ON THE DISTRIBUTION OF VARIOUS METACERCARIAE OF TREMATODES WITHIN THE FISH BODY

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In the orient, particularly in Japan and China, numerous species of fishes are found not seldom to be the second intermediate hosts of various species of trematodes. When the prevalence of a certain species of such trematodes is to be surveyed, one of the shortest ways is to examine the infestation of its metacercaria on certain species of fish. Among such species of fish, *Pseudorasbora* and *Sarcocheilichthys* are the most convenient ones for the purpose, because these are the most common fish in such areas and are usually found infected with almost all species of metacercariae. However, the distribution of metacercariae within fish body varies as the part of fish body varies. The purpose of this work is to determine as to which part of fish body is preferred by metacercariae to harbour mostly.

MATERIALS AND METHODS

As materials, each fifteen specimens of *Pseudorasbora parva* and *Sarcocheilichthys sinensis* were adopted. They were obtained from a Chinese market in Shanghai and were 7-8 cm in their body length.

The fish body was divided first into five portions: head, gills, scales, fins and muscles including adjacent subcutaneous tissues. Among them, fins and muscles are, as seen in Fig. 1, again subdivided into the following: fins (dorsal fin, tail fin and others), and muscles (muscles adjacent to tail, muscles adjacent to dorsal fin, muscles adjacent to breast fin, muscles adjacent to head and the rest). For collecting metacercariae from fish body, the digestion method was employed. This method was proved to be capable of collecting more than 60% of all metacercariae infesting in fish body (Komiya et al. 1951). All metacercariae thus collected were identified and then counted under dissecting microscope.

RESULTS

1. The total number of all species of metacercariae infested in fish body (Table 1, 2).

Average number of the total metacercariae of all species infesting per one individual *Pseudorasbora* was 6,424.3, the highest number being 10,257 and the lowest 163, whereas that infesting per one individual *Sarcocheilichthys* was 941.1, the highest being 3,438 and the lowest 108. Among various parts of infestation in *Pseudorasbora*, muscles showed the highest percentage, 69% of the total number of metacercariae, which were followed with head (12%) and fin (10.5%). In *Sarcocheilichthys*, muscles harboured 55%, head 23.7%, and fin 15.5% of the total number of metacercariae.

2. Number of each species of metacercariae infested in fish body.

The species of metacercariae found in both species of fish were as follows: *Clonorchis sinensis*, *Cyathocotyle orientalis*, *Echinochasmus japonicus*, *Exorchis oviformis*, *Metacercaria hasegawai* a, *Prosochynchus echinatus* and *Metacercaria shinjoi*. Distribution of these metacercariae in each species of fish body was as follows:

a. In *Pseudorasbora*: *Exorchis oviformis* showed the highest incidence. Average number infesting per one fish body was 3,073, about 50% of all metacercariae, the highest number in one fish amounting to 6,392: the average number of *Cyathocotyle orientalis* was 2468.8 per one

Fig. 1

Body of fish showing the respective part examined.
 1. dorsal fin, 2. tail fin, 3. breast fin, 4. muscles adjacent to tail, 5. muscles adjacent to dorsal fin, 6. muscles adjacent to breast fin, 7. muscles adjacent to head.

fish, about 38% of all metacercariae and the highest incidence in one fish amounted to 8,595: the incidence of *Clonorchis sinensis* was relatively small, the average number per one fish being about 24% of all metacercaria, the highest incidence in one fish amounting to 206.

b. In *Sarcocheilichthys*: Here, the incidence of *Clonorchis* showed the highest among all species of metacercariae, its average number per one fish was 695.7, about 74% of all metacercariae, and its highest incidence amounted to 2,888 in one fish; the average number of *Exorchis* per one fish was about 19% of all metacercariae.

3. Distribution of various metacercariae within the fish body.

a. *Clonorchis sinensis*. The majority of the larva of this species was infesting in muscles and adjacent subcutaneous tissues; in *Pseudorasbora*, about 83%, and in *Sarcocheilichthys*, about 63% of the total number collected were found in muscles. But the incidence in head showed relatively a large number, 7% in the former and 22% in the latter. As compared with the above mentioned parts; fins, scales and gills, showed remarkably lower infestation.

b. *Cyathocotyle orientalis*. This species of metacercaria showed also the highest incidence in muscles; in *Pseudorasbora*, about 80% of the total number. The percentage infested in head was also relatively high; about 11% of the total number. The incidence in fins, scales and gills was low as that of *Clonorchis*. In *Sarcocheilichthys* we were not able to discuss its distribution as its total number was too small.

c. *Echinochasmus japonicus*. As already known, this was found exclusively in gills.

