Zooplankton of Kanchanaburi Province, Thailand

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Key word : species composition, distribution, tropical zooplankton, freshwater,Thailand

Abstract

The freshwater zooplankton of 5 types of water body in the western part of Thailand was studied for twelve months. Twenty-one species of Protozoa, eighty-eight species of Rotifera, twenty-eight species of Cladocera, two species of Calanoida and two species of Cyclopoida were found in samples collected monthly in 1998. In general, Rotifera dominated in all water-bodies, although fluctuations occurred during the year. Samples from the reservoir heavily vegetated yield the highest number of species. The following species are common Thai zooplankton: *Arcella bathysoma*, *A. vulgaris*, *Centropyxis aculeata*, *Difflugia lebes*, *D. urceolata*, *Euglypha filifera*, *Anuraeopsis fissa*, *Brachionus angularis*, *B. falcatus*, *Filinia longiseta*, *Keratella cochlearis*, *K. tropica*, *Lecane bulla*, *L. papuana*, *Polyarthra vulgaris*, *Trichocerca similis*, *Ceriodaphnia cornuta*, *Bosminopsis deitersi*, *Diaphanosoma excisum* and *Moina micrura*. A tropical rare species, *Daphnia lumholzi*, was found in rivers, reservoirs and man-made lake in this study. Copepoda was a minor component in the study area where *Thermocyclops crassus* was common throughout the year. One calanoid copepod, *Phyllodiaptomus sasikumari* found in a richfield is the first record in Thailand. Seasonal variation of species composition might not be so pronounced, however number of species at most sampling locations increased during wet season.

Introduction

The freshwater zooplankton of Kanchanaburi province has been sparsely investigated. The first publication on diversity of zooplankton in the area was the report of environmental and ecological investigation for Upper Quae Yai project (EGAT, 1980). In the last decade, there have been investigations carried out in various localities in Thailand (Pholpunthin, 1997; Sanoamuang, 1998, 1999; Sanoamuang and Kanla, 1995; Sanoamuang and Athib ai, 2002). The aim of the present study is to provide information of diversity and distribution of zooplankton of this province. Kanchanaburi province is located in the west part of the western region of Thailand where it is mostly a land of mountains, valleys and alluvial plains. The Mae Klong, the main river of the western region, begins at Pak Phraek in Kanchanaburi where two main tributaries converge, the Quae Yai and Quae Noi.

Kanchanaburi is the largest province in the western area with 19,483 square kilometers, and is 125 kilometer from Bangkok. Average rainfall about 1,150 mililitre. Average air temperature about 28.1 $^{\circ}$C. Summer season is from March to May, rainy season is from June to October, and winter season is from November to February.

Materials and Methods

Between January 1999 to December 2000, monthly plankton sampling was made from various types of habitats (Fig.1), using 30 cm diameter nets of 26 mm and 60 mm mesh sizes. Ten to thirty liters of water were filtered through plankton nets, in case the water level is very low, e.g. rice fields or temporary ponds. Cladoceran and copepods were sorted out under an Olympus binocular dissecting microscope. Identification and drawing of zooplankton specimens using an Olympus CH series microscope with attach drawing tube. Specimens were also photographed.

Sampling stations

Sampling stations consisted of 25 stations based on water flowing characteristics : lentic and lotic habitats. Lentic habitats were rivers (10), while lotic habitats were reservoirs of various depths (4), man-made lake (6), swamp (1), temporary pond/ditch (2), and ricefields (2).

