Seasonal Variation of Snail population of *Parafossarulus manchouricus* and larval trematode infection in River Kumho, Kyungpook Province, Korea*

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INTRODUCTION

The possible existence of *Clonorchis sinensis* (*C. sinensis*) cercaria in the snails collected in the river Napook, Nanam, Hampook Province, Korea was first reported by Hirose (1913). He found a larval trematode thought to be the cercaria of *C. sinensis*.

In the same year, Muda (1913) found that the snails collected from a river in Haeju city, Whanghae Province, Korea harbored the cercaria of *Metagonimus* species and the fresh-water fish caught in the same river had the metacercaria of the fluke.

Kobayashi (1917) described the twelve kinds of cercariae found from the fresh-water snail, *Semisulcospira* species, which were collected in several parts of Korea. The additional description of Kobayashi (1918) was presented on the eight kinds of cercariae found in Kyung-gi and Chun-nam Provinces and one furcocercous cercaria in the vicinity of Seoul, Korea.

In the meantime, Kobayashi (1914) was successful for the first time in determining the second intermediate hosts of *C. sinensis*, based on the discovery of encysted larvae from the

fresh-water fishes belonging to the family Cyprinidae in Japan.

From 1918 to 1920, Muto has made persistent efforts to discover the first intermediate host of *C. sinensis*, and he found the cercaria of *C. sinensis* from *Parafossarulus manchouricus* (*P. manchouricus*) snails which were collected in the vicinity of lake Biwa, Japan. As a result, the life cycle of *C. sinensis* was clearly established.

Kobayashi (1922) presented the unifying technique in describing the morphological features of cercariae, with an additional report of the thirteen kinds of cercariae newly found in Korea.

Shiba (1933) found two species of *Parafossarulus* snail, *Bulimus striatus* Benson and *Bulimus kiusiuensis* Hiradie in Korea, and reported that *Bulimus striatus* would seem to serve as the first intermediate host of *C. sinensis* but the role of *Bulimus kiusiuensis* is unknown.

In the studies in the river Kumho, Kyungpook Province, investigations dealing with the infestation of *P. manchouricus* snails with the cercaria of *C. sinensis* were made by Nishimura (1943), Lee and Kim (1958), and Choi *et al.* (1975). A survey taken in the Kimhae area, Kyungnam Province, Korea, Chun (1963) found many *P. manchouricus* snails infested with many kinds of larval trematodes.

* The results of this study were presented at the Spring meeting of the Korean Society for Parasitology in 1980.

It has been well known that the existence of *P. manchouricus* snails and the infestation of the snails with the cercaria of *C. sinensis* in a certain area are essential factors in determining its endemicity.

The present paper summarizes the seasonal variation of the snail population and the infestation rates for the cercariae of digenetic trematodes carried out in the river Kumho, Kyungpook Province, Korea from 1975 to 1979.

GEOGRAPHICAL CONDITION OF SURVEYED AREA

The snail habitat is the river-bed of Kumho approximately 100 meters in length located

Fig. 1. Map of Taegu city in Kyungpook Province, showing Dongchon, snail habitat in the river Kumho.

under the bridge A-yang, in Dongchon, Taegu city. It is 30 kilometers by road to Yeongcheon town, Kyungpook Province, and lies in the northeast district of Taegu city (Fig. 1).

The river Kumho has its origin in the northeast corner of Yeongcheon town. It is about 2 kilometers from the town, where two streams Jaho and Kochon join, and then run through two counties, Yeongcheon and Kyungsan, followed by Taegu city. It then joins the river Nakdong in Dalseong county, Kyungpook Province, Korea. There are 16 rivulets in the basin.

The snail habitat is about 20 meters above sea level and the soil is composed of sand, mud and rock. The water in the river is relatively permanent, slow-flowing and usually contains abundant organic material and sewage.