d. *Exorchis oviformis*. In *Pseudorasbora*, about 69% of the total number were found infested in muscles, about 15% in head and 14% in fins, whereas, in *Sarcocheilichthys*, about 30% in muscles, 25% in head, and 25% in gills, thus in this fish, a relatively high incidence was observed in head and gills as compared with the former.

e. *Metacercaria hasegawai* a. Distribution of this metacercaria showed the same pattern as that of *Exorchis*; in *Pseudorasbora*, about 69% of the total number were found infested in muscles, 17% in head, 12% in fins, whereas in *Sarcocheilichthys*, about 30% in muscles, 32% in head and 30% in fins.

f. This is a metacercaria of *Cercaria shinjoi*, an echinostomous one (Komiya and Tajimi, 1941). It was found infested only in *Sarcocheilich-*

thys. Its incidence in various parts of fish body was as follows: about 30% of the total number in muscles, 26% in head and 29% in scales.

g. *Metorchis orientalis*. The incidence of this metacercaria was found particularly in large number in *Pseudorasbora*. Its distribution in various parts of fish body was about the same as that of *Clonorchis*; about 75% of the total number in muscles, 17% in heads and the rest in other parts.

4. Distribution of various metacercariae within muscles.

As above mentioned, the majority of all metacercariae were found mainly in muscles except the larva of *Echinochasmus*. Tables 7 and 8 show the distribution of each species of metacercariae within muscles of various parts. As seen in these tables, the majority of the total number of all species of metacercariae were found in "the rest" muscles and those infesting in muscles adjacent to tail were only 10% in *Pseudorasbora* and 18% in *Sarcocheilichthys* of the total number. However, when the number of metacercariae per one gram of muscles of each part was calculated, the percentage of metacercariae infesting in muscles adjacent to tail, head and breast and dorsal fins was proved to be relatively high, as shown in Tables 9 and 10.

The distribution of principal species of metacercariae within muscles of each part was as follows:

a. *Clonorchis sinensis*. In *Pseudorasbora*, muscles adjacent to breast fin showed the highest incidence, about 39% of the total number, and those adjacent to tail about 24% and to dorsal fin about 20%. In *Sarcocheilichthys*, muscles adjacent to head showed the highest incidence, about 31%, and those adjacent to tail about 20% and to dorsal fin 18%.

b. *Cyathocotyle orientalis*. In *Pseudorasbora*, muscles adjacent to tail showed the highest incidence, about 32%, and those adjacent to breast fin 21% and adjacent to head 20% and to dorsal fin 18%. In *Sarcocheilichthys*, as the infesting number of metacercariae was small, the incidence is not referred to in this paper.

c. *Exorchiis oviformis*. In *Pseudorasbora*, about 23% of the total number were found in muscles adjacent to tail, whereas the percentage of metacercariae found in those adjacent to dorsal and breast fins, adjacent to head were about the same (18 to 21%). In *Sarcocheilichthys*, those found in muscles adjacent to breast fin showed the highest per-

centage, 38%, which was followed by muscles adjacent to head (24%).

d. *Metacercaria hasegawai* a. In *Pseudorasbora*, muscles adjacent to head showed the highest percentage, about 27%, which was followed by those adjacent to head (26%). In *Sarcocheilichthys*, as the number of infesting metacercariae was too small, nothing is referred to in this paper.

e. *Metorchis orientalis*. In *Pseudorasbora*, muscles adjacent to tail showed the highest incidence, about 27%, which was followed by muscles adjacent to head (26%). In *Sarcocheilichthys* as, the infesting number of metacercariae was too small, nothing is referred to in this paper.

DISCUSSION AND SAMMARY

a. Clonorchis infection in two species of fish.

Previously one of the authors (Komiya and Tajimi, 1940) reported that in Shanghai area in China, the fish harbouring the largest number of Clonorchis was *Sarcocheilichthys nigripennis*. At that time it was also proved that *Pseudorasbora* was not typical second intermediate host of Clonorchis in that area, but was of more significance as that of *Metorchis*. Here we proved that *Sarcocheilichthys sinensis* was more important as a second intermediate host of Clonorchis than *Pseudorasbora*, of which incidence of harbouring Clonorchis metacercariae had been low (0.4% of the total number of all species of metacercariae). On the other hand, Hisayama (1938) reported that in *Pseudorasbora* in Okayama prefecture in Japan, the incidence of Clonorchis had been very high (76% of the total number of all species of metacercariae). As to the reason why such a difference comes to manifest between the same species of fish in these two areas, sufficient materials are not available at present.

b. Route of Clonorchis infection to fish.

