

An Observation on the Reinfection Pattern of *Metagonimus yokogawai* among Inhabitants in Tamjin River Basin

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=Abstract=The reinfection pattern of *Metagonimus yokogawai* was studied at Tamjin river basin, one of its well-known endemic areas in Korea. Stool specimens of a total of 230 inhabitants were examined and 68 (with high egg counts) out of 99 positive cases were treated with 10 mg/kg single dose of praziquantel in January 1984. Follow-up stool examinations were performed every 3 months for a period of one year.

The results were as follows:

1. The pretreatment egg positive rate was 43.0% and their average EPG 1,560 (range; 0~20,800). The rate in male inhabitants was higher (46.9%) than in females (39.3%), and age groups older than 21 (male) and 31 (female) years revealed over 70% and 60% positive rates, respectively.

2. After the treatment, the rate in whole subjected people decreased to 16.7% in April, but increased thereafter to 24.5% in July, 24.7% in October and 32.1% in January ('85). The average EPGs in April and July were remarkably lower than before treatment, but it returned back to or exceeded the pretreatment level in October and January('85).

3. Up to half (10.6~54.3%) of the treated inhabitants appeared reinfected during the follow-up period, while only a few proportion (3.4~7.9%) of uninfected cases turned to egg positive. Approximately a half of infected but untreated cases turned to egg negative, which suggests spontaneous cure.

From the results, it is inferred that new infection by *M. yokogawai* occurs mainly in the season from mid-summer (July) to late autumn (November or so), especially to people who like to eat raw sweetfish.

Key Words : *Metagonimiasis, Metagonimus yokogawai, Reinfection pattern, Tamjin river*

INTRODUCTION

In metagonimiasis due to infection by *Metagonimus yokogawai*, the chief clinical complaints are diarrhea and abdominal pain (Seo 1978), although such symptoms do not necessarily occur in all of even heavily infected cases (Kang *et al.* 1983). Its endemic areas are scattered along the riverside

areas near the east and south coasts in Korea (Seo *et al.* 1981). Especially the Sumjin and Tamjin river basins are well known endemic areas (Hong *et al.* 1969; Chai *et al.* 1977; Seo *et al.* 1981). Its treatment is successful with 10-20 mg/kg praziquantel (Rim *et al.* 1978; Lee *et al.* 1984).

The second intermediate host of *M. yokogawai* is the sweetfish, *Plecoglossus altivelis* (Hong *et al.* 1969). But the availability of sweetfish itself as well as the metacercarial density in their flesh is greatly different by seasons in a year and by locality where

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they are caught (Seo *et al.* 1982; Song *et al.* 1985; Kim *et al.* 1979). Such factors seem to be closely related to the reinfection patterns, including seasonal tendency, in each endemic area and to the different endemicity by the locality. With human subjects, however, there has been no study on its reinfection patterns in Korea.

This study was carried out to observe the chronological change, due to reinfection, in the prevalence and intensity of *M. yokogawai* infection among the inhabitants of 2 small villages in Kangjin-gun, a riverside area of the Tamjin river, for a period of one year after a mass treatment with praziquantel.

MATERIALS AND METHODS

Two small villages (Sukyo-ri and Dokchon-ri) in Kangjin-gun, Jeonranam-do (Fig. 1), where is a highly endemic area of metagonimiasis in the Tamjin river basin, were selected for this study. A total of 230 inhabitants were subjected to qualitative stool examination in January ('84) both by cellophane thick smear and formalin-ether concentration techniques to detect *M. yokogawai* eggs, followed by quantitative examination by Stoll's egg counting technique.

