

## Infestation status of *Paragonimus westermani* metacercariae in the second intermediate host in Ulchin county, Kyungpook Province\*

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### INTRODUCTION

Human paragonimiasis is sporadically distributed in the mountainous districts of Korea and is still recognized as a major public health problem in various parts of Kyungpook Province.

Epidemiological studies on *P. westermani* in this Province have been carried out by many investigators since Miyairi's first report on *Paragonimus* metacercariae among crayfish and crabs collected at Keomoon stream, Chilgok county in 1917.

Ichinomiya(1924) made a survey of paragonimiasis among the residents of five counties in Kyungpook Province, using sputum examinations, and reported that the incidence of *P. westermani* was found to be high, and that the infection rate was higher among males than females in all localities studied.

Kobayashi(1926) in his studies of the final and the intermediate hosts of *P. westermani* in Korea reported that this infection was prevalent not only in man but also in dogs, cats, pigs, and even in tigers, leopards, foxes, wolves and wild cats. Based upon the positive rate of 8.0 per cent among 350,000 examinees he concluded that paragonimiasis was one of the most important parasitic diseases in Korea.

In Kyungpook Province, Kim *et al.* (1974) found a high incidence of paragonimiasis among

the residents in eight counties, and regarded it as one of the major clinical and public health problems.

In the same year, Park and Choi(1974) reported the distribution of the metacercariae of *P. westermani* from the crayfish collected in 4 out of 65 streams of Kyungpook Province.

Afterwards, on the crayfish intermediate host of *P. westermani* in the Province, results in Dalseong county have been reported by Chung *et al.*(1974), and Choi *et al.*(1983); in Chilgok county by Kim and Choi(1977), Shon and Choi(1977), and Lee and Choi(1979); in Wiseong county by Choi and Hwang(1981), and Choi *et al.* (1981); in Yeongpung county by Choi *et al.*(1983), and Lee and Choi(1984); in Andong county by Park *et al.* (1984); in Yeongyang county by Choi *et al.* (1983); in Cheongsong county by Choi *et al.* (1983); and in Ulchin county by Joo *et al.* (1985).

However, few reports on epidemiological studies of intermediate host for the lung fluke in Ulchin county have been available.

The objectives of this survey are to determine the population density of crayfish intermediate hosts and the infestation of crayfish with encysted larvae of *P. westermani* in Ulchin county of Kyungpook Province, Korea.

### MATERIALS AND METHODS

**1. Survey areas:** Ulchin county, Kyungpook Province which was incorporated from Kangweon Province since 1963, was selected as the area of

\* The results of this survey were presented at the 28th annual meeting of the Korean Society for Parasitology in 1986.

survey.

It is located in the northeast part of Kyungpook Province at 36.1°–37.8° north latitude, and has a total annual rainfall of 1,088 mm, a mean temperature of 13.6°C and is characterized by wide seasonal temperature variations (–6.3 to 28.3°C).

The six localities in this county were selected as the surveyed areas because the crayfish, the second intermediate host of *P. westermani*, is found in the streams. The localities are from 100 to 300 meters at altitudes and the bed of the streams is mainly composed of pebbles and rock with sand. The water in the streams is relatively permanent and slow-flowing and there are many *Semisulcospira* snails and crayfish in the water.

More detailed geographical conditions of surveyed areas were presented by Joo *et al.* (1985).

**2. The crayfish intermediate host:** From May to October in 1986, the collections of freshwater crayfish, *Cambaroides similis*, were made once or twice monthly in six localities by hand.

The population density of the crayfish was measured by the number of crayfish collected per man-hour. The crayfish collected were brought to the Parasitology laboratory and were dissected into the cephalothorax, the liver, the gills, the heart, and the leg muscles.

They were compressed between two slides(50 × 90 mm), and examined for the presence of the encysted larvae of *P. westermani* under a binocular dissecting microscope.

The cysts obtained from the crayfish were

immediately fed to the dog. The adult worms obtained from the dog after six months of infection were flattened between two slides in 70 per cent alcohol and stained with Semichon's acetocarmine. The stained preparations were studied morphologically for the identification of species.

## RESULTS

Table 1 shows the population density of the crayfish, *C. similis*, in the habitats in the vicinity of three streams in Ulchin county, altogether with environmental conditions.

The population density of the crayfish in the surveyed areas varied considerably. The population in the Ducheon habitat of the Namdae basin was somewhat higher than that in the others, and the approximate number of crayfish collected ranged from 8 to 13, with an average of 10 per man-hour.

