

## Metacercarial Density of *Metagonimus yokogawai* in *Plecoglossus altivelis* in Kyungpook Province, Korea\*

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*Tribolodon hakonensis*, the sea-run dace, taken from the rivers in Kyungpook Province have frequently been found to harbor a number of the metacercariae of *Metagonimus yokogawai* (*M. yokogawai*).

Although this fish is known to be able to live in both fresh and salt water, it is generally agreed that the young fish are infected with the metacercaria of *M. yokogawai* during their growth in the fresh-water. In addition, most of the metacercariae of the fluke, as indicated by Choi et al. (1966), were found in the scales of sea-run dace.

Recently, Chun (1960a) found *M. yokogawai* in 54 per cent of 100 *Plecoglossus altivelis*, the sweetfish, caught in the river Namcheon, running through Milyang City, Kyungnam Province, Korea. He (1960b) found a trematode belonging to *Metagonimus takahashii* from *Carassius carassius* in Kimhae and Sasang areas. Kang et al. (1964) recovered *M. yokogawai* from 93.3 per cent of 56 sweetfish collected in Cheju Province (Quelpart Island).

In a study of the larval trematodes of fresh-water fish collected in the river Kumho in Kyungpook Province, 11 species of fish were found to harbor the cyst of *Metagonimus* species (Lee, 1968). Thus, the data reported by nume-

rous workers seemed to indicate that most of the cysts are parasitized on the scales of fish (Chun, 1960a and 1960b; Kang et al., 1964; Choi et al., 1966; and Lee, 1968).

More recently, Seo and his coworkers (Hong and Seo, 1969; and Yeo and Seo, 1971) stressed that the most heavily infected portion of *Plecoglossus altivelis* (*P. altivelis*) was the flesh.

The present paper is an attempt to review the previously published information and to relate it to additional data obtained on two fish hosts of *P. altivelis* and *Tribolodon hakonensis*.

### MATERIALS AND METHODS

Brackish-water fish, *P. altivelis* and *Tribolodon hakonensis* (*T. hakonensis*), were caught at the rivers Hyungsan, Oseep, and Yucheon in Kyungpook Province between July and October, 1976.

Usually 50 of each fish were collected in the rivers. As a matter of convenience, small fish specimens, 10-23cm in length and weighing 22-105 grams were obtained in preference to larger ones. The abdominal walls were opened using instruments and the intestinal contents were removed from the fish to prevent auto-digestion. The fish brought to our laboratory were stored in a refrigerator.

In order to determine the distribution of the

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metacercariae in the fish hosts, the fish were dissected into three parts, flesh, scale and fin.

One gram of flesh, 200 scales, and all fins were taken from the fish using a knife. Adding a few drops of tap-water, they were compressed between the large slides (50×90mm) and examined for the presence of the metacercaria of *M. yokogawai* under a binocular dissecting microscope.

In order to isolate the metacercariae from the fish and estimate the average number of cysts in a fish, the digestion technique has been applied; almost all of the flesh was taken from the fish and mixed with artificial gastric juice. The juice consisted of 3.0ml of diluted hydrochloric acid, and 0.3gm of pepsin per 100ml of distilled water.

The beakers containing the mixture were incubated in a water-bath at 37°C for 3 hours. This mixture was stirred with a glass rod and allowed to stand for a minutes to gather the isolated metacercariae on the central portion of beaker.

The metacercariae attached to the scales and fins were also collected using the juice, and the total number of cysts per fish were calculated.

Some of the metacercariae obtained were studied morphologically for the determination of species and the others were administered orally to three mice to obtain the adult worms of *M. yokogawai*.

The mice were killed 6 days after the admi-

nistration. Thereafter, the intestine removed were incubated in the Petri-dishes containing warm saline, and the adult worms were collected using a micropipette.

The worms collected were fixed with 70 per cent alcohol and stained with the Semichon's acetocarmine and observations made supplemented those made on living materials.

## RESULTS

### 1. Distribution of the metacercariae:

Table 1 shows the number of fish examined in three different rivers and the distribution of metacercariae of *M. yokogawai* in *P. altivelis*. One hundred and twenty-eight fish were caught at the rivers Hyungsan, Oseep, and Yucheon in Kyungpook Province. The encysted larva of *M. yokogawai* were recovered from all fish. Of the total fish examined, the cysts were found in the flesh of 94.5 per cent, in the scales of 85.2 per cent and fins of 91.4 per cent.

