CHAPTER 3

RESULTS

3.1 Prevalence of metacercariae in cyprinoid fish

A total number of 478 cyprinoid fish representing four species collected from natural habitats, and 297 of two species from fish farms were examined. The overall prevalence of metacercaria infections in cyprinoid fish collected from natural habitats was 98.1% (Table 3) and from fish farms was 73.0% (Table 4). However, infection with *O. viverrini* (Figure 2, Appendix A) was only 5.0% in natural habitats and 0.6% in fish farms. The positive rate of *O. viverrini* metacercariae in fish from natural habitats was statistically significantly higher than that from fish farms ($\chi^2 = 10.6$, $P < 0.001$) (Table 5). Similarly, infections with metacercariae of *Haplorchis* sp. I (Figure 3, Appendix A), *Haplorchis* sp. II (Figure 4, Appendix A), *Haptorchis* sp. III (Figure 5, Appendix A) and *Centrocestus* species (Figure 6, Appendix A) in fish collected from natural habitats were also significantly higher than those from fish farms ($\chi^2 = 115.7$, $P < 0.0001$; $\chi^2 = 14.4$, $P < 0.0001$; $\chi^2 = 3.9$, $P < 0.05$; $\chi^2 = 7.5$, $P < 0.005$, respectively).

3.2 Intensity of metacercariae in cyprinoid fish

The geometric mean number of *O. viverrini* metacercariae per fish derived from the 24 positive cyprinoid fish from natural habitats was 3.7 (95% confidence interval = 2.4-5.7) (Table 3, 6), whereas only 1 metacercaria was found in each of the positive fish collected from fish farms (Table 7). Similarly, the intensity values of the other kinds of metacercariae were also higher in fish from natural habitats.

3.3 Density of metacercariae in cyprinoid fish

Average density of *O. viverrini* metacercariae in fish from natural habitats and fish farms were 0.2 and 0.001 (Table 8, Table 9), respectively. It can be seen that the average numbers of all kinds of metacercariae per 100 g of fish from natural habitats were much higher than those from fish farms.

3.4 Prevalence of metacercariae in raw-fish products

A total of 35 samples of "*pla-jom*" were examined, and 19 of which (54.3%) were found infected with metacercariae (Table 10). However, most of them were completely degenerated (Figure 7, Appendix A), a few were partially degenerated with no movement observed under light microscope (Figure 8, Appendix A). These findings indicate that the observed metacercariae are not viable. Definite identification of these metacercariae was therefore not possible.

Of the 30 samples of "*pla-som*" examined, no metacercariae were found (see detail in section 2.1.2).

Table 3. Prevalence of metacercariae in cyprinoid fish collected from natural habitats in Chiang Mai province.

Place (Amphoe)	Species of fish*	No.	Total no. infected (%)	No. of fish infected					
				O. viverrini	*Haplorchis* sp. I	*Haplorchis* sp. II	*Haplorchis* sp. III	*Centro.* species	unidentified
Muang	*P. leiacanthus*	50	50 (100)	-	50	16	-	-	-
Hangdong	*C. repasson*	50	50 (100)	-	50	50	-	50	-
	P. leiacanthus	50	50 (100)	-	50	14	-	-	13
	Osteochilus spp.	81	72 (88.9)	5	72	22	2	6	2
Sarapee	*P. leiacanthus*	51	51 (100)	9	51	31	2	-	9
Sansai	*P. leiacanthus*	47	47 (100)	-	47	16	5	-	-
	E. metallicus	48	48 (100)	-	48	-	-	-	-
	Osteochilus spp.	50	50 (100)	-	50	5	-	-	-
Doisaket	*P. leiacanthus*	51	51 (100)	10	51	51	14	-	-
	Total	**478**	**469**	**24**	**469**	**205**	**23**	**56**	**24**
	(%)		**(98.1)**	**(5.0)**	**(98.1)**	**(42.9)**	**(4.8)**	**(11.7)**	**(5.0)**

* Figures of fish are shown in Appendix B

Table 4. Prevalence of metacercariae in cyprinoid fish collected from fish farms in Chiang Mai province.