The metacercariae of *Clonorchis sinensis*, *Exorchis oviformis* and *Cyathocotyle orientalis* were found mainly in muscles and their adjacent connective tissues but also found in scales, gills and fins in small number. It is worth to mention that these metacercariae were found in the soft tissues in head relatively large in number. For instance, Clonorchis were found 7.1% and 21.6% of the total number of all metacercariae in both species of fish in our present results and 7% and 19.9% in those of the previous workers, as shown in Table 11. Vogel (1934) observed that the cercaria of *Opisthorchis felineus* entering into fish body mainly along its

fins and encysted in muscles and adjacent connective tissues. The experimental infection of fish with *Clonorchis* made by the senior author (1940) also prove that the main route of *Clonorchis* infection to fish was that along fins. However, the relatively high incidence of *Clonorchis* and other metacercariae in the soft tissues of head can hardly be explained by above mentioned route of infection. The authors think it rather natural that such an infection was caused by adhesion and penetration by the cercariae through the mucosa of the oral cavity when the cercaria was sucked into the mouth of the fish with water by the respiration of the latter. In other words, the relatively high incidence of *Clonorchis* in the soft tissues of head suggests that the aspiration act of fish should be the secondary route of its infection.

c. Effective method of examining *Clonorchis* metacercaria from fish body.

The various species of metacercariae infesting fish body, particularly that of *Clonorchis*, were proved to harbour relatively in high percentage in muscles adjacent to fins, which fact gives us the facility of examining such metacercariae from fish body. The practical procedure of the method is as follows:

Take two or three grams of muscles adjacent to tail and head and breast fin, press them thin between two slide glasses and examine them under dissecting microscope. In this way, the infesting metacercariae can be easily discovered.

REFERENCE

- 1) Hasegawa, T.: On the encysted metacercariae infested in *Pseudorasbora parva* (Temminck and Schlegel). Okayama Medical Journ. 47. 1397, 1935. (in Japanese).
- 2) Hisayama, M.: The seasonal variation of trematodes larvae in their first and second intermediate hosts. Okayama Medical Journ. 50. 327, 1938. (in Japanese).
- 3) Hsü, H. E.: Studies on certain problems of *Clonorchis sinensis*. VII Further advance in the study of the life cycle of *Clonorchis sinensis*. Chinese Med. Journ. 55. 542, 1939.
- 4) Komiya, Y. and Tajimi, T.: Study on *Clonorchis sinensis* in the district of Shanghai. 5. The cercaria and metacercaria of *Clonorchis sinensis* with special reference of their excretory system. Journ. Shanghai Science Inst. Section IV. (5) 91. 1940. a.
- 5) Komiya, Y. and Tajimi, T.: Study on *Clonorchis sinensis* in the district of Shanghai. 6. The life cycle of *Exorchis oviformis*, with special reference

- of the similarity of its larval forms to that of *Clonorchis sinensis*. Journ. Shanghai Science Inst. Sect. IV (5), 109. 1940, b.
- 6) Komiya, Y. and Tajimi, T.: Metacercarie from Chinese *Pseudorasbora parva* Temminck and Schlegel with special reference to their excretory system. Journ. Shanghai Science Inst. N.S. 1. (1), 69. 1941.
 - 7) Komiya, Y. and Murase, K.: Efficacy of digestion method for collecting metacercariae from the fish body. Jap. Med. Journ. 4.(1), 43. 1951.
 - 8) Vogel, H.: Der Entwicklung von *Opisthorchis felinus* (Riv.) nebst Bemerkungen über die Systematik und Epidemiologie. Soologica. 33. Ht. 86. Stuttgart.