The water level in the habitat is fairly constant except 2 to 3 days after heavy rain. Many types of marsh plants and grasses covers the entire area. There are many kinds of freshwater fish and *P. manchouricus* snails in the water.

MATERIALS AND METHODS

In order to determine the seasonal variation of the snail population, that is, the earliest time in the year snail begin to appear, the time of the highest snail population, and the time the snail disappear in the habitat, the authors canvassed the Dongchon snail habitat of Taegu city, in Kyungpook Province, Korea.

The collections of snails, *P. manchouricus* were made once or twice weekly in the habitat from February 5, 1975, to August 22, 1979. The density of the snail population was measured by the approximate number of snails collected per square meter of river bed. The snails were collected by hand and put into dry plastic buckets with marsh plants and grasses and forwarded to the Parasitology laboratory.

In order to determine the infestation of snails

with the cercariae of digenetic trematodes, the snails collected were examined using both immersing and crushing techniques (Komiya and Suzuki, 1964). Ten or twenty snails were isolated in petri-dishes containing about 40ml of tap water for 24 hours, and observations made on the liberation of cercariae of digenetic trematodes. In each dish, the snails revealing trematode cercariae were crushed to determine the total percentage infection.

In order to determine the specific name of cercariae, the morphological features of larvae liberated from the snails were first studied in the living state. Neutral red was frequently used in *intra vitam* staining to differentiate the germinal material from the rest. Some of the cercariae shed from the snails were then stained with Semichon's acetocarmin and the observations made supplemented those made on living material.

In order to determine the arrangement and the total number of flame cell in a cercaria, the living specimens stored in a refrigerator were put on the slide glasses and the cover glass slipped on. All the edges of the cover glass were then sealed with paraffin-vaseline mixture. Observations were made under the oil immersion lens. Usually, flame cells and tubules could be seen under considerable cover glass pressure, but the excretory system of *C. sinensis* cercaria is very difficult to trace because of the existence of pigmented masses in the entire body and the fine structure of canals.

The keys of morphological characteristics of larval trematodes are as follows:

Cercaria of *C. sinensis* (Cobbold, 1875)

The mature cercaria is parapleuro-lophocercous in form and its body length is 220~240 μ m and width 62~93 μ m. The tail is 360~480 μ m in length and 34~45 μ m in width at the level of its junction with the body. Minute spines and 7 pairs of slender sensory hairs are present on the surface. The oral sucker (30~45 $\times$ 23~35 μ m) and pharynx (11 $\times$ 12 μ m)

are distinct, but the acetabulum, oval in shape and one third of the oral sucker in size, is not fully developed. The penetrating glands consisting of 7 pairs are fine granular and the esophagus and intestinal ceca are faintly outlined. The excretory bladder is inverted triangular or oval in shape and occupies the posterior part of the body. The genital anlage is faintly outlined as a cell mass dorsal to the acetabulum (Microphotograph 1).

The main excretory canal originates at the upper corner of the bladder and runs upward to mid-body, where the canal divides into anterior and posterior collecting tubes. The anterior collecting tube divides again into two tertiary collecting tubes and the posterior tube into three, each connecting with three flame cells by their collecting capillaries. Thus the flame cell formula is $2 \times [(3+3) + (3+3+3)] = 30$.

The details of morphological and biological features of this cercaria were presented by Muto (1918 a and 1918b), Ito (1926), Komiya and Tajimi (1940), Komiya (1961), Ito (1962) and Chun (1963).

Cercaria of *Cyathocotyle orientalis*

Faust, 1921

The cercaria liberated is fork-tailed in shape and its body is 135~230 $\times$ 70~130 μ m in size. The oral sucker (35~45 $\times$ 27~30 μ m), prepharynx (5 μ m), pharynx (15~18 $\times$ 15~20 μ m) and esophagus (10~15 μ m) are distinct. The length of the tail stem is 240~350 $\times$ 30~50 μ m in size and that of the furca is 190~250 $\times$ 20~30 μ m.