Place (Amphoe)	Species of fish*	No.	Total no. infected (%)	No. of fish infected					
				O. viverrini	*Haplorchis* sp. I	*Haplorchis* sp. II	*Haplorchis* sp. III	*Centro.* species	unidentified
Muang	*Osteochilus* spp.	50	50 (100)	-	50	-	-	-	-
	P. gonionotus	50	50 (100)	-	50	22	-	-	-
Hangdong	*P. gonionotus*	50	28 (56)	-	22	10	-	11	-
Sarapee	*P. gonionotus*	47	47 (100)	-	47	45	4	44	-
Sansai	*P. gonionotus*	50	31 (62)	2	24	10	2	1	12
Doisaket	*P. gonionotus*	50	11 (22)	-	11	-	-	-	-
	Total	**297**	**217**	**2**	**204**	**87**	**6**	**56**	**12**
	(%)		**(73.0)**	**(0.6)**	**(68.7)**	**(29.3)**	**(2.0)**	**(18.8)**	**(4.0)**

* Figures of fish are shown in Appendix B

Table 5. Statistical comparison of the prevalence of *Opisthorchis viverrini* metacercariae infection in cyprinoid fish from natural habitats and fish farms.

Sources	No. of fish		Total
	with *O. viverrini*	without-*O. viverrini*	
natural habitats	24	454	478
fish farms	2	295	297
Total	**26**	**749**	**775**

$\chi^2 = 10.6$, df = 1, $P < 0.001$

Table 6. Intensity of metacercariae in cyprinoid fish collected from natural habitats in Chiang Mai province.

Place (Amphoe)	Species of fish	No.	No. of metacercariae/fish geometric mean±SD (range)					
			O. viverrini	*Haplorchis* sp. I	*Haplorchis* sp. II	*Haplorchis* sp. III	*Centrocestus* species	unidentified
Muang	*P. leiacanthus*	50	-	178.6±1.4 (98-366)	5.3±2.1 (1-18)	-	-	-
Hangdong	*C. repasson*	50	-	22.9±1.5 (10-42)	11.3±1.5 (6-27)	-	41.8±1.5 (18-130)	-
	P. leiacanthus	50	-	228.1±1.3 (120-395)	2.5±2.3 (1-10)	-	-	-
	Osteochilus spp.	81	3.4±4.0 (1-18)	49.3±7.2 (1-779)	5.9±2.9 (1-39)	1.4±1.6 (1-2)	9.3±1.6 (1-26)	10
Sarapee	*P. leiacanthus*	51	3.3±1.9 (1-10)	40.4±1.9 (10-198)	2.6±2.1 (1-18)	5.9±1.2 (5-7)	-	13.9±1.4 (8-20)

Table 6 (continued)

Place (Amphoe)	Species of fish	No.	No. of metacercariae/fish geometric mean±SD (range)					
			O. viverrini	*Haplorchis* sp. I	*Haplorchis* sp. II	*Haplorchis* sp. III	*Centrocestus* species	unidentified
Sansai	*P. leiacanthus*	47	-	65.1±1.7 (18-140)	4.1±2.7 (1-18)	1.8±1.8 (1-4)	-	-
	E. metallicus	48	-	21.1±1.5 (8-37)	-	-	-	-
	Osteochilus spp.	50	-	10.0±1.2 (6-15)	1	-	-	-
Doisaket	*P. leiacanthus*	51	4.6±2.6 (1-15)	44±3.7 (6-948)	23.3±2.3 (3-202)	8.7±2.4 (1-15)	-	-
	Average		**3.7±2.8**	**73.2±2.3**	**7±2.2**	**4.4±1.9**	**25.5±1.5**	**11.9±1.4**

Table 7. Intensity of metacercariae in cyprinoid fish collected from fish farms in Chiang Mai province.

Place (Amphoe)	Species of fish	No.	No. of metacercariae/fish geometric mean±SD (range)				
			O. viverrini	*Haplorchis* sp. I	*Haplorchis* sp. II	*Haplorchis* sp. III	*Centrocestus* species	unidentified
Muang	*Osteochilus* spp.	50	-	44.6±1.6 (19-151)	-	-	-	-
	P. gonionotus	50	-	68.3±1.6 (18-219)	4.1±2.0 (1-10)	-	-	-
Hangdong	*P. gonionotus*	50	-	3.7±2.5 (1-17)	1.1±1.5 (1-4)	-	1.9±1.5 (1-3)	-
Sarapee	*P. gonionotus*	47		10.8±2.0 (2-68)	11.3±2.0 (2-28)	2.2±2.0 (1-6)	12.4±2.0 (2-62)	-
Sansai	*P. gonionotus*	50	1	2.7±1.6 (1-6)	1.7±1.7 (1-5)	1	2.2±1.7 (1-5)	1.5±1.8 (1-4)
Doisaket	*P. gonionotus*	50	-	4.3±1.8 (2-10)	-	-	-	-
	Average		**1**	**22.4±1.8**	**4.5±1.8**	**1.6±1.5**	**5.5±1.7**	**1.5±1.8**

