summer season. The dotted area (Hadong Eup) is the main town in Hadong Gun.

the 0.4 percent of *Metagonimus* infection rates from 40,581 people. And they made a comment on the rather higher infection rate of *M. yokogawai* from students in South Kyongsang Do

(11.7%) and students in South Cholla Do. (3.9%). Author have an opportunity to pursue the further observations on this minute intestinal fluke infection in Hadong Gun(County), South Kyongsang Do(Province) with very interesting results.

Materials and Methods

Surveyed populations: The surveyed groups were shown in Table 1. The stool specimens were collected from 292 schoolchildren, 67 middle-school students, and 102 inhabitants in Hwagae Myon, Hadong Gun and 60 rural officers (including policemen) scattered over the whole district of Hadong Gun, South Kyongsang Do. (Fig. 1)

Table 1. Results of stool examination conducted in Hadong county.

	Examined groups				Total
	Schoolchildren	Students	Inhabitants	Officers	
No. examined	292	67	102	60	521
No. positive	275 (94.2)	65 (97.0)	101 (99.0)	60 (100.0)	501 (96.2)
A. lumbricoides	210 (71.9)	54 (80.6)	69 (67.6)	25 (41.7)	358 (68.1)
T. trichiurus	227 (77.1)	56 (83.6)	92 (90.2)	53 (88.3)	428 (82.1)
Hookworm	15 (5.1)	—	15 (14.7)	3 (3.0)	33 (6.3)
T. orientalis	16 (5.5)	—	14 (13.7)	32 (53.3)	62 (11.9)
E. vermicularis	13 (4.5)	1 (1.5)	2 (2.0)	—	16 (3.1)
C. sinensis	4 (1.4)	—	3 (2.9)	24 (40.0)	31 (6.0)
P. westermani	1 (0.3)	2 (3.0)	—	—	3 (0.6)
M. yokogawai	88 (30.1)	32 (47.8)	59 (57.8)	42 (70.0)	221 (42.4)
Taenia spp.	5 (1.7)	—	3 (2.9)	1 (1.7)	9 (1.7)
Hymenolepis nana	3 (1.0)	—	—	—	3 (0.6)
H. diminuta	1 (0.3)	—	—	—	1 (0.2)

The stool examination methods employed in this survey were cellophane thick smear method and formalin ether technique.

Table 2. Age and sex distribution of *Metagonimus* infection in *Hadong* county.

Age (yr.)	Sex	No. exam.	No. positive	Percent of posit.
0— 9		216	52	24.1
	Male	99	27	27.1
	Female	117	25	21.4
10—19		192	80	41.7
	Male	131	64	48.9
	Female	61	16	26.2
20—29		29	23	79.3
	Male	21	19	90.5
	Female	8	4	50.9
30—39		36	30	83.3
	Male	28	24	85.7
	Female	8	6	75.0
40—49		28	21	75.0
	Male	23	18	78.3
	Female	5	3	60.0
50+		20	14	70.0
	Male	12	9	75.0
	Female	8	5	62.5
Total		521	220	42.4
	Male	314	161	51.3
	Female	207	59	28.5

Examinations of stool specimens: The surveyed populations were directed to collect the hen-egg sized stool samples in vinyl envelops and transported to laboratory in Seoul. All of the specimens were subjected to examine with cellophane thick smear technique for the rapid screening and detection of ova and formalin-ether technique for the precise identificatoin. If the quantity of stool was sufficient, it was subjected to check the egg counting by the method of Stoll's dilution egg counting technique.

Observations on the worms collected from the infected persons: Some of the infected persons were treated with Yomesan and collected the worms by the method of Seo et al. (1971). The worms collected were fixed with 10 percent formalin, stained with Semichon's acetocarmine and measured for identification. The ova samples were also measured for their dimensions.

Observation on the infection status of first intermediate host: The snail host of

Metagonimus spp. (*Semisulcospira libertina*) were collected from of Hwagae Myon and examined the Infection status under the dissecting microscope by the dissection of digestive gland on September, 1969.