Minute spines and 10 pairs of sensory hairs are present on the surface of the body. The excretory bladder is small and the main excretory canals consists of 2 pairs anastomosed together. The flame cell formula is $2 \times [(3+3) + (3+3)] = 24$.

At the same time, minute spines on the furca are present and the excretory canal of the tail opens at the terminal of the furca (Microphotograph 2).

The details of morphological features were reported by Yamaguti (1940), Inatomi (1953), Ito (1962) and Chun (1963).

Cercaria of *Exorchis oviformis*

Kobayashi, 1915

The morphology of *Exorchis oviformis* cercaria is

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Plate 1. Microphotographs and the schematic figures of cercariae (larval fluke) found from the snail, *Parafossarulus manchouricus* (1mm=20 μ m)

1. *Clonorchis sinensis*

2. *Cyathocotyle orientalis*

3. *Exorchis oviformis*

4. *Loxogenes liberum*

similar to that of *C. sinensis*. The cercaria is para-pleuro-lophocercous in forms, its body ($148\sim 200\times 80\sim 100\mu\text{m}$) is elongated pyriform and it has a pair of pigmented eye spots. The oral sucker is round ($22\mu\text{m}$) and has a small brush-like arrangement at the dorsal side of the mouth. The esophagus and intestine are not outlined. The acetabulum is not yet developed. 7 pairs of fine granular penetrating glands are large cells situated in the middle of the body.

The tail attached to the dorsal part of the body is about twice the body length and has a thin broad membrane on the ventral and dorsal sides (Microphotograph 3). The excretory bladder is V-shaped. The flame cell pattern is $2\times[(2+2)+(2+2)]=16$.

The details were reported by Okabe (1936), Komiya and Tajimi (1940) and Chun (1963).

Cercaria of *Loxogenes liberum* Seno, 1907

The cercaria liberated is oval and has minute spines and 13 pairs of sensory hairs on the surface of body. The body measures $145\sim 200\times 60\sim 80\mu\text{m}$, the tail $90\sim 180\times 20\sim 30\mu\text{m}$ and the oral sucker $40\sim 45\mu\text{m}$. The acetabulum is $28\sim 30\mu\text{m}$ in size, situated a

little behind the middle of the body. The stylet $20\sim 30\times 5\sim 6\mu\text{m}$ in size is present in the oral sucker. 4 pairs of penetrating cells are present, of which the anterior 2 pairs are of coarse granular and the posteriors of fine granular materials (Microphotograph 4).

The flame cell formula is $2\times[(2+2)+(2)]=12$. The details were reported by Kobayashi (1922), Faust (1924), Origi (1930), Okabe (1937) Yamaguti (1937 and 1938), and Chun (1963).

RESULTS

Table 1 presents the earliest dates when snails appear and the water temperature at that time in Dongchon habitat of the river Kumho. From 1975 to 1979, the snails firstly appeared on the river-bed was consistently in April, between the 4th and 11th days. At that time, the water temperature measured at 2~3 p.m. in the habitat ranged from 13 to 14°C and the average number of snails per square meter of the river bed was 2 to 8.

Table 1. Five years' observations of the earliest dates snails begin to appear and the water temperature at that time in Dongchon* habitat of river Kumho, Kyungpook Province, Korea

Year	Earliest date when snail appeared	Water temperature at 2~3 p.m.	Avg. No. of snails/m ²
1975	April 4	13°C	8
1976	April 11	14°C	3
1977	April 4	13°C	2
1978	April 6	14°C	2
1979	April 8	14°C	2

* Dongchon is a part of Taegu city.

Table 2. Dates of peak population of *Parafossarulus manchouricus* and the water temperature at the time in the habitat of river Kumho

Year	Dates of peak population	Water temperature at 2~3 p.m.	Maximum No. of snails/m ²
1975	June 25	25°C	153
1976	June 23	24°C	40
1977	June 29	26°C	38
1978	June 28	25°C	22
1979	June 26	26°C	17

In Table 2, the dates the maximum number of snails were found in the habitat of river Kumho are listed according to the year studied.

