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Epidemiological Survey of *Paragonimus westermani* in Ulchin County, Kyungpook Province, Korea*

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INTRODUCTION

Since Ichinomiya's first report on the existence of autochthonous cases of paragonimiasis among the residents in Kyungpook Province, Korea in 1924, many investigators have made studies on the prevalence of *Paragonimus westermani* among the residents (Kim *et al.*, 1974; Kim and Choi, 1977; Shon and Choi, 1977; Lee and Choi, 1979; Choi and Hwang, 1980; Choi *et al.*, 1981), and on the infestation rate for *Paragonimus* metacercariae in crayfish and crab intermediate hosts (Park and Choi, 1974; Choi *et al.*, 1983: Park *et al.*, 1984; Lee and Choi, 1984).

As a result, *P. westermani* infections among the residents are found to be distributed sporadically in the mountainous areas of Kyungpook Province, especially in the Dalseong and Cheongsong Counties, in which high prevalence of the encysted larvae among the crayfish had been reported in the past.

From their studies on the *P. westermani* in Kyungpook Province, Kim and coworkers (1974) reported that *Cambaroides similis* caught in the mountain streams in this district were moderately infested with cysts of *P. westermani*, and that 4.3 percent of residents were infected with this lung fluke.

Afterwards, among the studies on *P. westermani* in the Province, results in Dalseong county have been reported by Chung and coworkers (1974); in Chilgok county by Kim and Choi (1977), Shon and Choi (1977), and Lee and Choi (1979); in Wiseong county by Choi and Hwang (1980) and Choi and coworkers (1981); in Youngpung county by Lee and Choi (1984); in Andong county by Park and coworkers (1984).

However, epidemiological studies on *P. westermani* have not been undertaken in Ulchin county because of its relative isolation and the lack of attention given to the problem of paragonimiasis.

The present paper presents the infestation rates for cercarial and metacercarial larvae of *P. westermani* in the snails and crayfish, and the prevalence of this lung fluke among the residents in Ulchin county, Kyungpook Province.

GEOGRAPHICAL CONDITIONS OF SURVEYED AREAS

Ulchin county is situated in the hilly and mountainous areas of northeast part in Kyungpook Province, Korea at 36.1~37.8 degrees north latitute, having an area of 988 square kilometers, and is bordered on the north by Samcheok county, on the south by Yeongdeok county, on the west by Bonghwa and Yeongyang counties, and on the east by eastern sea of Korea (Fig. 1).

The county is under the influence of a typical continental climate of the eastern coast affected by both high atmospheric pressure from the cold continent and low one from the Pacific

* The results of this survey were presented at the 26th annual meeting of the Korean Society for Parasitology (1984).

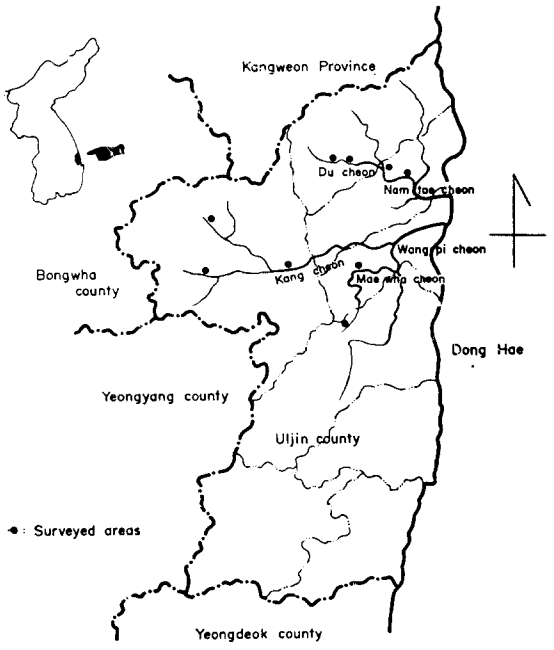

Fig. 1. Surveyed areas in Ulchin(Uljin) county in Kyungpook Province, Korea.

Ocean in the summer season. Therefore, seasonal fluctuation of temperature and precipitation is very large.

The seven localities, Ducheon, Samdang, Hadang, and Chunglim villages in the vicinity of the Namdae stream, Sokwang and Samkeon villages in the bank of Kwang stream, and Kusan village in the Wyangpi basin, in this county were selected as the study areas because the crayfish, the second intermediate host of *P. westermani*, is found in the streams.