In Table 2, the numerical distribution of metacercariae is listed according to the species and the portions of fish. A total of 43,327 cysts were collected from 10 *P. altivelis*, with an average of 4,333. Of these, 31,004 (71.6%) of the encysted larvae were found in the flesh, whereas the rates on the scales and fins were 16.5 and 11.9 per cent, respectively. On the contrary, the total number of cysts recovered from *T. hakonensis* was smaller than that of

Table 1. Distribution of encysted larvae of *Metagonimus yokogawai* in *Plecoglossus altivelis*

River	No. of fish examined	Length of fish (cm)	Metacercaria rate (%)	Metacercariae found in					
				Flesh		Scale		Fins	
				No.	%	No.	%	No.	%
Hyungsan	41	10—17	100	41	100	35	85.4	38	92.7
Oseep	45	12—23	100	43	95.6	35	77.8	39	86.7
Yucheon	42	18—23	100	37	88.1	39	92.9	40	95.2
Total	128	10—23	100	121	94.5	109	85.2	117	91.4

**Table 2.** Comparison of numerical distribution of *Metagonimus* metacercariae between *Plecoglossus altivelis* and *Tribolodon hakonensis*

Fish	Fish No.	Length of fish(cm)	No. of metacercariae found			Total
			Flesh	Scale	Fins	
<i>Plecoglossus altivelis</i>	1	10	285(86.9)	16( 4.9)	27( 8.2)	328
	2	13	1,620(86.0)	151( 8.0)	113( 6.0)	1,884
	3	16	9,042(70.8)	2,856(22.4)	869( 6.8)	12,767
	4	12	2,687(66.4)	418(10.3)	943(22.3)	4,048
	5	14	1,333(92.1)	56( 3.9)	58( 4.0)	1,447
	6	15	2,107(55.5)	366( 9.6)	1,320(34.8)	3,793
	7	10	2,396(65.5)	385(10.5)	875(23.9)	3,656
	8	14	850(82.4)	115(11.1)	67( 6.5)	1,032
	9	17	1,813(88.0)	144( 7.0)	103( 5.0)	2,060
	10	12	8,871(72.1)	2,665(21.6)	776( 6.3)	12,312
Total		12—17	31,004(71.6)	7,172(16.5)	5,151(11.9)	43,327(100)
<i>Tribolodon hakonensis</i>	1	10	251(10.3)	1,993(81.4)	204( 8.3)	2,448
	2	12	185(12.3)	1,224(81.3)	96( 6.4)	1,505
	3	7	61( 6.0)	923(90.5)	37( 3.5)	1,021
	4	14	156( 9.0)	1,325(76.4)	247(14.6)	1,728
	5	12	132( 8.1)	1,236(75.7)	264(16.2)	1,632
	6	10	107( 8.0)	1,128(83.2)	120( 8.8)	1,355
	7	9	155(10.9)	1,211(85.0)	59( 4.1)	1,425
	8	12	143(11.7)	997(80.6)	96( 7.8)	1,236
	9	13	36( 8.8)	323(79.4)	49(11.6)	408
	10	15	324(12.2)	2,100(79.2)	228( 8.6)	2,652
Total		7—15	1,550(10.0)	12,460(80.9)	1,400( 9.1)	15,410(100)

( ) : Percentage

**Table 3.** Correlation of number of metacercariae and length of *Plecoglossus altivelis*

Length of fish (cm)	No. of metacercariae found from flesh (ea)									Total
	0—100	100—200	200—300	300—400	400—500	500—600	600—700	700—800	800—	
10—12	5	6	5	1	—	—	1	1	—	19
12—14	9	6	4	—	1	2	—	1	2	25
14—16	9	5	4	1	1	—	—	—	—	20
16—18	5	3	—	—	—	—	—	—	3	11
18—20	10	3	2	—	—	—	—	—	—	15
20—22	19	6	—	1	1	—	1	—	—	28
22—	3	—	—	—	—	—	—	—	—	3
total	60	29	15	3	3	2	2	2	5	121

Remark:  $\bar{X}=178.9\pm203.9$ ,  $\bar{Y}=16.2\pm3.8$ ,  $r=-0.0005(P>0.05)$ .

*P. altivelis*. In addition, the metacercaria was found more abundantly on the scales than in the flesh and fins.

The correlation of the number of metacercariae found in the flesh and the length of *P. altivelis* is presented in Table 3. The average values for the number of encysted larvae and the length of fish were  $178.9 \pm 203.9$  each and  $16.2 \pm 3.8$  cm, respectively, and its correlation coefficient,  $r$  was  $0.0005 (p > 0.05)$ . From these values, no significant regressions between these two groups are encountered.

## 2. Morphological observations on larval and adult *M. yokogawai*:

The details of the morphological features in the identification of *M. yokogawai* have been in accord with a previous report (Choi et al., 1966).

## DISCUSSION

The presence of larval trematode of *Metagonimus* species in snails and fish was indicative of infection in the intermediate hosts of fluke (Muta, 1913 and 1914; Katsurada, 1913; Murata, 1914; and Mine, 1916) and could result in human infection (Kobayashi and Kwon, 1917; Kojima and Ko, 1919; Yokogawa, 1922; Hara and Himeno, 1924; and Furuyama, 1930).