The infestation rates for *Paragonimus* metacercariae from crayfish in the surveyed areas of Ulchin county are presented in Table 2. A total of 127, 15.5 per cent out of 817 crayfish was found to be infected with metacercariae of the lung fluke. The infestation rates ranged from 5.7 per cent in Samdang to 25.1 per cent in Ducheon habitat in the vicinity of Namdae stream, 1.9 per cent in Samkeon to 15.3 per cent in Sokwang in the bank of Kwang stream, and 3.0 per cent in Kusan of Wyangpi basin, respectively.

Table 3 presents the demonstration rates for

**Table 1.** Population density of crayfish in six localities in Ulchin county, Kyungpook Province, Korea (1986), together with environmental conditions

Stream	Environmental conditions at surveyed localities			Population density of crayfish (No. of crayfish/man-hour)		
	Habitat	Administrative district	Bottom structure	Minimum	Maximum	Mean
Namdae	Ducheon	Buk myun	Pebble and rock	8	13	10
	Samdang	Buk myun	Pebble and rock	1	4	2
	Hadang	Buk myun	Pebble and rock	1	5	2
Kwang	Sokwang	Seo myun	Rock and pebble	5	7	6
	Samkeon	Seo myun	Rock and pebble	3	4	3
Wyangpi	Kusan	Keonnam myun	Rock and pebble	1	3	2
Total				1	13	4

**Table 2.** Infestation rates for *Paragonimus* metacercaria from crayfish in Ulchin county, Kyungpook Province, Korea(1986)

Stream	Habitat	No. crayfish examined	Crayfish with metacercaria	
			Number	Per cent
Namdae	Ducheon	327	82	25.1
	Samdang	159	9	5.7
	Hadang	38	3	7.9
Kwang	Sokwang	203	31	15.3
	Samkeon	53	1	1.9
Wyangpi	Kusan	37	1	3.0
Total		817	127	15.5

encysted larvae of the lung fluke from the body parts of infected crayfish. The number of crayfish infested and the encysted larvae of lung flukes from the body parts showed wide variations according to the surveyed areas. In Ducheon and Sokwang habitats, the majority of larvae were found in the three parts of body; the

cephalothorax, the gills, and the liver in order. The rates were 87.8 per cent and 68.8 per cent in the cephalothorax, 54.9 per cent and 35.4 per cent in the gills, and 2.4 per cent and 2.3 per cent in the liver, respectively.

In Table 4, numerical distribution of *Paragonimus* metacercariae in the various tissues and organs and the average number of the cysts per infested crayfish is tabulated in the six surveyed areas. In Ducheon habitat in the vicinity of Namdae stream, a total of 155 metacercariae detected, 97 or 62.6 per cent were harboured in the cephalothorax, 35 or 35.5 per cent in the gills, and 3 or 1.9 per cent in the liver, respectively. The rates obtained from crayfish collected in Sokwang habitat in the Kwang basin were similar to those in Ducheon habitat, while, in Hadang and Kusan habitats, the metacercariae were found in only the cephalothorax.

The average number of *Paragonimus* meta-

**Table 3.** Demonstration rates of encysted larvae of *P. westermani* from the body parts of infected crayfish(1986)

Stream	Habitat	No. of infected crayfish	Body parts of crayfish			
			Cephalothorax	Gills	Liver	Others*
Namdae	Ducheon	82	72( 87.8)**	45( 54.9)	2(2.4)	—
	Samdang	9	7( 77.8)	3( 33.3)	—	—
	Hadang	3	3(100.0)	—	—	—
Kwang	Sokwang	31	22( 68.8)	11( 35.4)	1(3.2)	—
	Samkeon	1	—	1(100.0)	—	—
Wyangpi	Kusan	1	1(100.0)	—	—	—
Total		127	105( 82.7)	61( 48.0)	3(2.4)	—

\* Others include the heart, leg muscle, and tail muscle.

\*\* Number in parentheses means the percentage.

**Table 4.** Numerical distribution of *Paragonimus* metacercariae in the body parts of crayfish(1986)

Stream	Habitat	No. of crayfish infected	No. of cysts detected	Mean of cyst/ crayfish	Body parts of crayfish		
					Cephalothorax	Gills	Liver
Namdae	Ducheon	82	155	1.9	97( 62.6)	55( 35.5)	3(1.9)
	Samdang	9	11	1.2	8( 72.7)	3( 27.3)	—
	Hadang	3	3	1.0	3(100.0)	—	—
Kwang	Sokwang	31	48	1.5	24( 50.0)	23( 47.9)	1(2.1)
	Samkeon	1	1	1.0	—	1(100.0)	—
Wyangpi	Kusan	1	1	1.0	1(100.0)	—	—
Total		127	219	1.7	133( 60.7)	82( 37.4)	4(1.8)

( ): Percentage.

cercariae per infested crayfish was relatively less; 1.9 in the Ducheon and 1.2 in the Samdang in the Namdae basin, 1.5 in the Sokwang in the bank of Kwang stream, and 1.0 in the Kusan in the vicinity of Wyangpi stream.