The localities are from 100 to 300 meters above sea level and bottom structure of the streams are mainly composed of pebbles and rock, with sand(Table 1).

In all villages the streams are essentially used by the residents for domestic and agricultural purposes.

The water in the streams is relatively permanent and slow-flowing and there are many *Semisulcospira* snails and crayfish in the water.

MATERIALS AND METHODS

1. The snail intermediate host:

From May to October in 1984, the collections of snail, *Semisulcospira libertina*, were made once or twice monthly in the four localities, Ducheon, Samdang and Chunglim villages in the vicinity of the Namdae stream, in two localities, Sokwang and Samkeon villages, in the bank of Kwang stream, and in one locality, Kusan village, in the Wyangpi basin.

The population density of the snail was measured by the approximate number per square meters of stream bed.

The snails were collected by hand and put into dry plastic buckets with aquatic plants and grasses and forwarded to the Parasitology Laboratory. They were examined for the presence of cercariae of *P. westermani* using both immersing and crushing techniques(Miyazaki, 1961).

2. The crayfish intermediate host:

The fresh-water crayfish, *Astacus similis*, were collected in seven localities by hand. The crayfish collected were brought to the laboratory,

Table 1. Environmental conditions at surveyed areas in Ulchin county, Kyungpook Province(1984)

Stream	Village	Administrative district	Bottom structure	Mean of water depth (cm)
Namdae	Ducheon	Buk myun	Pebble and rock	50
	Samdang	Buk myun	Pebble and rock	70
	Hadang	Buk myun	Pebble and rock	80
	Chunglim	Ulchin town	Pebble and sand	140
Kwang	Sokwang	Seo myun	Pebble and rock	40
	Samkeon	Seo myun	Pebble and rock	60
Wyangpi	Kusan	Keonnam myun	Pebble and rock	50

and were dissected into the liver, the heart, the gills, the cephalothorax, and the legs.

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

The metacercariae obtained from the crayfish were fed to dogs.

The adult worms obtained from the dog after 6 months of injection were flattened in 70 per cent alcohol, and stained with Semichon's acetocarmine.

The stained preparations were studied morphologically for the identification of species.

3. Intradermal test:

Epidemiological surveys on paragonimiasis using *Paragonimus* antigen for intradermal test were carried out among the residents aged from 3 to 60 years living in seven localities of Ulchin county. The *Paragonimus* antigen, Lot number 840123, made in the National Institute of Health, Tokyo, Japan was used in the present survey.

Intradermal injections, approximately 0.02ml of 1:10,000 *Paragonimus* antigen(VBS), were made on the volar surface of the forearm. The wheals obtained were measured immediately after the injections, and another measure was taken from 15 to 30 minutes later. Wheals which had increased an average of 4mm or more were considered as positive reactions, 3mm or less were negative while 3.5mm were recorded as doubtful.

4. Sputum examination:

Sputum specimens were collected from individuals who showed a positive intradermal test for paragonimiasis.

The sputum specimens, collected in sterilized bottles, were brought to the Department of Parasitology Laboratory. They were dissolved in 5% NaOH solution, and centrifuged for 5 minutes at 3,000 revolutions per minute.

The supernatant fluid was discarded except for about 0.5ml in which deposit was suspended.

The deposit was put on the microslide, and examined microscopically for *Paragonimus* eggs.

5. Stool examination:

Stool specimens were collected from individuals in Ulchin county during the period from June to October in 1984.

The specimens, collected in cartons, were forwarded to the Parasitology Laboratory and examined by the formalin-ether sedimentation technique (Ritchie, 1948).

RESULTS

The distribution of the *Semisulcospira* snail and the infestation rates for the cercaria of *P. westermani* among the snails collected in the seven habitats in the vicinity of three streams in Ulchin county, Kyungpook Province is presented in Table 2. The distribution ranges and the population density of the snail in the habitats varied considerably. The range of the snail habitats was from 250 to 700 meters, and the approximate number of snails collected in the habitats ranged from 5 to 25, with an average of 15 per square meter of stream beds.