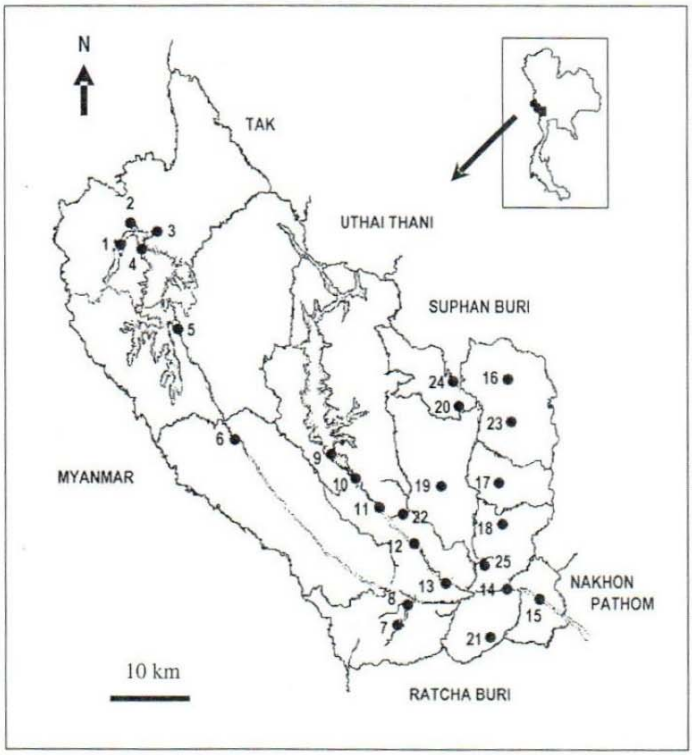

Fig. 1 Kanchanaburi province showing sampling locations

Results and Discussion

Species composition

A species list and distribution of zooplankton in Kanchanaburi province are shown in Table 1. Rotifera forms a major component of zooplankton. Among 141 species identified were 21 Protozoa, 88 Rotifera, 28 Cladocera, 2 Calanoida and 2 Cyclopoida. Ostracoda was quite common in this study, but they could not be identified.The occurrence of Ostracoda in tropical zooplankton has been noted by Apstein (1907) and Klie (1935).

Table 1 A species list and distribution of zooplankton. * common species; ** : new record; X indicates presence of species.

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
Phylum Protozoa (Total)	10	14	11	7	11	9	12	10	11	12	13	12	10	12	12	11	7	8	16	9	10	5	7	6	6
Subphylum Plasmodroma																									
Class Sarcodina																									
Order Testacida																									
Family Arcellidae																									
1. *Arcella bathysoma* Ehrenberg*		X	X		X	X		X	X	X	X	X	X	X	X	X		X	X	X			X	X	
2. *A. megastoma* Ehrenberg	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3. *A. vulgaris* Ehrenberg *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4. *Lesquereusia spiralis* Ehrenberg								X	X	X															
Family Difflugiidae																									
5. *Difflugia acuminata* Ehrenberg		X					X			X					X	X		X	X			X			
6. *D. bacillifera* Penard		X			X																				
7. *D. corona* Wallich	X		X								X														
8. *D. lebes* Penard *	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
9. *D. oblonga* Ehrenberg*		X	X			X	X				X	X		X	X			X	X				X		
10. *D. urceolata* Carter*	X	X	X	X		X	X	X		X	X	X			X	X	X		X	X	X			X	

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
11. *Centropyxis aculeata* Stein *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X
12. *C. ecornis* Ehrenberg		X			X	X	X					X	X		X	X			X				X		
Family Euglyphidae																									
13. *Euglypha filifera* Leidy *	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X			X		X	X		X	X
Order Heliozoida																									
Family Actinophryidae																									
14. *Actinophrys sol* Ehrenberg	X	X	X				X	X	X		X					X			X						
15. *Actinosphaerium eichhorni* Ehrenberg	X	X	X	X	X		X	X	X	X	X	X	X	X		X		X	X	X	X				
Subphylum Ciliophora																									
Class Ciliata																									
Order Gymnostomatida																									
16. *Coleps* sp.												X							X	X	X				
17. *Didinium nasutum* Müller		X							X		X								X						
Order Hypotrichida																									
18. *Euplotes* sp.										X				X											