Table 1. Number of metacercariae in various parts of respective fish body (*Pseudorasbora parva*)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	Average number per fish
Head	22 13.5 %	552 4.6 %	1435 14.8 %	1026 13.9 %	1233 19.9 %	988 19.1 %	1735 17.6 %	912 16.6 %	881 8.6 %	1663 13.3 %	511 10.6 %	606 16.9 %	176 4.5 %	94 11.6 %	411 8.6 %	12195 12.7 %	813
Gills	34 20.9 %	126 1.1 %	427 4.4 %	1132 15.4 %	389 6.3 %	517 10.5 %	765 7.8 %	165 3.0 %	40 0.4 %	222 1.8 %	2373 49.0 %	71 2.0 %	82 2.1 %	96 11.9 %	432 9.0 %	6871 7.1 %	458.1
Scales	1 0.6 %	62 0.5 %	62 0.6 %	41 0.6 %	114 1.8 %	60 1.2 %	40 0.4 %	32 0.6 %	100 1.0 %	59 0.5 %	11 0.2 %	14 0.4 %	17 0.4 %	3 0.4 %	46 1.0 %	662 0.7 %	44.1
Fins	7 4.3 %	1215 10.2 %	948 9.7 %	609 8.3 %	1040 16.8 %	597 12.1 %	1420 14.4 %	490 8.9 %	895 8.7 %	1283 10.2 %	244 5.0 %	300 8.4 %	686 17.5 %	46 5.7 %	332 6.9 %	10112 10.5 %	674.1
dorsal fin	4 2.5 %	133 1.1 %	165 1.7 %	66 0.9 %	67 1.1 %	93 1.9 %	161 1.6 %	52 1.0 %	105 1.0 %	105 0.8 %	26 0.5 %	37 1.0 %	74 1.9 %	3 0.4 %	18 0.4 %	1109 1.2 %	73.9
tail fin	3 1.8 %	736 6.2 %	621 6.4 %	454 6.2 %	826 13.3 %	398 8.1 %	1072 10.9 %	350 6.4 %	584 5.7 %	999 8 %	155 3.2 %	208 5.8 %	538 13.8 %	38 4.7 %	294 6.1 %	7276 7.6 %	485.1
other fins	0 0 %	346 2.9 %	162 1.7 %	89 1.2 %	147 2.4 %	106 2.2 %	187 1.9 %	88 1.6 %	206 2.0 %	176 1.4 %	33 1.3 %	55 1.5 %	74 1.9 %	5 0.6 %	20 0.4 %	1727 1.8 %	115.1
Muscles adjacent to tail	99 60.7 %	9929 83.6 %	6860 70.5 %	4556 61.9 %	3417 55.2 %	2807 57.1 %	5915 59.9 %	3830 70.9 %	8341 81.4 %	9316 74.4 %	1703 35.4 %	2587 72.3 %	2953 75.5 %	569 70.4 %	3582 74.6 %	66524 69.0 %	4434.9
dorsal fin	19 11.7 %	1415 11.9 %	883 9.1 %	995 13.5 %	783 12.6 %	468 9.9 %	1317 13.3 %	611 11.1 %	1911 18.6 %	1277 10.2 %	412 8.5 %	369 10.3 %	665 17.0 %	99 12.3 %	984 20.5 %	12226 12.7 %	815.1
bredst fin	17 10.4 %	2081 17.5 %	1284 13.2 %	641 8.7 %	467 7.5 %	432 8.8 %	1174 11.9 %	690 12.6 %	1273 12.4 %	1234 9.8 %	222 4.6 %	411 11.5 %	465 11.9 %	76 9.4 %	558 11.6 %	11025 11.4 %	735
head	11 6.8 %	373 3.1 %	331 3.4 %	395 5.4 %	301 4.9 %	208 4.2 %	457 4.6 %	256 4.7 %	730 7.1 %	553 4.4 %	149 3.1 %	114 3.2 %	262 6.7 %	31 3.8 %	177 3.7 %	4348 4.5 %	289.9
Other muscles	12 7.4 %	1006 8.5 %	688 7.0 %	1396 19.0 %	820 13.2 %	633 12.9 %	836 8.5 %	393 7.2 %	1029 10.0 %	1209 9.6 %	493 10.2 %	458 12.8 %	369 9.4 %	81 10.0 %	697 14.5 %	10115 10.5 %	674.3
	40 24.5 %	5054 42.5 %	3679 37.8 %	1129 15.3 %	1046 16.9 %	1048 21.3 %	2131 21.6 %	1940 35.3 %	3398 33.1 %	5043 40.2 %	427 8.8 %	1235 34.5 %	1192 30.5 %	282 34.9 %	1166 24.3 %	28810 29.9 %	1920.7
Total	163 100 %	11884 100 %	9732 100 %	7364 100 %	6193 100 %	4919 100 %	9875 100 %	5489 100 %	10257 100 %	12543 100 %	4842 100 %	3578 100 %	1914 100 %	569 100 %	4803 100 %	96364 100 %	6424.3