The infestation rate for the *Paragonimus* cercaria in the snails was very low. A total of 6,575 snails were examined for the presence of the cercaria, of which only 1 or 0.152 per thousand snails were found to be infested with *P. westermani*.

Table 3 shows the number of crayfish exa-

Table 2. Snail population density and infestation rates for *Paragonimus* cercaria from *Semisulcospira libertina* caught in habitats in Ulchin county(1984)

Habitat	Approximate range of snail habitat (m)	Approximate No. of snail*	Number of snail examined	Proportion infested per thousand
Ducheon	450	25	3,025	0.33
Samdang	200	15	1,510	0
Hadang	700	20	200	0
Chunglim	300	10	54	0
Sokwang	500	15	1,216	0
Samkeon	400	10	458	0
Kusan	540	5	112	0

* per M^2 of stream bed

Table 3. Demonstration of *Paragonimus* metacercaria from crayfish in surveyed areas in Ulchin county (1984)

Habitat	No. of crayfish examined	Crayfish with metacercaria	
		Number	Percent
Ducheon	187	73	39.0
Samdang	159	9	5.7
Sokwang	134	29	21.6
Samkeon	53	1	1.9
Sangcheon	54	0	0
Kusan	17	1	5.9
Total	604	113	18.7

mined and the infestation rates for *Paragonimus* metacercariae from crayfish in the habitats.

The infestation rates of the encysted larvae from the crayfish examined were 39.0 per cent in the Ducheon and 5.7 per cent in the Samdang in the bank of Namdae stream, 21.6 per cent in the Sokwang and 1.9 per cent in the Samkeon in the vicinity of the Kwang stream, and 5.9 per cent in the Kusan in the Wyangpi basin, respectively.

In Table 4, the prevalence of *P. westermani* among the residents is tabulated by the seven villages and by the number examined and the positive per cent of the reactions.

The prevalence rates for *P. westermani* among the residents in the vicinity of the Namdae stream were relatively high, 42.9 per cent in Ducheon village, 36.8 per cent in Samdang, 31.5 per cent in Hadang, and 31.0 per cent in Chunglim, respectively, while rates among the residents in the Kwang and Wyangpi stream basins were lower, and the prevalence of this lung fluke varied from 10.4 to 18.4 per cent.

Table 5 summarizes the prevalence of *P. westermani*, based on positive intradermal tests, among the residents in Ulchin county by sex and age group. A total of 819 individuals were examined, 211 or 25.8 per cent were found to have positive reactions.

In the sex specific rate of infections, the rate was significantly higher in males than that in females; 30.8 per cent in males and 19.9 per cent in females ($t>2$).

In age specific rate of infections, it was found to be 18.9 per cent in the 0~9 year age group and 23.1 per cent in the 10~19 year age group.

The rates subsequently increased and reached a maximum of 37.5 percent in the 30~39 year age group, after which it remained 35.0 percent, followed by an abrupt decrease in the 60 or older age group.

The comparison of results of *Paragonimus* eggs by means of the sputum and stool examinations at the same time on 92 individuals who showed a positive intradermal test for paragonimiasis in an endemic area, Ulchin county is shown in Table 6. Demonstration of *Paragonimus* eggs by sputum examination was 39.1 per cent, and by stool examination 21.7 per cent.

Table 4. Prevalence of *Paragonimus westermani* among residents in seven different villages in the vicinity of streams in Ulchin county, revealed by *Paragonimus* intradermal test (1984)

Stream	Village	Male		Female		Total	
		No. tested	Percent positive	No. tested	Percent positive	No. tested	Percent positive
Namdae	Ducheon	70	54.3	56	28.6	126	42.9
	Samdang	53	37.7	42	35.7	95	36.8
	Hadang	64	34.4	47	27.7	111	31.5
	Chunglim	39	33.3	32	28.1	71	31.0
Kwang	Sokwang	53	17.0	23	21.7	76	18.4
	Samkeon	137	21.9	136	11.0	273	16.5
Wyangpi	Kusan	26	19.2	41	4.9	67	10.4
Total		442	30.8	377	19.9	819	25.8

Table 5. Prevalence of *Paragonimus westermani* by sex and age group among residents in Ulchin county, Kyungpook Province, revealed by intradermal test (1984)