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
Order Peritrichida																									
19. *Epistylis* sp.					X									X			X				X				
20. *Pyxicola affinis* Kent	X			X	X	X	X		X	X	X		X	X	X				X	X	X				X
21. *Vorticella* sp.												X	X	X	X		X		X	X					
Phylum Rotifera (Total)	42	46	35	39	31	34	38	35	30	46	42	32	28	35	23	36	31	43	40	45	31	13	7	15	5
Class Monogononta																									
Order Ploima																									
Family Brachionidae																									
22. *Anuraeopsis coelata* (Beauchamp)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X				
23. *A. fissa* (Gosse)	X	X	X	X		X		X	X	X	X	X	X	X	X	X		X	X	X	X				
24. *A. navicula* (Rousselet)	X	X		X	X		X			X	X	X	X	X		X		X		X					
25. *Brachionus angularis* Gosse*	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X			
26. *B. calyciflorus* Pallas																X	X		X	X		X			
27. *B. caudatus* Barrois and Daday	X	X	X	X	X		X	X		X	X		X			X	X	X	X	X	X				
28. *B. dichotomus* Shephard	X	X	X	X	X	X		X			X														

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
29. *B. diversicornis* Daday														X											
30. *B. donneri* Brehm	X	X	X	X				X			X							X			X				
31. *B. falcatus* Zacharias*	X	X	X	X	X	X		X	X	X	X	X	X		X	X		X	X	X	X	X			
32. *B. forficula* Wierzejski	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X				
33. *B. quadridentatus* Hermann*		X	X	X	X	X		X	X	X	X				X	X	X	X		X	X	X			X
34. *B. niwati* Sanoamuang, Segers & Dumont																			X	X					
35. *B. urceolaris* O.F.M		X					X									X		X				X			
36. *Colurella hindenburgi* Steinecke												X	X												
37. *C. obtusa* (Gosse) *	X	X	X	X	X	X	X		X	X	X		X	X	X			X	X	X	X		X	X	
38. *C. uncinata* (Müller)												X		X											
39. *Dipleuchlanis propatula* Gosse														X				X	X	X					
40. *Euchlanis dilatata* Ehrenberg				X	X	X	X	X	X	X	X		X	X	X		X		X	X	X				
41. *Heterolepadella ehrenbergii* (Perty)										X															
42. *Keratella cochlearis* Gosse	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
43. *K. lenzi* (Berzins)																				X					
44. *K. tropica* (Apstein)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
45. *Lepadella acuminata* (Ehrenberg)	X				X		X				X	X	X	X											
46. *L. ovalis* (O.F.M)	X	X			X	X	X				X	X		X	X	X	X	X	X	X	X	X	X	X	
47. *L. patella* (O.F.M)					X	X	X					X			X			X				X	X	X	
47. *L. rhomboides* (Gosse)				X	X	X	X		X	X	X					X	X	X	X	X	X				
48. *Macrochaetus sericus* (Thorpe)							X			X	X		X											X	
49. *Mytilina ventralis* (Ehrenberg)		X		X				X	X	X	X	X		X	X		X		X					X	
50. *Plationus patulus* (O.F.M)		X	X	X			X	X		X	X					X	X	X	X	X				X	X
51. *Platyias quadricornis* (Ehrenberg)	X					X		X			X							X	X		X				
52. *Tricrotria tetractis* (Ehrenberg)	X	X					X									X	X								
53. *Tripleuchlanis plicata* (Levander)		X				X	X	X	X	X	X		X						X					X	
Family Lecannidae																									
54. *Lecane aculeata* (Jakubski)		X					X		X																
55. *L. arcauta* (Bryce)									X						X										
56. *L. batillifer* (Murray)																				X					
57. *L. blachei* Berzi										X										X					
58. *L. bulla* (Gosse) *	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
59. *L. closterocerca* (Schmarda)										X	X			X											
60. *L. curvicornis* (Murray)													X							X	X				
61. *L. decipiens* (Murray)					X	X	X			X		X	X	X			X		X					X	
62. *L. hamata* (Stokes)					X							X		X										X	
63. *L. hastata* (Murray)							X										X	X	X	X					
64. *L. hornemanni* (Ehrenberg)																		X							
65. *L. inopinata* Harring & Myers																								X	
66. *L. lateralis* Sharma																				X					
67. *L. leontina* (Turner)	X		X	X						X	X							X		X			X		
68. *L. ludwigii* (Eckstein)										X		X		X				X		X					
69. *L. luna* (O.F.Müller)		X	X			X				X				X		X	X	X	X	X					
70. *L. lunaris* (Ehrenberg)	X	X	X		X		X	X	X	X	X		X	X	X						X				
7X. *L. monostyla* (Daday)																				X					
72. *L. nana* (Murray)							X	X											X						
73. *L. papuana* (Murray) *	X	X	X	X		X	X	X	X	X			X		X		X	X	X	X	X	X		X	
74. *L. obtusa* (Murray)												X													