### DISCUSSION

Since Miyairi's first report on the demonstration of *Paragonimus* metacercariae from crayfish collected in the stream Keomoon, Chilgok county of Kyungpook Province, many investigators have made studies on the prevalence of the lung fluke among the residents, and on the infestation status for *Paragonimus* metacercariae in the crayfish and crabs. By these studies, the endemic foci of *P. westermani* have been found to be distributed sporadically in the mountainous districts of Kyungpook Province, especially in the Dalseong, Yeongyang, Yeongpung, and Cheongsong counties, in which high infestation rate of the encysted larvae among the crayfish have been reported.

Ulchin county is situated in the hilly and mountainous district of the northeast part of Kyungpook Province, therefore, few reports on the epidemiological studies of *P. westermani* and

other intestinal parasites have been available in this county because of its relative isolation and the lack of attention given to problems of human parasitic diseases.

The results in this study showed that the infestation rate for *Paragonimus* metacercariae from crayfish collected at six habitats in the vicinity of three streams was relatively high but the intensity of infestation with the cysts was low as compared with earlier reports available (Table 5).

In the survey of the intermediate hosts of *P. westermani*, little work was done before the end of the Korean War, although *C. similis* and *Potamon dehaani* were known as the intermediate hosts of the lung fluke in Korea. After the war, the immunodiagnostic, epidemiological, clinical, roentgenologic and therapeutic studies of *P. westermani* in Korea have made remarkable progress with the efforts of medical parasitologists, public health officials, and medical members serving with the U.S. military services.

Park and Song(1961) conducted an epidemiological and clinical studies on paragonimiasis in Korean children, and reported that the most important source of *Paragonimus* infection was crayfish ingestion during measles due to the

**Table 5.** The reported infestation rates of crayfish intermediate hosts with *Paragonimus* metacercariae in Korea

Reported by	Locality	No. of crayfish examined	Infestation rate(%)	Mean/crayfish
Park & Song (1961)	Taegu city	1,164	58.0	—
Ahn <i>et al.</i> (1966)	Namhae county	426	59.0	90.0
Chun (1970)	Haenam county	152	73.6	1.4
Kim <i>et al.</i> (1974)	Dalseong county	218	5.5	—
	Cheongsong county	335	1.8	—
Park & Choi (1974)	Dalseong county	5,505	24.2	5.7
	Yeongyang county	302	10.3	2.7
	Yeongpung county	271	7.4	2.2
	Cheongsong county	115	9.5	2.1
Rim <i>et al.</i> (1975)	Kanghwa county	41	100.0	54.3
Lee <i>et al.</i> (1979)	Kanghwa county	128	90.6	38.6
Choi <i>et al.</i> (1983)	Yeongyang county	57	1.8	2.0
	Dalseong county	160	5.6	2.9
	Cheongsong county	62	8.1	1.6
Lee & Choi (1984)	Yeongpung county	86	3.5	1.3
Park <i>et al.</i> (1984)	Andong county	71	4.2	2.0
Authors (1986)	Ulchin county	817	15.5	1.7

misconception that raw juice of crayfish was effective in bringing out the rash. By their survey on crayfish intermediate host it was found that the infestation rate of *Paragonimus* metacercariae among 1,165 crayfish collected from 5 mountainside streams around Taegu city was 58.0 per cent.

Park and Choi(1974) conducted a comprehensive survey on the distribution of the metacercariae in the second intermediate hosts of the lung fluke, and reported the infestation rate for *Paragonimus* metacercariae among crayfish to be high and that no metacercariae of the fluke both in *Eriocheir japonicus* and in brackish-water crabs were obtained in this Province. They also reported that 49.3 per cent of total metacercariae detected in the Judong stream of Dalseong county were found in the cephalothorax, 26.6 per cent in the gills, 13.5 per cent in the liver, 6.4 per cent in the tail muscle, 2.9 per cent in the leg muscle, and 1.8 per cent in the heart, respectively.

Quite recently, Choi *et al.*(1983) in a study of comparative infestation of *P. westermani* metacercariae from crayfish in same areas surveyed by Park and Choi(1974) reported that the population density and infestation rate of crayfish with *Paragonimus* metacercariae in endemic areas decreased drastically. They also suggested that the pesticides used for agricultural purposes might contribute to the control of *C. sinensis* and *P. westermani* infestation by breaking their life cycles.