Relults

Results of stool examination: Total 521 people were examined, and the results were presented in Table I. The soil-transmitted heilminthes infections were comparatively high and heavy, especially *A. lumbicoides*(68.1%) and *T. trichiurus*(82.1%). Among the cestode infection, the authors found a case of 10-year-old girl who discharged the ova of *Hymenolepis diminuta*. Among the snail transmitted helminthes, *C. sinensis* ova were found from 6.0 percent and they were chiefly confined to rural officers. The ova of *P. westermani* were found from 3 children in Hwagae Myon. The recovery rate of the *Metagonimus* spp. was 42.4 percent out of 521 examinations. It was the highest among the rural officers(70.0 %) residing over the entire Hadong Gun, the next in 102 inhabitants(57.8%), middle-school students(47.8%) and 30.1 percent in primary schoolchildren.

The patterns of infection rates according to age and sex were presented in Table 2. The infection rates were distinctively increased from 20-29 year-old group and form a plateau pattern in both sexes. The infection rates of male were about two-times higher than those of female.

Table 3 shows the results of egg-counting of *Metagonimus* ova in 112 people. The mean value of E. P. G. of *Metagonimus* ova among the 26 infected inhabitants and 32 infected rural officers were very similar, around 6,000. As in case of infection rate, the mean E. P. G value were clearely increased from 20-29 year-old group(Table 4).

Table 5 shows the patterns of mixed infections of *Metagonimus* with *Clonorchis sinensis*. From inhabitants of Hwagae Myon, *C. sinensis* infection was found in 7 cases(1.5%) out of 461. But in case of rural officers *C. sinensis* ova were found in 40 percent and almost all of them showed the mixed infection with *Metagonimus*.

Table 6 shows the results of measurements of adult worm of heterophyid trematode from 4 cases who were rural officers in Hadong Eup. From these data authors were able to identify the worms of *Metagonimus yokogawai* (Katsurada, 1912).

The result of measurement of ovs observed during the examination was tabulated in Table 7. The worms collected from 4 cases were all identified as *Metagonimus yokogawai*. However

Table 3. Mean E. P. G. of *Metagonimus* ova among the infected cases.

Groups	Ages(yr.)	Sex	No. of cases counted	Sum of individual E. P. G.	Mean E. P. G.
Schoolchildren	7—12		52	49,200	946
		Male	34	33,400	982
		Female	18	15,800	878
Inhabitants	4—78		26	141,300	5,919
		Male	17	141,300	8,294
		Female	9	12,600	1,400
Rural officers	25—55	Male	32	191,900	5,996

Method employed: Stoll's dilution egg counting technique

Table 4. Age and sex distribution of E. P. G. of *Metagonimus* infected cases.

Age (yr.)	Sex	No. of cases counted	Sum of individual E. P. G.	Mean E. P. G.
0—9	Male	13	13, 200	1, 015
	Female	13	15, 900	1, 223
10—19	Male	23	33, 000	1, 435
	Female	7	3, 400	485
20—29	Male	14	62, 600	4, 471
	Female	2	2, 300	1, 150
30—39	Male	17	98, 700	5, 806
	Female	2	2, 500	1, 250
40—49	Male	13	57, 100	4, 392
	Female	1	900	900
50—+	Male	5	106, 800	21, 360
	Female	2	1, 800	900
	Male	85	371, 400	4, 369
	Female	27	26, 800	993
		Total 112	Total 398, 200	Average 3, 555

the remarkable variations in size of ova were observed(Table 8).

The first intermediate host, *Semisulcospira libertina* was caught in the upper stream in Hwagae Myon on September 1969 and examined by the dissection of digestive gland. The ophthalmo-pleurolophocercus cercaria and their rediae were found in 45 out of 500 snails examined. (9. 0%).

The morphological features of some of the ophthalmo-pleurolophocercus cercariae that authors found in this survey were exactly in accord with the former description of the cercaria of *Metagonimus yokogawai*.

Discussion

In this observations on the human infections of *Metagonimus yokogawai* in Hadong Gun, South Kyongsang Do, Korea, authors for the first time, have described a heavy endemic foci of this intestinal trematode. They have attempted to summarize the earlier reports on the incidences of *Metagonimus yokogawai* infection among Koreans on the basis of egg detection(Table 9). Among them, Furuyama's report(1927) on the results from Changnyong area, South Kyongsang Do and that of Cho (1968) were shown the highest incidences. And it was suspected from earlier reviews on the *Metagonimus* infection in Korea(Kobayashi, 1925; Mills, 1927) that Koreans usually showed the lower infection rate than the Japanese, residing the same area at the time of survey. Mills(1927) made comments that indigenous inhabitants of Koreans have the habits less commonly to eat raw flesh of fresh water sweet fish(P. altivelis) than the Japanese, so that it caused the lower incidence rate.