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank									Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl													
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
75. *L. pyriformis* (Daday)														X											
76. *L. quadridentatus* (Ehrenberg)										X				X											
77. *L. signifera* (Jennings)																									X
78. *L. stenroosi* (Meissner)		X												X					X						
79. *L. stichaea* Harring	X	X			X					X	X	X	X			X		X		X					
80. *L. tenuiseta* Harring		X																							
81. *L. thienemanni* (Hauer)													X	X											
82. *L. unguitata* (Fadeev)		X															X	X			X				
83. *L. ungulata* (Gosse)										X	X														
Family Notommatidae																									
84. *Cephalodella* sp.		X					X											X						X	
85. *Scaridium longicaudum* (Müller)		X				X																			
Family Trichocercidae																									
86. *Trichocerca capucina* (Wierz. and Zach.)		X	X	X																					
88. *T. cylindrica* (Imhof)	X	X		X				X	X	X	X	X		X		X									
89. *T. pusilla* (Jennings)	X	X	X	X		X	X		X	X	X	X		X		X				X	X				

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
90. *T. ruttneri* Donner	X												X												
91. *T. similis* (Wierzejski) *	X	X	X	X	X	X		X		X	X	X	X		X	X	X	X	X		X			X	
Family Gastropodidae																									
92. *Ascomorpha ovalis* (Carlin)	X	X	X	X	X	X	X	X	X	X	X	X		X		X			X	X	X				
Family Asplanchnidae																									
93. *Asplanchna brightwelli* (Gosse) *	X	X	X	X	X	X	X	X	X	X		X	X	X		X		X	X	X	X	X			
Family Synchaetidae																									
94. *Polyarthra vulgalis* Carlin *	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X
95. *Synchaeta* sp.	X	X	X	X			X		X	X	X	X	X	X		X	X	X	X	X	X				
96. *Ploesoma* sp.	X	X	X	X												X									
Order Flosculariacea																									
Family Testudinellidae																									
97. *Testudinella patina* (Hermann)		X	X			X	X		X	X	X	X			X	X	X	X	X	X				X	
98. *Trochosphaera aequatorialis* (Semper)					X					X	X	X						X							
99. *Pompholyx complanata* (Gosse)	X		X	X		X	X	X								X	X	X	X	X					
100. *Filinia camasecla* Myers	X	X	X	X	X	X		X		X	X					X	X	X	X		X				

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
101. *F. longiseta* (Ehrenberg) *	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X			
102. *F. opoliensis* (Zacharias)				X		X	X	X			X			X		X	X	X	X	X	X				
103. *Sinantherina spinosa* (Thorpe)	X			X	X	X		X		X							X	X							
Family Hexarthridae																									
104. *Hexarthra intermedia* Wiszniewski *	X	X	X	X	X	X		X	X	X	X	X			X	X	X	X	X	X	X	X			
105. *H. mira* (Hudson)	X	X	X	X					X		X					X	X	X	X	X	X				
Family Conochilidae																									
106. *Conochilus* sp.	X	X	X	X				X		X	X					X	X		X	X	X				
Order Collothecacea																									
Family Collothecidae																									
107. *Collotheca* sp.	X	X	X	X	X		X	X	X	X			X	X		X				X			X		
Class Digononta																									
Family Philodinidae																									
108. *Rotaria* sp.							X					X		X											
109. Unknown bdelloidea	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X					X