It has been generally accepted that the fish such as *P. altivelis*, *Carassius carassius*, and *T. hakonensis* collected from several areas in Korea were heavily laden with the metacercaria of *M. yokogawai* (Chun, 1960a and 1960b; Kang et al., 1964; Choi et al., 1966; Lee, 1968; and Hong and Seo, 1969).

Recent investigations on *M. yokogawai* of fish in Korea, as reported by Chun (1960a and 1960b), Kang et al. (1964), and Choi et al. (1966), indicates that the majority of cysts are found in the scales of the fish.

However, the data reported by Hong and Seo (1969) are of interest because they found

another distribution of the cysts from the *P. altivelis* caught at Hwagae Myun, Hadong county, Kyungnam Province, Korea. Hong and Seo (1969) found most of the metacercariae in the flesh, and lesser on the scales or fins of fish.

This is in marked contrast to the high infestation rate of cysts on the scales of fish reported in many surveys in Korea. Therefore, the question as to the distribution pattern of the cysts of *M. yokogawai* in the portions of *P. altivelis* and *T. hakonensis* has arisen.

Many references have been available in the literature on comparative susceptibility of various fish to *M. yokogawai* (Ito, 1963). Apparently the widely known fish hosts of the fluke in Korea are *P. altivelis* and *T. hakonensis*. Because of brackish water fish, both fish must be infected with the larval stage of *M. yokogawai* during growth in fresh-water.

The study of taxonomic accounts in *M. yokogawai* indicate that it very closely resembles that of *M. takahashii*, although the recent study of Miyata (1944) has somewhat clarified the taxonomic criteria on Genus *Metagonimus* trematodes.

In the present study, the results obtained from *P. altivelis* are in agreement with those reported by Hong and Seo (1969). Firstly, the most heavily infected portion of fish was the flesh, the subcutaneous tissue next, and the least often infected was the scales. Secondly, the average number of metacercariae per fish was approximately 4,000.

The distribution of *M. yokogawai* cysts in *T. hakonensis* was vice versa. It can be seen (Table 2) that the cysts were found most frequently on the scales.

There appeared to be no relationship between total metacercarial densities and the length of fish (Table 3). As might be expected, the densities varied from fish to fish, and even in the same species of fish they fluctuated. Pro-

bably differences in the size and sex of fish host, the localities and season collected seemed to exert influence over the metacercarial density.

Analysis of the average number of larval trematodes on the scales in relation to the infection index of fish on the basis of the average number of metacercariae on 200 scales (Oshima et al., 1964) yielded little of significance.

Our observations on *P. altivelis* agree with those of Hong and Seo (1969) in the distribution pattern of *M. yokogawai* metacercariae in *P. altivelis* and the larger number of cysts in almost all fish.

### SUMMARY

In order to determine the intensity of infection with the encysted larvae of *Metagonimus yokogawai* among *Plecoglossus altivelis*, sweetfish, caught at the rivers in Kyungpook Province, Korea were examined in the period from July to October, 1976. The data were compared with the results obtained from *Tribolodon hakonensis*, the sea-run dace, caught at the river Hyungsan in the Province.

A total of 128 *Plecoglossus altivelis* were examined. All the fish were infected with the metacercaria of *Metagonimus yokogawai*. The metacercarial rate for the fluke in the flesh was higher than the rates in the fins and scales. The average number of larvae per sweetfish was 4,333, compared with the average of 1,541 from the sea-run dace.

It was found that the highest number of encysted larvae was found in the flesh of sweetfish, whereas it was encountered on the scales of sea-run dace. In the distribution pattern of the cysts, there was no relationship between the size of fish and the intensity of infection.

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==국문초록==

## 경북지역 은어의 橫川吸蟲 피낭유충의 기생상

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경상북도내 하천에서 잡은 은어에서의 橫川吸蟲 피낭유충의 감염상을 구명함과 아울러 황어의 본충감염상과 비교해 보기 위해 1976년 6월부터 동년 9월까지 은어는 형산강 오십천 및 유천에서, 황어는 형산강에서 잡아서 양고기의 橫川吸蟲 유충의 분포상과 감염정도를 조사 하였다.

형산강 오십천 및 유천에서 잡은 은어 128마리는 모두 橫川吸蟲 피낭유충에 감염되어 있었고 이 고기의 체부별 기생율에 있어서 고기살과 지느러미의 기생율은 비늘의 그 율에 비해 높았다. 본피낭유충의 감염율은 은어에서는 한 마리당 4,000개내외, 황어에서는 1,500개 내외로서 은어에서 많았으며 고기의 체부별 본피낭유충의 감염도는 은어에서는 비늘보다 고기살에 많았고 황어에서는 비늘에 많았다.

이번 조사에서 은어에서의 어장과 고기살 1 gram당 橫川吸蟲 피낭유충수와와의 사이에는 유의적 상관을 인정할 수 없었다.