At present time, Hadong Gum(surveyed area), especially in Hwagae Myon, is one of the well known areas of the abundant production

Table 5. The status of mixed infections and snail transmitted trematodes infection.

Groups	No. examined	Mixed infection status		
		Metagonimus only	*Metagonimus* + *C. sinensis*	*C. sinensis* only
Primary schoolchildren	292	85	3	1
Middle school students	67	32	—	—
Inhabitants	102	57	2	1
Rural officers	60	23	19	5

Table 6. The result of the measurement of heterophid worms collected from the inhabitants of Hwa-gae Myon.

Dimension	(in mm)
Length	1.097
Width	0.390
Oral sucker	0.068×0.047
Ventral sucker	0.136×0.082
Pharynx	0.066×0.047
Ovary	0.068×0.048
Vitellarian follicles	
Seminal vesicle	0.123×0.068
Seminal receptacle	0.139×0.088
Testes Right	0.139×0.102
Left	0.151×0.097

Table 7. The result of the measurement of ova collected from inhabitants infected with heterophid trematode. (in μ)

Dimensions	Mean±S. D.
Length (L)	29.3±1.9
Width (W)	17.5±1.0
Opercular length	2.3±0.4
Opercular width	7.5±0.7
Op. L./L.(%)	7.8%
Op. W/W.(%)	42.9%

*Total 100 Ova were measured under x970 magnification.

of sweetfish(Plecoglossus altivelis) in Korea. The people in this county believe that the sweetfishes are completely free of fluke larvas and rather persuade to enjoy the delicious tastes of the flesh, notwithstanding the health education of the local government. As reported in previous papers of these series(Hong et Seo, 1969), P. altivelis caught in Hwagae Myon on September 1969, showed 100% of infection with metacercariae of *Metagonimus yokogawai* and reported 3,851 metacercariae per fish and 105 per gram of flesh of this fish. As for the scale index proposed by Oshima et al. (1966), in those of fishes, it was 11.8 among 10 fishes, and it is suggested that this area of Hwagae Myon is one of highly endemic areas in Korea.

As shown in Table 1, 2, 3, and 4 the average infection rate was 42.4 percent. and mean E. P. G. was 3,555 in 112 persons. Both the infection rates and the mean E. P. G. sharply increased in the age bracket of 20-29 and formed thereafter a plateau pattern.

And these were much higher in males than in females except in 0-9 year-old groups. On this matter the possible explanation will be made that the raw fresh-water fishes are chiefly eaten by adult males as an hors-d'oeuvre during the drinking as it observed in case of *C. sinensis* infection.

The rural offrcers and policemen interestingly showed the highest infection rates of this worm (70.0%) and out of 42 cases of metagonimiasis 19(45.2%) were mixed-infected with *C. sinensis* and only 5 cases out of 60 examined were found to be singly infected with *C. sinensis*. However, it must be taken into account that these officers are not to be considered indigenous, and often changed their offices according to the regulation of the local government within this province of South Kyongsang Do, in which the well known endemic foci of *C. sinensis* are scattered all over.

Authors collected 500 samples of *Semisul-*

Table 8. The distribution percentile of heterophyid ova length collected from inhabitants.

Ranges of dimension(in μ)	>26.0	26.1—28.0	28.1—30.0	30.1—32.0	32.1—34.0	34.1<
Distribution Percentile(%)	2	22	47	18	10	1*

The maximum size observed; 35.6 μ.

Table 9. The reported prevalence of *Metagonimus yokogawai* infections in Korea since 1914.