Table 2. Number of metacercariae in various parts of respective fish body

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	Average number per fish
Head	224 25.8%	142 32.4%	63 42.0%	327 19.6%	15 13.9%	116 28.7%	62 36.5%	50 18.1%	626 23.3%	116 29.8%	307 25.6%	146 29.2%	414 27.3%	106 41.1%	633 18.4%	3347 23.7%	223.1
Gills	113 13.0%	20 4.6%	4 2.7%	25 1.5%	0 0%	17 3.8%	5 2.9%	2 0.7%	53 2.0%	8 2.1%	60 5.0%	27 5.4%	90 6.9%	21 8.1%	108 3.1%	553 3.9%	36.9
Scales	9 1.0%	19 4.3%	12 8.0%	34 2.0%	0 0%	3 0.7%	0 0%	11 4.0%	61 2.3%	3 0.8%	7 0.6%	4 0.8%	47 3.1%	0 0%	69 2.0%	279 2.0%	18.6
Fins	186 21.5%	99 22.6%	26 17.3%	240 14.4%	13 12.0%	95 21.1%	30 17.7%	34 12.3%	443 16.5%	106 27.3%	1164 13.7%	106 21.2%	230 15.2%	74 28.7%	335 9.7%	2181 15.5%	145.4
dorsal fin	6 0.7%	4 0.9%	4 2.7%	81 4.9%	5 4.6%	21 4.7%	12 7.1%	6 4.7%	107 4.0%	23 5.9%	41 3.4%	11 2.2%	47 3.1%	13 5.0%	107 3.1%	488 3.5%	32.5
tail fin	112 12.9%	83 18.9%	16 10.7%	111 6.7%	6 5.6%	34 7.5%	2 1.2%	24 8.7%	237 8.8%	65 16.7%	58 4.8%	72 14.4%	139 9.2%	39 15.1%	141 4.1%	1139 8.1%	75.9
other fins	68 7.8%	12 2.7%	6 4.0%	48 2.9%	2 1.9%	40 8.9%	16 9.4%	4 1.5%	99 2.0%	18 4.6%	65 5.4%	23 4.6%	44 2.9%	22 8.5%	87 2.5%	554 3.9%	36.9
Muscles adjacent to	335 38.6%	159 36.2%	45 30.0%	1042 62.5%	80 74.1%	220 48.8%	73 43.0%	179 64.9%	1506 56.0%	156 40.1%	663 35.2%	217 43.4%	736 43.5%	57 22.1%	2293 36.7%	7761 55.0%	517.4
Total	24 2.8%	20 4.6%	5 3.3%	68 4.1%	3 2.8%	10 2.2%	10 5.9%	27 9.3%	128 4.8%	15 3.9%	101 8.4%	32 6.4%	69 4.6%	14 5.4%	224 6.5%	750 5.3%	50.0
dorsal fin	52 6.0%	29 6.6%	8 5.3%	99 6.0%	16 14.8%	31 6.9%	8 4.7%	29 10.5%	238 8.9%	33 8.5%	89 7.4%	14 2.8%	71 4.7%	5 1.9%	372 10.8%	1094 7.8%	72.9
breast fin	34 3.9%	29 6.6%	4 2.7%	19 1.1%	16 14.8%	16 3.6%	12 7.1%	11 4.0%	85 3.2%	21 5.4%	90 7.5%	36 7.2%	54 3.6%	14 2.9%	98 2.9%	539 3.8%	35.9
head	103 11.9%	34 7.7%	14 9.3%	199 11.9%	11 10.2%	61 13.5%	6 3.5%	46 16.7%	407 15.1%	35 9.0%	96 8.0%	52 10.4%	161 10.6%	5 3.5%	375 10.9%	1609 11.4%	107.3
Other muscles	122 14.1%	47 10.7%	14 9.3%	657 39.4%	34 31.5%	102 22.6%	37 21.8%	66 23.9%	648 24.1%	52 13.4%	287 23.9%	83 16.6%	381 25.1%	15 5.8%	1224 35.6%	3769 26.7%	251.3
Total	867 100%	439 100%	150 100%	1668 100%	108 100%	451 100%	170 100%	276 100%	2689 100%	389 100%	1201 100%	500 100%	1517 100%	258 100%	3438 100%	14121 100%	941.4