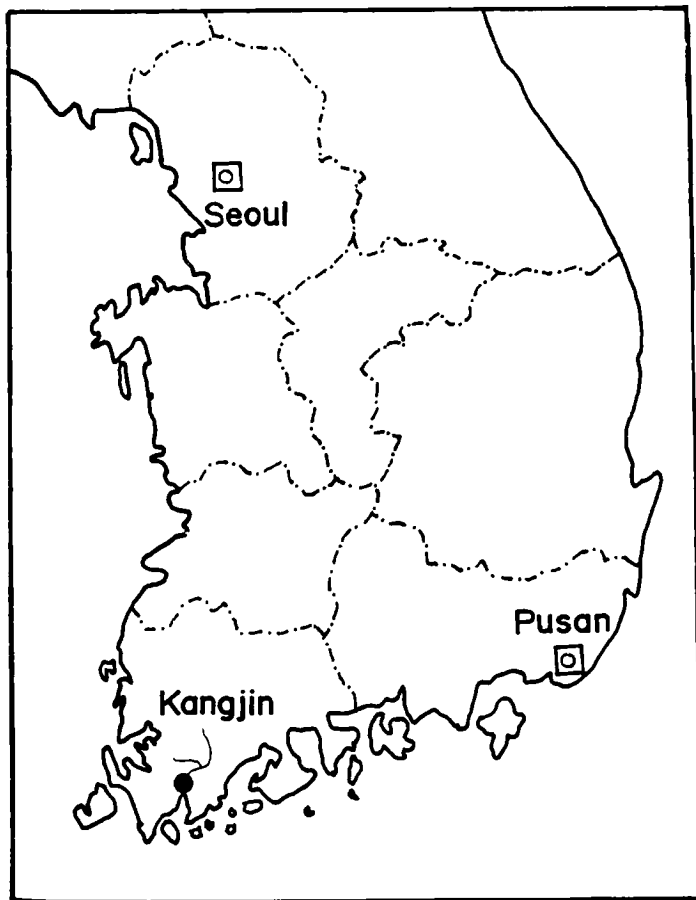


Fig. 1. Surveyed area(●) in the Tamjin river basin.

Total 99 egg positive cases were found and 68 of them, who revealed higher EPG (eggs per gram of feces) than 500, were treated with 10 mg/kg single dose of praziquantel. In majority of the treated cases, magnesium purgation was performed to facilitate the worm expulsion.

After the treatment, all subjected inhabitants, irrespective of the results of preliminary stool examination or of acceptance of the treatment, were successively examined their stools by the same methods as above, every 3 months for a period of one year, *i.e.* in April, July, October ('84) and in January ('85). The results obtained in each examination were compared and analyzed.

RESULTS

1. Preliminary Status of *M. yokogawai* Infection

Out of 230 inhabitants examined in January ('84), total 99 (43.0%) were positive for the eggs of *M. yokogawai* (Table 1). Their EPG value was 1,560 in average and 0~20,800 in range. The rate and intensity of infection were not significantly different between two villages.

The egg positive rates, when analyzed by sex

Table 1. Preliminary infection status of *M. yokogawai* in inhabitants of Kangjin-gun in January ('84)

Village	No. of exam.	No. of posit.	EPG	
			mean	range
Sukyo-ri	125	51(40.8)	1,680	0-13,800
Dokchon-ri	105	48(45.7)	1,450	0-20,800
Total	230	*99(43.0)	1,560	0-20,800

* Sixty-eight positives among them were treated with 10 mg/kg single dose of praziquantel.

Table 2. Egg positive rate of *M. yokogawai* by age and sex of inhabitants in Kangjin-gun in January ('84)

Age	No. posit/No. exam.(%)		
	Male	Female	Total
Under 10	1/18 (5.6)	2/17(11.8)	2/35 (8.6)
11-20	10/40(25.0)	4/30(13.3)	14/70(20.0)
21-30	4/ 5(80.0)	1/ 7(14.5)	5/12(41.7)
31-40	5/ 7(71.4)	7/11(63.6)	12/18(66.7)
41-50	16/19(84.2)	12/20(60.0)	28/39(71.8)
Over 50	17/24(70.8)	20/32(62.5)	37/56(66.1)
Total	53/113(46.9)	46/117(39.3)	99/230(43.0)

and age of the inhabitants, were significantly different according to their sex and age (Table 2). Total 53 (46.9%) out of 113 male inhabitants were positive for the eggs of *M. yokogawai*, while a little lower proportion, 46 (39.3%) of 117 females, revealed positive results. The positive rate became remarkably higher by increase of their age, to reveal over 70% rate in males older than 21 years and over 60% in females older than 31 years.

2. Results of Follow-up Examinations

Whole Subjected People: The changing pattern of *M. yokogawai* endemicity in whole subjected people was put into analysis in order to understand general figures of reinfection in the subjected village. In April, total 203 inhabitants were examined and only 34 (16.7%) appeared egg positive (Table 3). The individual EPG was less than 3,800 and their average EPG 650, which were remarkably decreased values compared with the pretreatment level. After July until January ('85), the rate increased again and appeared to be 24.5, 24.7 and 32.1 % in July, October and January ('85), respectively (Table 3 & Fig. 2). The average EPG in July was somewhat lower (410) than in April but it revealed significantly increased values (2,790 and 1,710) in October and January ('85). The highest individual EPG (upper limit in range) was also re-