Authors	Year reported	Subjects	Area surveyed	No. examined	Reported infection rates	Remarks
Muto	1913					
Mine	1914	Hosp. patients Nurses, Students	Seoul	K; 150	1.7%	
Kobayashi et Gon	1917	Out-patients	Seoul	K; 323	0.6%	
Kojima et Ko	1919	Out-patients & Students	Jinchu, S. Kyongsang	K; 1,1000	2.1%	
Hara et Himent	1923	Ceneral population	S. Kyongsang	K; 1,141	K; 4.4%	Namhae; 6.6%
				J; 478	J; 4.8%	Hamyang; 1.7%
						Changyong; 4.3%
Yabe et al.	1923	Out-patients	Taegu, N. Kyongsang	J; 3,328	3.4%	
Sanitary bureau, Chosen Gov.	1925	Rural inhabitants (Korean)	Nation-wide	N. Cholla	1,591 0.2%	Propences in which *M. yokogawai* were present.
				N. Kyong sang	6,533 1.0%	
				S. Kyongsang	444 0.9%	
				Kangwon	933 0.1%	
Furuyama	1927	Students, & inhabitants	Changyong S. Kyongsang	K & J; 192	21.0%	
Oda	1929	Out-patients	Chunjoo	K; 442	K; 0.2%	
			N. Cholla	J; 1158	J; 0.9%	
Hunter et al.	1949	General population	Nation-wide	919	1.6%	Choonchun; 1.2%
						Pusan; 1.1%
						Taegu; 6.9%
						Cheju; 8.6%
Lesser	1956	General population	Seoul & Inchon	268	1.9%	
Lee et al.	1960	Schoolchildren	N. Kyongsang		Schoolchildren; 1.2%	
		High school girl			High school girl; 0.01%	
		General population			Gen. population; 0.3%	
Rim	1962	ROK soldiers	Wonju	1,963	0.8%	
Lee et al.	1966	Outqpatients	N. Kyongsang	5,288	0.2%	
Kim et al.	1968	Schoolchildren & inhabitants	Kimhae, S. Kyongsang	1,809	4.5%	
		〃	Kayang, Kyunggi	1,314	0.2%	
Cho	1968	Inhabitants	S. Colla Kwangjoo	400	1.3%	
			Najoo	200	1.5%	
			Hwasoon	100	14.0%	Seoul; 0.04%
			Changsung	200	—	Kyunggi; 0.1%
			Koksung	200	28.0%	Kangwon; —
Seo et al.	1969	Inhabitants	Nationwide	40,581	0.4%	N. Choongchung; 0.5%
						S. 〃 0.4%
						N. Cholla; 0.4%
						S. Cholla; 0.5%
						Pusan; 0.1%
						N. Kyongsang; 0.6%
Park et al.	1969	ROKA soldiers	Wonju	1,012	1.1%	S. 〃; 0.9%

K: Korean, J: Japanese residents inKorea (up to 1945)

cospira libertina in a stream of Hwagae Myon on Sept. 1969 and examined on the cercarial infections under dissecting microscope, and 45 (9.0%) snails out of them were found infected with the pleurolophocercus cercaria and their rediae in the digestive gland. For the specific diagnosis of these cercariae or rediae detected, further examinations on their morphology are supposedly needed in detail. In the review of Ito (1964) on the *Metagonimus* and other heterophyid trematode infections in Japan, he commented that the para-pleurolophocercus cercaria emerging from *S. libertina*, are supposed to be consisted of *M. yokogawai*, *M. y. takahashii*. *M. katsuradai* and *Pseudexorchis major*. *Ito et al.* (1959) reported on the cercariae parasitic in the *Semisulcospira libertina* in Shizuoka prefecture and concluded that the incidence of *Metagonimus* was relatively low from April to August and highest in May. The pleurolophocercus cercariae parasitic in snail host in Hwagae Myon were parasitized in relatively high percentage although they were not all to be the cercaria of *Metagonimus yokogawai*. This may be another evidence that the surveyed area Hwagae Myon is highly endemic foci of *Metaganimus*.

The adultworms collected after treatment of some cases found were all identified as *Metagonimus yokogawai*. However, the results of measurements of ova were not coincided with this observation and some of them were relatively large in size compared with that of *Metagonimus yokogawai*. It is suggested that the possible occurrence of other species of *Metagonimus yokogawai takahashii* or other heterophyid trematodes should be taken into account in this area.

Summary

An epidemiological observation on the human *Metagonimiasis* in Hadong Gun (County), South Kyongsang Do (Province), Korea was undertaken.