The highest population density of snails in the habitat was encountered in late June, every year, between 23rd and 29th. The temperature of the water was between 24 and 26°C. The maximum number of snails in the habitat in 1975 was 153 per square meter. In 1976 the number decreased to 40, and to 38 in 1977, dropping again to 22 in 1978 and 17 in 1979.

The dates of the disappearance of the snails from Dongchon habitat of the river Kumho and the temperature of water at that time is presented in Table 3. The snails disappeared from the habitat in early and mid-November, between November 3 and November 17. The temperature of the water at that time ranged from 10 to 13°C.

Table 3. Dates of disappearance of snail from Dongchon habitat of river Kumho and water temperature at the time

Year	Date of disappearance of snail	Water temperature at 2~3 p.m.
1975	November 17	12°C
1976	November 12	13°C
1977	November 9	10°C
1978	November 6	13°C
1979	November 3	12°C

Table 4 summarizes the monthly changes of snail population in Dongchon habitat of the river Kumho in the Province, from 1975 to 1979. In general, the snails were collected for the 8 months, April to November, every year. For instance, in 1976, the average number of snails in April was 9.3, it increased to 20.8 in May, and reached the peak, 30.5, in June. In July, the average decreased to 27.3, in August to 15.8, in September to 10.5, in October to 5.3, and in November to 1.3.

The general pattern of monthly changes of snail population in the other years is similar to those for 1976. The average snail population in the habitat in 1975 was 115.9, whereas the average in 1976 dropped abruptly to 30.5 and remained at approximately the same value, 29.3 in 1977. It then decreased at considerably lower rates, with the average of 18.7 in 1978 and 14.5 in 1979.

Table 5 lists the infection rates of cercariae of digenetic trematodes among the snails collected in Dongchon habitat of the river Kumho.

Four species of larval trematodes, *Clonorchis sinensis*, *Cyathocotyle orientalis*, *Exorchis oviformis* and *Loxogenes liberum* were found. Of these, the most frequently liberated cercaria was *Loxogenes liberum* 43.3 per cent, followed by *Exorchis oviformis* 6.2 per cent and *Cyathocotyle orientalis* 1.5 per cent. The least fre-

Table 4. Monthly changes in snail population in Dongchon habitat of river Kumho, Kyungpook Province, Korea (1975 to 1979) as revealed Number of snails per m² of river bed

Month	1975		1976		1977		1978		1979	
	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average
April	8-28	16.2	3-21	9.3	2-23	9.8	2-10	6.3	2-5	3.5
May	42-93	75.5	16-25	20.8	18-25	21.2	8-15	12.0	5-8	6.8
June	72-153	115.9	21-40	30.5	25-38	29.3	15-22	18.7	13-17	14.5
July	63-90	75.0	21-35	27.3	25-30	27.8	12-18	15.8	12-14	12.7
August	26-42	31.3	11-28	15.8	12-20	15.7	10-15	12.2	6-10	8.0
September	10-25	17.3	9-13	10.5	7-10	8.0	6-10	7.3		
October	5-8	6.7	4-7	5.3	3-5	4.3	4-5	4.3		
November	1-3	2.3	1-3	1.3	1-3	1.5	1.3	1.5		

Table 5. Five years observation of larval digenetic trematodes from the snail, *Parafossarulus manchouricus* in Dongchon habitat of river Kumho, Kyungpook Province, Korea