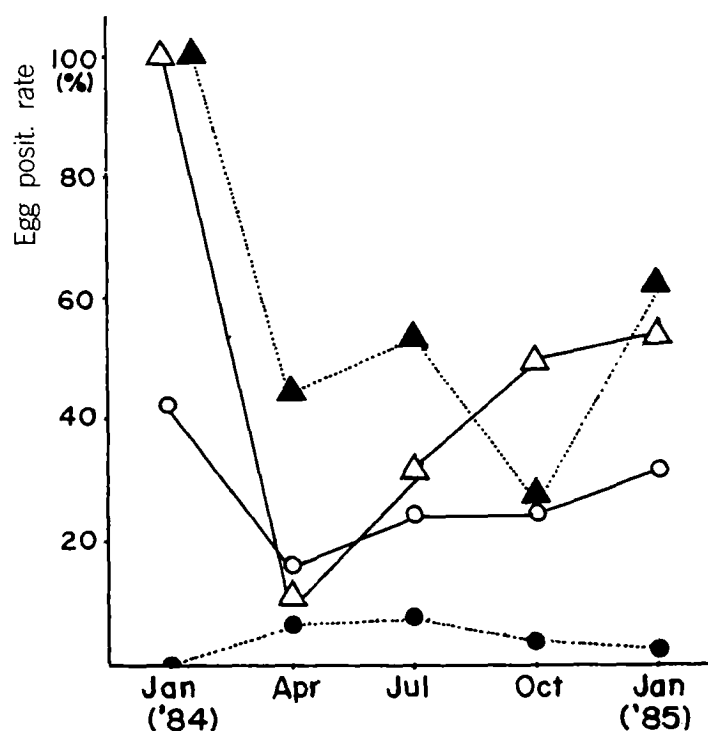


Fig. 2. Graphic view of the reinfection pattern of surveyed inhabitants with *M. yokogawai* for one-year period (○: whole inhabitants, △: treated cases in Jan. '84, ▲: egg positive but untreated cases in Jan. '84, ●: uninfected cases in Jan. '84).

Table 3. Follow-up results of *M. yokogawai* infection in inhabitants of subjected villages in Kangjin-gun

Date	No. of exam*	No. of posit.(%)	EPG	
			mean	range
Jan. 1984	230	99(43.0)	1,560	0-20,800
Apr. 1984	203	34(16.7)	650	0-3,800
July 1984	192	47(24.5)	410	0-4,800
Oct. 1984	146	36(24.7)	2,790	0-36,900
Jan. 1985	156	50(32.1)	1,710	0-16,400

* All of the previously infected (treated or not), uninfected as well as newly examined inhabitants were included.

markably increased, for example, 36,900 in October. This result represented a high rate and intensity of reinfection by *M. yokogawai* in the surveyed villages.

Treated Cases: Total 58 out of 68 praziquantel-treated (*M. yokogawai*-infected) cases were cooperative for follow-up examinations more than one time (Table 4). Their pretreatment EPG was 2,340 in average and up to 20,800 in its upper limit. After the treatment, the egg positive rate dropped to 10.6% in April, which seemed due to failure in the treatment rather than due to reinfection, but thereafter the rate remarkably increased to become 31.7% in July, 50.0% in October and 54.3% in January ('85), due to reinfection (Fig. 2). The EPG was much lower until July, 230~280 in average and 1,600 in its highest value, however, it suddenly increased after then to become 1,980 (average) and 13,500 (highest value) in October and 1,960 and 16,300 in January ('85). It was apparent that more than half of the previously infected cases were reinfected after the treatment, rather heavily, during the one-year follow-up

Table 4. Follow-up results of praziquantel-treated (infected) cases

Date	No. of exam.	No. of posit.(%)	EPG	
			mean	range
Before tx.				
Jan. 1984	58*	58(100.0)	2,340	0-20,800
After tx.				
Apr. 1984	47	5 (10.6)	280	0-600
Jul. 1984	41	13 (31.7)	230	0-1,600
Oct. 1984	26	13 (50.0)	1,980	0-13,500
Jan. 1985	35	19 (54.3)	1,960	0-16,300

* 58 out of 68 treated cases were cooperative for follow-up stool examination(s).

period.

Previously Uninfected Cases: The reinfection (positive conversion of eggs) rate in this group was comparatively much lower than the treated group. Out of 131 uninfected cases (Jan., '84), 98 were cooperative for follow-up examinations, but throughout the follow-up period, only a few (3.4~7.9%) turned to egg positive and their EPG appeared not high (Table 5 & Fig. 2). This result provided a suggestion that *M. yokogawai* reinfection did not randomly occur to all of the residents in the subjected village but occurred selectively to certain group, probably to those who favour to eat raw sweetfish.