Age group (Year)	Male		Female		Total	
	No. tested	Percent positive	No. tested	Percent positive	No. tested	Percent positive
0~9	77	18.2	66	19.9	143	18.9
10~19	161	28.6	145	17.2	307	23.1
20~29	39	25.6	31	29.0	70	27.1
30~39	39	46.2	17	17.6	56	37.5
40~49	55	43.6	35	25.7	90	36.7
50~59	43	37.2	40	27.5	83	32.5
60~	28	28.6	43	11.6	71	18.3
Total	442	30.8	377	19.9	819	25.8

Table 6. Comparison of detection rates for *P. westermani* eggs by means of sputum and stool examinations (1984)

Cutaneous reaction	Sputum test			Stool test		
	No. tested	No. positive	Percent positive	No. tested	No. positive	Percent positive
Positive	92	36	39.1	92	20	21.7
Negative	16	0	0	324	2	0.6
Total	108	36	33.3	416	22	5.3

In this instance *Paragonimus* eggs were found in 2 cases or 0.6 percent in 324 stool specimens that showed a negative intradermal test for paragonimiasis.

DISCUSSION

The results obtained in this study generally provide certain evidence that the prevalence for *P. westermani* among the residents in Ulchin county was relatively high, and the crayfish intermediate host caught in the vicinity of three streams, Namdae, Kwang, and Wyangpi which run through the central part of this county were heavily infested with the encysted larvae of *P. westermani*.

Ulchin county is situated in the hilly and mountainous district of northeast part in Kyungpook Province which was admitted from Kangweon Province since 1963. Therefore, the details of the epidemiology of *P. westermani* and other intestinal parasitic diseases in this county have not yet been studied.

A little factual data can be found related to the epidemiology of *P. westermani* and infestation rate of the crayfish host with encysted larvae of this lung fluke in Kyungpook Province, Korea.

Ichinomiya(1924) conducted a survey on the prevalence of paragonimiasis among the residents in the Province, using sputum examination, and reported for the first time that the rate of the fluke was 6.1 per cent. He also commented that the residents are generally fond of crabs, often uncooked or immersed in soybean sauce, and take the liquor of crushed crab or crayfish for the treatment of measles.

These customs seem to be the main cause of this fluke infection in the residents, especially in children.

Similar results have been obtained by Kobayashi(1926) and Bercovitz (1937). After the Korean War, Walton and Chyu (1958) carried out a nation-wide survey on the prevalence of clonorchiasis and paragonimiasis in Korea, and reported that the rate for *P. westermani* among

the residents and officials in Andong, Pohang and Yeongcheon cities was 3.5 per cent, 4.6 per cent and 4.9 per cent, respectively.

Subsequently Kim and coworkers (1974) conducted a comprehensive survey for *P. westermani* in Kyungpook Province, using skin reactions with *Paragonimus* antigen, and reported prevalence rate of this lung fluke among residents to be high, 4.3 per cent, and Shon and Choi(1977) in a study of *P. westermani* in Chilgok county reported a high prevalence of 23.4 per cent, and claimed that three endemic foci of this lung fluke exist in this county.

Quite recently, Choi and Hwang(1980) carried out an epidemiological study of *P. westermani* in the same areas of Wiseong county surveyed by Ichinomiya(1924), and reported that the overall infection rate of this fluke was 4.0 per cent in a total of 569 residents examined. They reached the conclusion that Sam-chun village was still the endemic focus of *P. westermani* on the basis of the positive intradermal reaction of the residents examined and the demonstration of the metacercaria from the crayfish intermediate hosts of lung fluke.

In the present study, the prevalence rate for *P. westermani* among the residents in Ulchin county was found to be 25.8 per cent.

These results are similar to data reported by Kim and coworkers(1974) in Cheongsong and Dalseong counties, Shon and Choi (1977) in Chilgok county, Kyungpook Province, Rim and coworkers(1975) in Kanghwa county, Lee and coworkers(1980) in Pajoo county, Kyunggi Province, Kim and Yang(1964) in Cheju island, Cheon (1970) in Haenam county, Chunnam Province, Korea.

However, this study shows a higher prevalence than those reported by Kim and coworkers (1974) in Sangju, Andong, Taegu, and Yeongyang counties, Kim and Choi(1977) in Chilgok county, Choi and Hwang (1980) in Wiseong county, Kyungpook Province, although Lee and coworkers(1980), Ahn and coworkers (1966), Rim and coworkers(1980) reported much higher figures.