In the present study, the infestation rates of *Paragonimus* metacercariae in the crayfish was found to be 15.5 per cent. This result is similar to data reported by Park and Choi(1974) in Dalseong and Yeongyang counties, Choi *et al.* (1983) in Cheongsong county in Kyungpook Province. However, this study showed a lower infestation rate than those reported by Park and Song(1961) in Dalseong county of Kyungpook Province, Ahn *et al.* (1966) in Namhae county of Kyungnam Province, Chun(1970) in Haenam county of Chunnam Province, Rim *et al.*(1975) and Lee *et al.* (1979) in Kanghai county of

Kyunggi Province, although Kim *et al.* (1974), Choi *et al.* (1983), and Lee and Choi (1984) reported much lower figures.

When the demonstration rates for *Paragonimus* metacercariae in various tissues or organs of crayfish in this study were compared with those reported by previous investigators, it seemed that the rate in the cephalothorax was the highest, being found in 87.8 per cent, followed by the gills in 54.9 per cent and the liver in 2.4 per cent. These results are in agreement with the data obtained by Ahn *et al.*(1966), Chun(1970), Park and Choi(1974), Rim *et al.* (1975), and Lee *et al.*(1979), but much lower in the distribution of the crayfish and the infestation rates for *Paragonimus* metacercariae among the crayfish examined.

In present study, the intensity of infestation with the metacercarial larvae in crayfish was very low. The average number of the larvae per infested crayfish was from 1.0 in Kusan stream to 1.9 in Ducheon stream. The results are similar to those reported by Choi *et al.* (1983) in Dalseong and Cheongsong counties, and Park and Choi(1984) in Andong county of Kyungpook Province, but the degree of infestation with the *Paragonimus* metacercariae is lower than that reported by Ahn *et al.*(1966) in the Namhae county in Kyungnam Province, Park and Choi(1974) in Dalseong, Yeongyang, Cheongsong, and Yeongpung counties in Kyungpook Province, Rim *et al.*(1975) and Lee *et al.*(1979) in Kanghai county in Kyunggi Province.

The finding of this study supports the assumption that the low intensity of the larvae infestation in crayfish in Ulchin county may be due to on pesticides and artificial modifications on the water, which are inhibitory on the survival of larval trematodes. According to local officials, there have been newly established roads and factories near the streams and intense pesticides are sprayed in the rice paddies and farms in the vicinity. These may result in the destructive changes of natural environmental conditions, especially in the streams.

## SUMMARY

A study on the population density of crayfish intermediate hosts and infestation status of crayfish with encysted larvae of *Paragonimus westermani* in Ulchin county, Kyungpook Province, Korea was conducted from May to October in 1986.

The population density of the crayfish ranged from 1 to 13, with an average of 4 per man-hour. Among the six habitats, Ducheon had a somewhat higher density than that of the others.

Of eight hundred and seventeen crayfish examined, 127 or 15.5 per cent harboured the metacercarial larvae of *Paragonimus westermani*.

The majority of the larvae were found in three parts of the body: most frequently in the cephalothorax, next in the gills, and then in the liver.

The average number of metacercarial larvae per infected crayfish ranged from 1.0 to 1.9, with an average of 1.7.

Summarizing the results, this study indicates that the population density of crayfish intermediate host and infestation rates for the crayfish with encysted larvae of *Paragonimus westermani* in Ulchin county of Kyungpook Province is relatively high.

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＝國文抄錄＝

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1986년 5월부터 동년 10월까지 폐흡충 침윤지로 알려진 경북 울진군을 관류하는 남대천, 광천, 왕피천에서 가재의 분포상을 조사한 다음 가재에서의 폐흡충 피낭유충 기생상을 조사하였다.

가재의 서식밀도는 한사람이 한시간에 잡을수 있는 가재의 평균수로 표시하였으며, 이번 조사에서는 최소 1마리, 최고 13마리, 평균 4마리를 채집할 수 있었다.

가재에서의 폐흡충 피낭유충 검출률은 총 피집가재 817마리중 127마리(15.5%)였으며, 지역별로는 두천계곡에서 25.1%로 가장 높았다.

가재 체부위별 검출상은 감염가재 127마리에서 총 219개의 피낭유충을 검출하였으며, 이중 두흉부(60.7%), 아가미(37.4%), 간(1.8%)순으로 검출 할 수 있었으며, 감염가재 1마리당 평균 유출수는 1.7개 이었다.

이상의 성적으로 미루어 보아 경북 울진군 남대천, 광천, 왕피천 유역은 아직도 폐흡충 침윤지로 남아 있음을 알았다.

\* 이 논문은 계명대 특수과제 연구비로 이루어 졌음.