Table 3. Number of metacercariae in respective fish body

(Pseudorasbora parva)																		
Number of fish Species of meta- cercariae	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	total	Ave- rage number per fish	
Clonorchis sinensis	15 9.2%	3 0.03%	0 0%	206 2.8%	0 0%	78 1.6%	10 0.1%	0 0%	4 0.04%	37 0.3%	0 0%	0 0%	2 0.1%	9 1.1%	0 0%	364 0.4%	24.3	
Cyathocotyle orientalis	4 2.5%	1053 8.9%	4615 47.4%	4277 58.1%	1436 23.2%	719 14.6%	2512 25.4%	1394 25.4%	8595 83.8%	3544 42.6%	812 16.8%	341 9.5%	1622 41.4%	491 60.8%	3817 79.5%	37032 38.4%	2468.8	
Echinochasmus japonicus	29 17.8%	44 0.4%	323 3.3%	1103 15.0%	256 4.1%	426 8.7%	549 5.6%	103 1.9%	3 0.03%	165 1.3%	2342 48.4%	60 1.7%	37 1.0%	94 11.6%	420 8.7%	5954 6.2%	396.9	
Exorchis oviformis	31 19.0%	10565 88.9%	4656 47.8%	1264 17.2%	4283 69.2%	2477 50.4%	6392 64.7%	3717 67.7%	1530 14.9%	5275 42.1%	840 17.4%	2986 83.5%	1926 49.2%	146 18.1%	7 0.2%	46095 47.8%	3073.0	
Metaercari a hasegawaia	27 16.6%	11 0.1%	61 0.6%	4 0.1%	91 1.5%	279 5.7%	80 0.8%	58 1.1%	2 0.02%	74 0.6%	222 4.6%	1 0.03%	173 4.4%	1 0.1%	0 0%	1084 1.1%	72.3	
Metorchis orientalis	53 32.5%	208 1.8%	76 0.8%	510 6.9%	127 2.1%	937 19.1%	332 3.4%	217 4.0%	123 0.2%	1648 13.1%	625 12.9%	190 5.3%	153 3.9%	67 8.3%	559 11.6%	5825 6.0%	388.3	
Proserhynchus echinatus	0 0%	0 0%	0 0%	0 0%	0 0%	1 0.02%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	1 0.02%	0 0%	0 0%	2 0.01%	0.1	
Unclassified	4 2.5%	0 0%	1 0.01%	0 0%	0 0%	2 0.04%	0 0%	0 0%	0 0%	0 0%	1 0.02%	0 0%	0 0%	0 0%	0 0%	8 0.01%	0.5	
Total	163 100%	11884 100%	9732 100%	7364 100%	6193 100%	4919 100%	9875 100%	5489 100%	10257 100%	12543 100%	4842 100%	3578 100%	3914 100%	808 100%	4803 100%	96364 100%	6424.3	

Table 4, Number of metacercariae in respective fish body (Sarcocheilichthys)

Species of Metacercaria	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	Average number per fish
<i>Clonorchis sinensis</i>	337 38.9%	305 69.5%	92 61.3%	1487 89.2%	83 76.9%	262 58.1%	54 31.8%	209 75.7%	2193 81.6%	173 44.5%	861 71.7%	384 76.8%	1063 70.1%	44 17.1%	2888 8.4%	10435 78.9%	695.7
<i>Cyathocotyle orientalis</i>	0 0%	0 0%	0 0%	2 0.1%	0 0%	2 0.4%	0 0%	0 0%	0 0%	0 0%	5 0.4%	0 0%	0 0%	1 0.4%	0 0%	10 0.1%	0.7
<i>Echinochasmus japonicus</i>	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	23 4.6%	0 0%	0 0%	4 0.1%	27 0.2%	1.8
<i>Exorchis oviformis</i>	10 1.2%	35 8.0%	0 0%	19 1.1%	5 4.6%	16 3.6%	2 1.2%	17 6.7%	50 1.9%	21 5.4%	44 3.7%	10 2.0%	188 12.4%	2 0.8%	202 5.9%	621 4.4%	41.4
<i>Metacercaria hasegawai</i>	475 54.8%	68 15.5%	43 28.7%	76 4.6%	7 6.5%	170 37.7%	114 67.1%	49 17.8%	439 16.3%	192 49.4%	213 17.7%	80 16.0%	241 15.9%	211 81.8%	331 9.6%	2709 19.2%	180.6
<i>Metorchis orientalis</i>	0 0%	0 0%	0 0%	19 1.1%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	8 0.2%	27 0.2%	1.8
<i>Metacercaria shinjoi</i>	0 0%	29 6.6%	14 9.3%	36 2.2%	13 12.0%	0 0%	0 0%	0 0.1%	2 0.1%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	94 0.7%	6.3
<i>Proserhynchus echinatus</i>	0 0%	1 0.2%	0 0%	26 1.6%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	71 5.9%	3 0.6%	20 13.2%	0 0%	5 0.1%	126 0.9%	8.4
Unclassified	45 5.2%	1 0.2%	1 0.7%	3 0.2%	0 0%	1 0.2%	0 0%	1 0.4%	5 0.2%	3 0.8%	7 0.6%	0 0%	5 0.3%	0 0%	0 0%	72 0.5%	4.8
Total	867 100%	439 100%	150 100%	1668 100%	108 100%	451 100%	170 100%	276 100%	2689 100%	389 100%	1201 100%	500 100%	1517 100%	258 100%	3488 100%	14121 100%	941.4

Table 5. Number of metacercariae in various parts of fish body (Pseudorasbora total No. of 15)