Year studied	Snail No. examined	<i>C. sinensis</i> *		<i>C. orientalis</i> **		<i>E. oviformis</i> ***		<i>L. liberum</i> ****	
		No. pos.	Per cent	No. pos.	Per cent	No. pos.	Per cent	No. pos.	Per cent
1975	6,880	7	0.10	147	2.1	598	8.7	3,146	45.7
1976	4,950	6	0.12	85	1.7	322	6.5	2,310	46.7
1977	4,180	6	0.14	48	1.1	265	6.3	1,692	40.5
1978	3,210	4	0.12	26	0.8	103	3.2	1,358	42.3
1979	3,050	3	0.10	22	0.7	92	3.0	1,167	38.3
Total	22,270	26	0.12	328	1.5	1,380	6.2	9,673	43.4

* *C. sinensis* : *Clonorchis sinensis*

** *E. oviformis* : *Exorchis oviformis*

*** *C. orientalis* : *Cyathocotyle orientalis*

**** *L. liberum* : *Loxogenes liberum*

Table 6. Monthly liberation rates for larval trematodes from snails collected in Dongchon habitat, Kyungpook Province, Korea (1975~79)

Month	Snail No. examined	<i>C. sinensis</i>		<i>C. orientalis</i>		<i>E. oviformis</i>		<i>L. liberum</i>	
		No. pos.	Per cent	No. pos.	Per cent	No. pos.	Per cent	No. pos.	Per cent
April	2,260	0	0	9	0.4	28	1.2	900	39.8
May	3,840	3	0.08	44	1.2	193	5.0	1,505	39.2
June	5,050	9	0.18	105	2.1	361	7.2	2,509	49.7
July	5,220	8	0.15	101	1.9	406	7.8	2,622	50.2
August	3,310	6	0.18	48	1.5	281	8.5	1,659	50.1
September	1,800	0	0	19	1.1	99	5.5	737	40.9
October	790	0	0	2	0.2	12	1.5	117	14.8

quently liberated was *Clonorchis sinensis*, 0.1 per cent.

The monthly liberation rates for larval trematodes from the snails collected in Dongchon habitat are summarized in Table 6. In general, the liberation rates in the four kinds of larval trematodes were higher in June, July and August than in the other months of the year studied. The cercarial infection rates for *C. sinensis* were low, being between 0.08 and 0.18 per cent, but the rate for *Loxogenes liberum* was high, 39.8 per cent, even in April, continuing at fairly high rates from May to September, then dropping abruptly in October.

The cercarial infection rates for *Cyathocotyle orientalis* and *Exorchis oviformis* were quite low. The rate in the former was around 1.0 per cent and the latter around 5.0 per cent.

DISCUSSION

Kyungpook Province has been known as one of the endemic areas of *C. sinensis* in Korea. The epidemiological studies on *C. sinensis* in Kyungpook Province revealed a marked reduction in the prevalence of fluke among the residents (Choi *et al.*, 1973). In addition, the intermediate hosts studies indicated the reduction in the infestation of the snails with the cercaria of *C. sinensis* (Choi *et al.*, 1975) as well as the fresh-water fish with the metacercaria of the fluke (Choi, 1976). However, the details of the ecology of snail host in the vicinity of river Kumho have not yet been studied.

A little factual data can be found relative to the ecology of *P. manchouricus* snail and the

infestation rate of the snail with the cercaria of *C. sinensis* in Korea. Hirose (1913) reported for the first time in Korea that a kind of cercaria, similar to the cercaria of *C. sinensis* was found from the snails collected in Nanam, Hampook Province, Northern part of Korea. The results reported by Hirose (1913) are different from the data obtained by many investigators (Kobayashi, 1918; Kobayashi, 1925; Shiba, 1933; Nishimura, 1943; Lee and Kim, 1958) who observed that the distribution of *P. manchouricus* was limited to the southern parts of Korea.

On the other hand, Matsumoto (1915) conducted a survey of clonorchiasis for the first time in Korea. It was found that the prevalence of *C. sinensis* in 349 schoolchildren in the vicinity of Taegu was 18.6 per cent. At that time, no snail host survey was done.