The main factors contributing to the higher prevalence among the residents in Ulchin county than that in other counties, Kyungpook Province were considered to be inadequate public health education, absence of any specific remedy, and socio-economic conditions of this county because of its relative isolation and the lack of attention given to the problem of parasitic diseases.

According to local officials, there has been no reliance put on the therapeutic efficacy of raw juice of crayfish in the treatment of measles by the majority of residents.

The majority of residents in the villages along the sides of the streams enjoy the collection of the crayfish and also consuming raw or uncooked crayfish with rice-wine, but are not concerned about infection of *P. westermani*.

The sex specific rate for *P. westermani*, with the prevalence significantly higher in males than in females at all ages, is in agreement with previous findings(Ichinomiya, 1924; Walton and Chyu, 1958; Kim *et al.*, 1974; Joo, 1977: Shon and Choi, 1977; Kim and Choi, 1977; Joo, 1979; Choi and Hwang, 1980; Choi *et al.*, 1981).

Likewise, the prevalence being higher among males than females suggests that this is probably related to some differences in the opportunities of eating raw or uncooked crayfish intermediate hosts as was observed in cases of other fluke infections.

As Kim and coworkers (1974) indicated, males have more opportunities to go mountain climbing than females and are fond of collecting crayfish in the streams, where they eat raw or uncooked crayfish. A study of Joo (1977) mentioned that adult males were fond of rice-wine with uncooked crayfish, but women usually were not, and did not share such a habit.

In the studies of the crayfish intermediate hosts of *P. westermani* in Kyungpook Province, Park and Choi (1974) carried out a study on the distribution of the metacercariae in the second intermediate hosts of the lung fluke, and reported that 1,394 or 7.6 per cent among 18,452 crayfish

were infested with the encysted larvae and that 49.3 per cent of total metacercaria detected were found in the cephalothorax and 26.6 per cent in the gills and the other 24.1 per cent in the liver, heart and other parts of the body.

Choi and coworkers(1983) in a study of comparative infestation of *P. westermani* metacercaria from crayfish in same endemic areas surveyed by Park and Choi(1974) reported that the population density of crayfish in the areas and the infestation rate for the crayfish with the encysted larvae of this lung fluke were drastically decreased.

In the present study, a total of 604 crayfish were examined, and of these 18.7 per cent were infested with encysted larvae of *P. westermani*. The results obtained in this study are similar to those reported by Park and Choi(1974), but the degree of infestation with the metacercaria is higher than that reported by Kim and coworkers(1974), Choi and coworkers(1983), Park and coworkers(1984), and Lee and Choi(1984).

In the studies of the first intermediate hosts, *Semisulcospira libertina*, of *P. westermani* and the infestation rate for the snails with the cercariae of digenetic trematodes in Korea, Kobayashi(1918) in a study of cercariae from *Semisulcospira* snails collected in the several areas of Korea found twelve kinds of cercariae.

From their studies on the cercariae parasitic to *S. libertina* in Kimhae plain, Han and Chun (1963) reported six species of larval trematodes, *Cercaria acanthatrium*, *Cercaria longicerca*, *Cercaria yoshidae*, *Metagonimus* species, and four kinds of undetermined cercariae. Quite recently, Choi and coworkers(1982) conducted an infestation pattern of larval trematodes in *Semisulcospira* snails in one of the endemic areas of *P. westermani* in Kyungpook Province, and reported that the infestation rate for the *Paragonimus* cercaria among the snails was relatively low, being 0.04 per cent by the immersing and crushing techniques, and the rate of snails with larval trematodes was decreased.

In this study, the population density of *Semisulcospira* snails in three streams surveyed in Ulchin county is relatively abundant and the infestation rate for the cercariae of *P. westermani* among the snails collected in the habitats was found to be 0.0152 per cent.

These results are in agreement with the data obtained by Choi and coworkers(1982) in Dalseong county, Park and coworkers(1984) in Andong county. Lee and Choi(1984) in Youngpung county, Kyungpook Province, but the degree of infestation with cercaria of *P. westermani* is lower than that reported by Choi and coworkers(1982).