Table 8. Density of metacercariae in cyprinoid fish collected from natural habitats in Chiang Mai province.

Place (Amphoe)	Species of fish	Average size of fish mean±SD		Mean density of metacercariae/100 g					
		length (cm)	weight (g)	*O. viverrini*	*Ha.plorchis* sp. I	*Haplorchis* sp. II	*Haplorchis* sp. III	*Centrocestus* species	unidentified
Muang	*P. leiacanthus*	7.6±0.8	7.8±2.0	-	1351.2	15.2	-	-	-
Hangdong	*C. repasson*	11.8±1.0	16.4±2.1	-	35.9	17.4	-	90.7	-
	P. leiacanthus	12.0±0.9	21.0±4.7	-	1127.4	5.9	-	-	-
	Osteochilus spp.	10.3±1.5	13.5±7.1	0.5	1050.1	18.8	0.2	6.5	0.9
Sarapee	*P. leiacanthus*	11.6±0.6	17.3±3.0	4.1	31.4	13.4	1.3	-	14.9
Sansai	*P. leiacanthus*	7.6±0.9	10.6±1.9	-	697.2	20	2.2	-	-
	E. metallicus	6.6±1.1	7.5±1.1	-	301.2	-	-	-	-
	Osteochilus spp.	10.7±1.4	14.1±2.4	-	72.7	1.3	-	-	-
Doisaket	*P. leiacanthus*	10.8±0.1	15.4±3.0	8.6	691.7	224.8	20.9	-	-
	Average			**0.2**	**77.6**	**4.5**	**0.3**	**1.4**	**0.1**

Table 9. Density of metacercariae in cyprinoid fish collected from fish farms in Chiang Mai province.

Place (Amphoe)	Species of fish	Average size of fish mean ± SD		Mean density of metacercariae/100 g					
		length (cm)	weight (g)	*O. viverrini*	*Haplorchis* sp. I	*Haplorchis* sp. II	*Haplorchis* sp. III	*Centrocestus* species	unidentified
Muang	*Osteochilus* spp.	13.4±1.0	19.7±2.2	-	256.1	-	-	-	-
	P. gonionotus	13.3±1.3	18.6±2.0	-	397.1	12.2	-	-	-
Hangdong	*P. gonionotus*	8.0±0.9	10.1±1.0	-	21.9	3.5	-	4.5	-
Sarapee	*P. gonionotus*	8.5±1.5	11.7±1.3	-	127.7	114.9	1.9	124.9	-
Sansai	*P. gonionotus*	12.8±1.2	42.0±7.4	0.1	3.5	0.9	0.1	0.7	0.6
Doisaket	*P. gonionotus*	12.4±0.9	12.4±0.9	-	2.6	-	-	-	-
Average				**0.001**	**11**	**1.8**	**0.02**	**1.8**	**0.008**

Table 10. Prevalence of metacercariae in "*pla-jom*" from 5 Districts in Chiang Mai province.

Place (Amphoe)	no. of sample (100g each)	fermentation (day)	no. positive (%)	no. of met.*	no. per 100 g of fish mean±SD	morphology of metacercariae** Type 1	Type 2
Muang	6	7	0	0	0	0	0
Hangdong	7	3	7	101	14.4±13.8	81 (80.2)	20 (18.8)
Sarapee	4	7	0	0	0	0	0
Sansai	8	3	4	47	11.7±3.7	35 (74.4)	12 (25.6)
Doisaket	10	3	8	66	8.2±7.9	53 (80.3)	13 (19.7)
Total	**35**		**19 (54.3)**	**214**	**11.4±5.0**	**169 (78.9)**	**45 (21.0)**

****Type 1 = Complete degeneration, Type 2 = Partial degeneration and no movement,**

*** = metacercariae**