In order to determine the role of snails as an intermediate host for *C. sinensis*, many freshwater snails in Korea were tested by Kobayashi (1914), but the determination of the intermediate snail host of *C. sinensis* was not successfully proved. In Japan, Muto (1918a, b) succeeded for the first time in proving that one of the *Parafossarulus* snails, *Bithynia striatula* var. *japonicus*, serves as the first intermediate host of *C. sinensis*. After Muto's important discovery, some ecological studies of the snails, *P. manchouricus*, were conducted.

Kobayashi (1925) succeeded in collecting the snails in the two tributaries of the river Nak-tong, and Shiba (1933) collected 2 species of *Parafossarulus* snails thought to be native snails in Korea, and stressed that one of the *Parafossarulus* snails would seem to serve as the intermediate host of *C. sinensis*.

Ten years later, Nishimura (1943) conducted a survey for *C. sinensis* in the Yeongcheon area in Kyungpook Province. From the snail survey, it was found that of the 213 snails collected

and examined for the presence of *C. sinensis* cercaria, 43.7 per cent, about half, harbored the larval trematode. Lee and Kim (1958) reported that 7.0 per cent of snails examined were infested with the cercaria in the river Kumho. Chun (1963) conducted a snail survey for the cercariae of digenetic trematodes among the snails collected in Kimhae plain, Kyungnam Province, and reported that seven kinds of cercariae were found, and their infestation rates ranged from 0.5 to 9.7 per cent. These results differ from those of recent studies in the river Kumho (Choi *et al.*, 1975) and Taeka (Choi, 1978) in Kyungpook Province, and in the river Nam (Choi, 1977) and Hwang (Hwang, 1978) in Kyungnam Province, and also in the present study. It was found that the snail, *P. manchouricus*, exists in very small numbers in limited areas within the rivers, and the infestation of the snails with the cercaria of *C. sinensis* is very low.

The present study revealed that the population density of snails in the habitat is low and has decreased over the five-year period from 1975 to 1979. The results given in Tables 1, 2, 3, and 4 show an expected decrease in the distribution and population density of the snails in the river Kumho. Choi *et al.* (1975) reported that *P. manchouricus* snails found in abundance until 1973 in the habitat of river Kumho. Now they are rare intermediate host, and demonstration of *C. sinensis* larvae from the snails has become apparently difficult in recent years.

It is of interest to note that the cercariae of *C. sinensis*, *Cyathocotyle orientalis*, and *Exorchis oviformis* have rarely been found in *P. manchouricus* in spite of the continued high rate of the cercaria of *Loxogenes liberum* from the snails collected in the same habitat.

The maintenance of high infestation rate of snails with the cercaria of *Loxogenes liberum* can hardly be explained. However, in the vicinity

of the river Kumho, large amount of pesticides have been widely used on the farm, and it seems quite possible that the cercaria of *Loxogenes liberum* is resistant to pesticides, whereas other cercariae are pesticide sensitive. Recently, Soh *et al.* (1980) reported that cercariae of *Loxogenes liberum* were destroyed in 50 minutes in 20µg/ml of mercury, and 2 hours in 20µg/ml of copper.

Other factors might be sought as contributing to the changing patterns. The massive drainage of industrial and home wastes into the river would affect the survival of snails and larval trematodes.

SUMMARY

Studies were conducted to determine the ecology of the snail, *Parafossarulus manchouricus*, the seasonal variation of the snail population, and the infestation rates of these snails with the cercariae of digenetic trematodes, in the snail habitat of river Kumho, in Dongchon of Taegu city, in Kyungpook Province, Korea, from 1975 to 1979.

The earliest time the snails were found was early in April every year. At that time the water temperature ranged from 13 to 14°C. The population density of the snails ranged from 2 to 8 per square meter.

The highest population density of snails was encountered in late June and the water temperature was between 24 and 26°C. The snails disappeared in early and mid-November, when the water temperature dropped to 10~13°C.