As previously indicated by Choi and coworkers (1982), the demonstration of *Paragonimus* cercaria from the snails has become apparently difficult in recent years. They also indicated that the large-scale use of pesticides, the destruction of natural environment by constructing dams and ponds in the upper streams, and a longer drought all year round in recent years would affect the ecology of snails and survival of larval trematodes in the streams.

It has been known that existence of the first intermediate hosts, *S. libertina*, and second intermediate hosts, crayfish and crabs, are essential factors in determining *Paragonimus* endemicity.

The surveyed areas in this study are located in the vicinity of stream Namdae, Wyangpi and Kwang in Ulchin county. The water in the streams is relatively permanent and slow-flowing and there are many *Semisulcospira* snails and crayfish in the water.

It is found in the present study that Ulchin county is one of the newly found endemic areas of *P. westermani*, on the basis of the infective cases found among the residents examined and demonstration of the *Paragonimus* metacercariae from the crayfish intermediate host of this lung fluke.

SUMMARY

In order to determine the epidemiological pattern of the *Paragonimus westermani*, the infestation rates for the cercarial and metacer-

carial larvae of digenetic trematodes in the snail and crayfish hosts, and the prevalence of *Paragonimus westermani* among the residents in the vicinity of the stream Namdae, Wyangpi, and Kwang, in the Ulchin county, Kyungpook Province were studied from March to October in 1984.

The population density of the snails per square meter of the habitats ranged from 5 to 25, with an average of 15. Among the seven habitats, one, Ducheon, had snails infested with the cercariae of *Paragonimus westermani*, and the proportion of infested snails was very low, the average being 0.152 per thousand.

Of six hundred and four crayfish examined, 113 or 18.7 per cent harboured the encysted larvae of *Paragonimus westermani*. A high infestation rate for the metacercariae in the crayfish was found in two habitats; 39.0 per cent in the Ducheon and 21.6 per cent in the Sokwang.

The prevalence of *Paragonimus westermani* among the residents in Ulchin county was relatively high, 25.8 per cent by the *Paragonimus* intradermal tests, and the difference in the rate of infection between males and females was found to be significant ($t>2$).

The results obtained in this study indicate that endemic foci of *Paragonimus westermani* exist in Ulchin county and the prevalence of this lung fluke among the residents is relatively high.

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＝國文抄錄＝

慶北 蔚珍郡에서의 肺吸蟲 疫學的 調査*

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慶北 蔚珍郡에서의 肺吸蟲 浸潤狀을 알아보기 위해 1984年 3月부터 10月까지 肺吸蟲의 第1中間宿主, 다슬기의 分布狀과 이들 다슬기에서의 肺吸蟲 有尾幼蟲의 寄生狀, 第2中間宿主, 가재에서의 本蟲 被囊幼蟲 寄生狀 및 住民들에서의 肺吸蟲 感染狀을 調査하였다.

蔚珍郡에서 7個地域의 다슬기 棲息處를 發見하였으며, 이들 棲息處에서의 다슬기의 分布密度는 河床 1m²當 5~25個, 平均 15個였으며, 이들 다슬기에서의 肺吸蟲 有尾幼蟲의 寄生率은 매우 낮아 0.0152%였다.

肺吸蟲의 第2中間宿主, 가재에서의 本蟲 被囊幼蟲 檢出率은 18.7%(604마리중 113마리)였으며, 이중 두천溪谷에서는 39.0%로 가장 높았으며, 그 다음은 소광溪谷(21.6%), 구산溪谷(5.9%) 순이었다.

蔚珍郡 住民 819名에서의 肺吸蟲 感染率은 25.8%였으며 性別 感染率에 있어서 男性은 30.8%, 女性은 19.9%로써 男女間의 有意的 差를 認定할 수 있었다($t>2$).

年齡群別 感染率에 있어서는 0~9세 18.9%로 시작하여 年齡이 많아질수록 그 率이 漸次로 增加하여 30~39세 群에서 37.5%로 最高置를 나타내었다.

以上의 成績으로 미루어 보아 慶北 蔚珍郡에서는 肺吸蟲 流行地域으로 남아있을 뿐만 아니라, 住民들에서의 肺吸蟲感染率은 아직도 높음을 알았다.

* 이 논문은 계명의대 특별연구비로 이루어졌음.