Infected but Untreated Cases: Cases in this group were most lightly infected among the egg positive cases examined in January ('84). Their preliminary EPG was as low as 280 in average value and individual values lower than 500 except for 2 cases with 1,000 and 1,400 EPG (Table 6). Spontaneous egg negative conversion was observed in 45.0% of them in April and their EPG decreased a little. After July, however, slight increase in egg positive rate and/or EPG, due to reinfection, was recognizable (Fig. 2). In January ('85) the average EPG appeared to be 690 and its highest value 3,800.

Table 5. Follow-up results of previously uninfected cases

Date	No. of exam.	No. of posit.(%)	EPG	
			mean	range
Jan. 1984	98*	0	—	—
Apr. 1984	82	6(7.3)	370	0-2,000
Jul. 1984	76	6(7.9)	70	0-200
Oct. 1984	54	2(3.7)	0	0
Jan. 1985	58	2(3.4)	1,000	0-2,000

*98 out of 131 uninfected cases were cooperative for follow-up examination(s).

Table 6. Follow-up results of infected but untreated cases.

Date	No. of exam.	No. of posit.(%)	EPG	
			mean	range
Jan. 1984	29*	29(100.0)	280	0-1,400
Apr. 1984	20	9(45.0)	160	0- 400
Jul. 1984	19	10(52.6)	310	0-1,100
Oct. 1984	16	4(25.0)	380	0- 700
Jan. 1985	13	8(62.5)	690	0-3,800

* 29 out of 31 infected but untreated cases were followed.

DISCUSSION

The prevalence of metagonimiasis in inhabitants of Kangjin-gun was as high as 43.0% in the present study (Jan., '84). This is a significantly high prevalence in Korea and it may be true that the endemicity of metagonimiasis in Tamjin river basin never decreased but rather increased when it was compared with the rates reported in 1977 (Chai *et al.* 1977) and in 1981 (Seo *et al.* 1981), 26.4 and 22.7% respectively.

In people of endemic areas, fishing of the sweetfish, the intermediate host of *M. yokogawai*, is one of their favorite recreations as well as one of important jobs. Eating the raw flesh with/without alcoholic beverage is one of their traditionally continuing habits. In endemic areas, therefore, its endemicity has been maintained high due to repeated and continuous occurrence of reinfection.

In the present study, the prevalence of *M. yokogawai* according to age and sex of the inhabitants showed a typical form of fish-transmitted helminthiasis, which was characterized by high prevalence and intensity among adult males and/or, though not equally high, adult females. Of course these age groups have more chances to eat raw sweetfish. Approximately the same age (sex)-prevalence pattern of metagonimiasis was reported in Sumjin (Kim *et al.* 1979) and Boseong river basin (Soh *et al.* 1978).

The egg positive rate of *M. yokogawai* in whole subjected people decreased to 16.7% in April, 3 months after the mass treatment. However, it gradually increased up to 32.1% until January ('85), due to reinfection. The intensity of infection, in EPG, also remarkably dropped 3 months after the treatment but gradually became higher until October and January ('85). It was suggested that, through a year, the reinfection should occur from before July and continue until later than October. The great majority of the reinfected cases appeared between July and October. According to Kim *et al.* (1979) who performed an epidemiological investigation on metagonimiasis in Hadong-gun, Sumjin river, one of the nearby located rivers to the Tamjin river, the sweetfish began to appear from late May and at that time it already harboured the metacercariae of *M. yokogawai*. They further observed that the metacercariae became gradually accumulated in the flesh of the fish until early November. Later than that time no sweetfish was caught from the river. When these observations

were taken into considerations, the seasonal reinfection pattern of subjected inhabitants in this study was quite plausibly explained. Especially in the treated cases who were egg positive and whose EPG high in the preliminary examination, the reinfection pattern was highly compatible with the above observations on the sweetfish host.

On the other hand, only a few inhabitants who were previously uninfected turned to be egg positive during the follow-up period. Compared with the treated cases (up to half), a remarkably lower proportion (less than 8%) appeared reinfected. It was suggested, therefore, that uninfected persons should be rarely reinfected while infected easily reinfected, depending on their fish-eating habit.

There are limited informations concerning the biological characteristics of *M. yokogawai* to correlate with epidemiological findings observed in this study. One of them is its life span in human host. There had been no paper on this subject, therefore, the turn-over pattern of worms in human intestine was hard to speculate or to give a detailed explanation for it. It seemed true, however, that most of the infected worms should live at least longer than 2-3 months in human host, since the prevalence and intensity of *M. yokogawai* were steadily high from October until January in the present study. It is well known that the sweetfish has a life span of only one year, from autumn (as eggs) to next autumn (as adults), and no adult fish is available in the winter season (Chung 1973; Kim *et al.* 1979), so that new human infection is hardly expected to occur after November. The prepatent period of *M. yokogawai* was reported only 1 week in various experimental animals (Ito, 1964), which is probably the same in human host.