The average snail population in June was 115.9 per square meter in 1975 but in 1976 dropped abruptly to 30.5 and remained at approximately the same level in 1977. It then decreased at considerably lower rates, with the average of 18.7 in 1978 and 14.5 in 1979.

The snails collected in the habitat were ex-

amined for the presence of cercariae of digenetic trematodes. Of these, four species, *Clonorchis sinensis*, *Cyathocotyle orientalis*, *Exorchis oviformis*, and *Loxogenes liberum* were found. The most frequently liberated cercaria was *L. liberum* 43.3 per cent, followed by *E. oviformis* 6.2 per cent and *C. orientalis* 1.5 per cent. The least frequently liberated was *C. sinensis* 0.1 per cent.

In the monthly liberation rates for larval trematodes, the higher rates were observed in June, July, and August every year, and the cercarial rates for *Clonorchis sinensis*, *Cyathocotyle orientalis* and *Exorchis oviformis* demonstrate a fairly consistently fluctuating downward trend over the five-year period, except for *Loxogenes liberum*.

Summarizing the results, this study indicated that the population density of snails in the habitat and the infection of the snail with the cercariae of digenetic trematodes has decreased over the five-year period from 1975 to 1979.

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= 國文抄錄 =

慶北 琴湖江 쇠우렁棲息處에서의 쇠우렁의 分布 및 吸蟲類 有尾幼蟲의 季節의 寄生狀

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1975년부터 1979년까지 5년동안에 慶北 大邱市 東村 琴湖江 쇠우렁棲息處에서 肝吸蟲 第1中間宿主 쇠우렁의 分布狀과 그 生態를 調査함과 아울러 이들 쇠우렁에서의 吸蟲類 有尾幼蟲의 寄生狀을 調査하였다.

쇠우렁棲息處에서 쇠우렁을 처음으로 찾아 볼 수 있는 時期는 每年 4月 初旬이었고, 이 期間 中 水溫은 13°C ~ 14°C였으며 쇠우렁의 分布密度는 棲息處 1m²當 2~8個였다.

쇠우렁의 最大 分布密度는 每年 6月下旬에 나타났고 이 期間 中 水溫은 24°C~26°C였으며, 11月 初旬과 中旬 사이에는 棲息處 河床表面에서 쇠우렁을 찾아 볼 수 없었으며 이때의 水溫은 10°C~13°C였다.

年度別 쇠우렁의 6月中 分布密度는 1975年 平均 115.9個였던 것이 1976년에는 平均 30.5個로 激減되었고 1977년에는 그 平均이 29.3個로 前年の 平均値와 비슷 하였으며, 1978年과 1979年の 平均値는 더욱 低下되어 각각 18.7個 및 14.5個였다.

쇠우렁에서 肝吸蟲, *Cyathocotyle orientalis*, *Exorchis oviformis*, 및 *Loxogenes liberum* 모두 4種의 吸蟲類 有尾幼蟲이 遊出되었다.

이 가운데서 *Loxogenes liberum* 有尾幼蟲의 遊出率은 43.4%로서 가장 높았고 肝吸蟲 有尾幼蟲의 그率は 0.1%로서 가장 낮았으며, *Cyathocotyle orientalis*, *Exorchis oviformis* 幼蟲에서는 各各 1.5% 및 6.2%로서 中間値를 나타내었다.

吸蟲類 有尾幼蟲의 月別 遊出率에 있어서는 大體로 6, 7 및 8월에 高率을 나타내었고, 年度別 遊出率은 *Loxogenes liberum*을 除外하고는 漸次로 低下되었다.

以上の 結果로 미루어 보아 慶北 大邱市 東村 琴湖江의 쇠우렁棲息處에서 쇠우렁은 每年 減少 될 뿐만 아니라 이들 쇠우렁에서의 吸蟲類 有尾幼蟲의 寄生率도 低下 됨을 알았다.