And the following results were obtained:

1) Total 521 people consisting of 292 primary schoolchildren, 67 middleschool students, 102 inhabitants in Hwagae Myon and 60 rural officers and policemen residing all over the Hadong Gun were examined, by the combination of cellophane thick smear technique and formalin-ether technique. Total 221(42.4%) out of 521 were found to discharge the ova of *Metagonimus* spp. The positive rates sharply increased in the age bracket of 20-29. And the male adults were found to be infected two times more than the females except 0 to 9 year-group.

2) Stoll's dilution egg counting technique was applied to 122 specimens. The figure of E. P. G. (Number of eggs per gram of feces) was revealed with distinct increase in the age 20 to 29 group, and it was also noted that the mean E. P. G. in males is about four times more than that in females. The mean E. P. G. of all examined was 3,555.

3) The most of the cases detected were found to be infected singly with the *Metagonimus* spp., who were residing in Hwagae Myon, and among the cases of *metagonimiasis* in rural officers, the mixed infection with *Clonorchis sinensis* was found in 45.2 percent.

4) Out of 500 snails (*Semisulcospira libertina*) collected in a stream in Hwagae Myon in September 1969, 45(9.0%) were found infected with ophthalmo-pleurolophocercus cercaria and its redia.

5) In order to make specific diagnosis on the basis of adultworms, 4 cases of *metagonimiasis* were treated with anthelmintics. All of the collected worms were identified to be *Metagonimus yokogawai* (Katsureda, 1912).

6) The heterophyid ova collected from the inhabitants were measured. And some atypical ova differing from those of *M. yokogawai*. were also noticed.

Some possibilities of the occurrence of other kinds of heterophyid trematodes in the surveyed area were mentioned.

<국문초록>

요꼬가와흡충(Metagonimus yokogawai)에 관한 연구

Ⅲ. 경남 하동군에서의 요꼬가와흡충 유행에 대한 역학적 관찰

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한국의 요꼬가와흡충 유행에 관한 조사는 많지 않았다. 저자등은 경남 하동군에서 요꼬가와흡충이 주민간에 심히 유행하고 있는것을 발견하고 이에 대하여 그역학적 검토를 행한바, 다음과 같은 흥미있는 결과를 얻었다.

1) 하동군 화개면 국민학교 아동 292명, 중학교 학생 67명, 주민 102명 및 하동군내 공무원 60명 등 총 521명에 대하여 새로판 후층도말법 및 Formalin-ether 법으로 대변검사를 한바, 220명(42.4%)에서 이형흡충난(異形吸虫卵)을 발견하였다.

이를 분석한 결과 20-29세군에서 부터 감염율이 급격히 상승되며 0-9세군을 제외하고는 남자가 여자의 2배 가량 높은 감염율을 보이고 있었다.

2) 총 122명에 대하여 Stoll 씨 희석충란계산법으로 충란배출량을 조사한바, 평균 E.P.G.는 3,555였고 이평균치 역시 20-29세군으로부터 급격히 상승되고 남자가 여자보다 4배 가량 높았다.

3) 화개면 주민의 경우 패류매개성 기생충중 Metagonimus 속 일종에 감염된 사람이 대부분이었으나 지방공무원의 Metagomimus 속 감염자중에서는 45.2%가 간흡충과 혼합감염되어 있었다.

4) 1969년 9월 화개면 쌍계천에서 수집한 S. libertina 500개를 dissecting microscope 하여서 검사한바 그중 45개(9.0%)에서 pleurolophocercus cercaria 혹은 그 redia 를 발견 하였다.

5) 감염자중 4명을 치료하여 얻은 성충체를 계측한바 모두 Metagonimus yokogawai(Katsurada, 1912) 였다.

6) 주민에서 수집한 이형흡충난을 계측한 결과 Metagonimus yokogawai 충난의 크기 범주에서 벗어나는 대형충난이 혼제함을 보았다.

위의 역학적 조사는 우리나라에 있어 성충감염 확인에 의한 요꼬가와흡충증(Metagonimiasis) 농후 유행지로 경남 하동군 화개면을 검사한 최초의 보고이며, 금후의 조사로 이형흡충증(Heterophyidiasis) 전반의 검출가능성을 지적하였다.

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