	Head	Gills	Scales	Fins				Muscles	Total
				dorsal	tail	others	total		
<i>Clonorchis sinensis</i>	26 7.1%	13 3.6%	1 0.3%	0 0%	3 0.8%	1 0.3%	4 1.1%	320 87.9%	364 100%
<i>Cyathocotyle orientalis</i>	4153 11.2%	68 0.2%	247 0.7%	337 0.9%	2375 6.4%	390 1.1%	3102 8.4%	29462 79.6%	37032 100%
<i>Echinochasmus japonicus</i>	0 0%	5954 10.0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	5954 100%
<i>Exorchi oviformis</i>	6814 14.8%	770 1.7%	383 0.8%	728 1.6%	4483 9.7%	1256 2.7%	6467 1.4%	31661 68.7%	46095 100%
<i>Metacercaria hasegawai</i> a	184 1.7%	34 3.1%	8 0.7%	18 1.7%	97 9.0%	18 1.7%	133 12.3%	725 66.9%	1084 100%
<i>Metacercaria orientalis</i>	1015 17.4%	31 0.5%	22 0.4%	23 0.4%	318 5.5%	62 1.1%	403 6.9%	4354 74.8%	5825 100%
<i>Prosorhynchus echinatus</i>	1 5.0%	1 5.1%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	2 100%
Unclassified	2 2.5%	0 0%	1 12.5%	3 37.5%	0 0%	0 0%	3 37.5%	2 2.5%	8 100%
Total	12195 12.7%	6871 7.1%	662 0.7%	1109 1.2%	7276 7.6%	1727 1.8%	10112 10.5%	66524 69.0%	96364 100%

Table 6. Number of metacercariae in various parts of fish body (Sarcocheilichthys total No. of 15)

	Head	Gills	Scales	Fins				Muscles	Total
				dorsal	tail	others	total		
<i>Clonorchis sinensis</i>	2250 21.6%	125 1.2%	169 1.6%	300 2.9%	651 6.2%	324 3.1%	1275 12.2%	6616 63.4%	10435 100%
<i>Cyathocotyle orientalis</i>	0 0	1 1.0%	1 1.0%	0 0	0 0	1 1.0%	1 1.0%	7 7.0%	10 100%
<i>Echinochasmus japonicus</i>	0 0	27 10.0%	0 0	0 0	0 0	0 0	0 0	0 0	27 100%
<i>Exorchis oviformis</i>	158 25.4%	155 25.0%	48 7.7%	21 3.4%	36 5.8%	19 3.1%	76 12.2%	184 29.6%	621 100%
<i>Metacercaria hasagawai</i> a	869 32.1%	231 8.5%	19 0.7%	161 5.9%	440 16.2%	192 7.1%	793 29.3%	797 29.4%	2709 100%
<i>Metacercaria shinjoi</i>	24 25.5%	2 2.1%	27 28.7%	1 1.1%	1 1.1%	3 3.2%	5 5.3%	86 38.3%	94 100%
<i>Metorchis orientalis</i>	0 0	0 0	0 0	0 0	0 0	0 0	0 0	27 10.0%	27 100%
<i>Proserhynchus echinatus</i>	46 36.5%	3 2.4%	12 9.5%	1 0.8%	2 1.6%	8 6.4%	11 8.7%	54 42.9%	126 100%
unclassified	0 0	9 12.5%	3 4.2%	4 5.6%	9 12.5%	7 9.7%	20 27.8%	40 55.6	72 100%
Total	3347 23.7%	553 3.0%	279 2%	488 3.5%	1139 8.1%	554 3.9%	2181 15.5%	7761 55.0%	14121 100%

Table 7. Number of metacercariae in various parts of muscles
(Pseudorasbora, total No. of 15)

	Muscles adjacent to tail	Muscles adja- cent to dorsal fin	Muscles adja- cent to breast fin	Muscles adja- cent to head	Other muscles	Total
Weight of muscles	6.4g (10.3%)	8.9g (14.4%)	3.2g (5.1%)	8.0g (12.9%)	35.6g (57.3%)	62g (100%)
Clonorchis sinensis	63 19.7%	725 22.5%	51 15.9%	37 11.6%	97 30.3%	320 100%
Cyathocotyle orientalis	6320 21.5%	4854 16.5%	2113 7.2%	4862 16.5%	11313 38.4%	29462 100%
Exorchis oviformis	5062 16.0%	5446 17.2%	1864 5.9%	4239 13.4%	15050 47.5%	31661 100%
Metacercaria hasegawai a	80 11.0%	119 16.4%	64 8.8%	117 16.1%	345 47.6%	725 100%
Metorchis orientalis	701 16.1%	533 12.2%	256 5.9%	859 19.7%	2005 46.0%	4354 100%
Unclassified	0 0%	1 50.0%	0 0%	1 50.0%	0 0%	2 100%
Total	12226 18.4%	11025 16.6%	4348 6.5%	10115 15.2%	28810 43.2%	66524 100%