Another interesting observation was that the egg positive rate among the untreated infected cases spontaneously decreased to 45.0% in April. It seemed either due to natural discharge of worms from human intestine or due to false negative results in the successive follow-up examinations because of their remarkably low worm burdens. But we applied two kinds of stool examination methods so as to elevate the detectability of eggs. Hence, when the technical problem was overlooked, it was cautiously suggested that about half of the flukes infected in human intestine should be discharged naturally within 6 months after the infection. Natural discharge of *M. yokogawai* within as short as a few weeks after infection was reported in poorly susceptible hosts such as mice (Hong *et al.* Seo

1969) and rats (Chai 1979). Reversely, however, it was also speculated that at least a small proportion of the worms should live in human intestine up to 1 year or more, if it was taken into consideration that the authors sometimes experienced egg positive results in people who did not eat sweetfish or other fresh water fishes in the past one or two years.

As mentioned above, there is a difficulty in the diagnosis of *M. yokogawai* infection by means of various kinds of stool examination techniques, because it produces very small amount of eggs (per worm/day), only 35-45 in the dog host (Ahn *et al.* 1981) or 20-60 in humans (Seo *et al.* 1985). Therefore, any of the techniques currently used is not expected to figure out the exact prevalence of metagonimiasis, especially in low endemic areas. The lightly infected cases may often appear to be egg negative in the routine stool examinations.

In conclusion, the reinfection by *M. yokogawai* was suggested to occur chiefly during the season from mid-summer (July) until late autumn (October or November) in the surveyed villages. There was a tendency that the reinfection occurred preferably and selectively to certain group of people, probably who habitually eat the raw sweetfish. The life span of this fluke in human host was suggested to be at least 2-3 months and possibly up to over 1 year, however, their majority seemed to be expelled within 6 months.

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= 국문초록 =

탐진강 유역 住民에 있어서 요꼬가와吸蟲 再感染 양상

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요꼬가와吸蟲 유행지로 알려진 全南 탐진강 유역(강진군) 住民에 있어서 이 吸蟲 再感染 양상을 관찰하였다. 총 230명의 住民에 대하여 대변검사를 실시하였고 99명의 요꼬가와吸蟲卵 양성자중 감염강도가 높은 68명에 대하여 1984년 1월 praziquantel 10mg/kg를 1회 투여하였다. 그 후 3개월마다 추적 대변검사를 실시하고 총란 양성율 및 EPG(대변 1 g내 검출총란수)의 변동상황을 관찰하였다. 그 결과는 다음과 같다.

1. 투약전 요꼬가와吸蟲卵 양성율은 43.0%, 평균 EPG는 1,560 (범위0~20,800)이었다. 남성의 양성율(46.9%)이 여성보다 (39.3%) 다소 높았고, 연령증가에 따라 높아지는 경향을 보여 20대 이상 남성 및 30대 이상 여성에서는 각각 70% 및 60% 이상의 양성율을 보였다.

2. 추적검사 결과, 투약후 마을 전체 住民의 총란양성율이 뚜렷이 감소되어 4월에 16.7%로 나타났으나 재감염에 의해 다시 양성율이 증가되어 7월에 24.5%, 10월에 24.7% 및 이듬해 1월에 32.1%로 나타났다. EPG값은 치료후 4월 및 7월에 650 및 410으로 각각 감소되었으나 10월에는 다시 2,790으로 급증하였다.

3. 치료를 받은 68명만을 대상으로 분석한 결과 이들의 총란양성율은 4월에 10.6%, 7월 31.7%, 10월 50.0% 및 1월에 54.3%로 1년만에 약 절반이 다시 양성으로 전환되었다. 그러나 처음에 음성이었던 住民의 경우에는 양성 전환자가 1년을 통하여 3.4~7.9%에 지나지 않았다. 또 총란양성이나 투약을 받지 않은 사람중에서 약 절반이 음성으로 전환되어 자연 치유되었을 가능성을 보였다.

이상의 결과로 미루어 보면 이 지역의 요꼬가와吸蟲 再感染은 주로 여름(7월)에서 늦가을(11월경) 사이에 이루어지는 것으로 추측되었고, 특히 은어 生食을 즐기는 특정인에게 선택적으로 再感染되는 것으로 보였다.