Table 8. Number of metacercariae in various parts of Muscles
(Sarcocheilichthys, total No. of 15)

	Muscles adjacent to tail	Muscles adja- cent to dorsal fin	Muscles adja- cent to breast fin	Muscles adja- cent to head	Other muscles	Total
Weight of muscles	6.5g (8.3%)	11.0g (14%)	4.3g (5.4%)	9.1g (11.6%)	47.4g (60.7%)	78.2g (100%)
Clonorchis sinensis	605 9.1%	931 14.1%	332 5.0%	1344 20.3%	3404 51.5%	6616 100%
Cyathocotyle orientalis	2 28.6%	1 14.3%	1 14.3%	2 28.6%	1 14.3%	7 100%
Exorchis oviformis	21 11.4%	22 12.0%	29 15.8%	39 21.2%	73 39.7%	184 100%
Metacercaria hasegawai a	90 11.3%	120 15.1%	154 19.3%	187 23.5%	246 30.9%	797 100%
Metacercaria shinjoi	5 13.9%	1 2.8%	6 16.7%	14 38.9%	10 28.0%	36 100%
Metorchis orientalis	0 0%	5 18.5%	1 3.7%	3 11.1%	18 66.7%	27 100%
Proserhynchus echinatus	20 37.0%	9 16.7%	10 18.5%	7 13.0%	8 14.8%	54 100%
Unclassified	7 17.5%	5 12.5%	6 15.0%	13 32.5%	9 22.5%	40 100%
Total	750 9.7%	1094 14.1%	539 6.9%	1609 20.7%	3769 48.6%	7761 100%

Table 9. Number of metacercariae per one gram of fish muscles (Pseudorasbora, total No. of 15)

Species of metacercaria	Muscles adjacent to tail	Muscles adjacent to dorsal fin	Muscles adjacent to breast fin	Muscles adjacent to head	Other muscles	Total
<i>Clonorchis sinensis</i>	9.8	8.1	15.9	4.6	2.7	41.2
<i>Cyathocotyle orientalis</i>	987.5	545.4	666.3	607.8	317.8	3118.8
<i>Exorchis oviformis</i>	790.9	611.9	582.5	529.9	422.6	2938.0
<i>Metacercaria hasegawai</i>	12.5	13.4	200.0	14.6	9.7	70.2
<i>Metorchis orientalis</i>	109.5	59.9	80.0	107.4	56.3	413.1
Unclassified	0	0.11	0	0.13	0	0.2
total	1910.3	1238.8	1358.8	1264.4	809.3	6581.5

Table 10. Number of metacercariae per one gram of fish muscles (Sarcocheilichthys, total No. of 15)

Species of metacercaria	Muscles adjacent to tail	Muscles adjacent to dorsal fin	Muscles adjacent to breast fin	Muscles adjacent to head	Other muscles	Total
Clonorchis sinensis	93.0	17.8%	77.2	147.7	71.8	474.4
Cyathocotyle orientalis	0.3	53.5	0.2	0.2	0.02	1.7
Exorchis oviformis	3.2	11.3	6.7	4.3	1.5	17.8
Metacercaria hasegawai a	13.9	12.6	35.8	20.6	5.2	86.3
Metacercaria shinjoi	0.8	2.5	1.4	1.5	0.2	4.8
Metorchis orientalis	0	35.7	0.2	0.3	0.4	1.4
Proserhynchus echinatus	3.1	1.14	2.3	0.8	0.2	7.2
Unclassified	1.1	10.9	1.4	1.4	0.2	4.5
Total	115.4	16.7	125.4	176.8	79.5	596.5

Table 11. Number of *Clonorchis sinensis*
in various parts of fish body

Author	Name of fish	Examined number of fish	Number of metacercaria	Number of metacercaria in head		Number of metacercaria in muscles		Remark
Hisayama (1938)	Pseudorasbora parva	239	153056	30402	19.9%	78772	51.5%	natural int.
Hsü (1939)	"	1	351	58	16.5%	284	80.9%	experimental inf.
Komiya Tajimi (1940)	"	1	1715	155	9%	1328	77.4%	"
Komiya Murase (1944)	"	15	364	26	7.1%	320	87.9%	Natural inf.
Ibid (")	Sarcochilichys sinensis	15	10435	2250	21.6%	6616	63.4%	"