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
Phylum Arthropoda																									
Class Crustacea																									
Subclass Branchiopoda																									
Order Diplostraca																									
Suborder Cladocera (Total)	9	11	9	10	7	7	6	12	7	16	10	9	7	9	3	6	9	8	6	5	5	5	2	2	6
Family Sididae																									
110. *Diaphanosoma excisum* Sars*	X	X	X	X		X				X	X	X	X	X		X	X	X	X	X	X	X	X		
Family Daphnidae																									
111. *Ceriodaphnia cornuta* Sars*	X	X	X	X	X			X		X		X	X	X	X	X	X	X	X	X	X	X			
112. *Daphnia lumholtzi* Sars	X	X	X	X	X			X		X		X									X				
113. *Scapholeberis kingi* Sars	X	X		X				X	X	X	X	X	X												
Family Moinidae																									
114. *Moina micrura* Kurz*	X	X	X	X	X		X	X		X					X	X	X	X	X	X	X	X			X
Family Bosminidae																									
115. *Bosmina longirostris* (O.F.Müller)	X	X	X	X	X	X		X	X	X		X	X	X		X	X								
116. *B. fatalis* Burckhardt	X	X	X	X	X	X		X		X				X		X	X								

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
117. *B. meridionalis* Sars	X	X		X		X																			
118. *Bosminopsis deitersi* Richard*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X			X
Family Macrothricidae																									
119. *Grimaldina brazzai* Richard								X			X														
120. *Ilyocryptus spinifer* Herrick																		X							
121. *Macrothrix triserialis* Brady																									X
122. *M. laticornis* Jurine		X												X				X		X		X			X
123. *Streblocercus pygmaeus* Sars										X															
Family Chydoridae																									
Subfamily Chydorinae																									
124. *Alona costata* Sars																	X								
125. *A. eximia* Kiser										X	X														
126. *A. karua* (King)									X				1												
127. *A. rectangular* Sars		X				X	X		X	X	X			X				X	X				X	X	
128. *A. verrucosa* Sars			X				X		X	X	X	X						X	X						X
129. *Camptocercus uncinatus* Smirnov							X	X																	

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
130. *Chydorus eurynotus* Sars			X	X	X	X		X	X	X	X	X						X							X
131. *C. reticulatus* Daday												X													
132. *C. parvus* Daday								X		X															
133. *Dunhevedia crassa* King										X				X			X								
134. *Ephemeroporus barroisi* (Richard)							X			X	X						X								
135. *Euryalona orientalis* (Daday)											X													X	
136. *Kurzia longirostris* (Daday)																			X						
137. *Leydigia acanthocercoides* (Fischer)													X	X											
Subclass Copepoda (Total)	2	2	2	3	2	4	2	3	3	3	3	4	1	3	1	2	4	4	3	4	4	1	0	0	1
Order Calanoida																									
Family Diaptomidae																									
Subfamily Diaptominae																									
138. *Neodiaptomus botulifer* Kiefer			X		X	X	X	X	X	X	X	X		X		X	X	X	X	X	X				
139. *Phyllodiaptomus sasikumari* Kiefer **																									
Order Cyclopoida																									
Family Cyclopidae																									

Table 1 (continued)

Taxa / Sampling Stations	Rivers							Reservoirs				Man-made Lakes/Irrigation Tank										Temporary Ponds		Ricefields	
								>100 m msl		50-100 m msl	<50 m msl														
	1	2	3	4	6	7	8	5	9	11	14	10	12	13	15	16	17	18	19	20	21	22	23	24	25
Subfamily Cyclopinae																									
140. *Mesocyclops thermocyclopoides* Harada	X	X		X		X		X	X		X	X		X			X	X	X	X	X				
141. *Thermocyclops crassus* (Fischer)				X		X				X	X	X					X	X		X	X				
142. Copepod nauplii	X	X	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X			X

Protozoa

Most of the protozoan listed in Table 1 were common in the samples and occurred both in lentic and lotic habitats. Common species were *Arcella bathysoma, A. vulgaris, Difflugia acuminata, D. oblonga, D. urceolata, Actinophrys sol,* and *Actinosphaerium eichhorni.* Two common genera in this study correspond with the work of Fernando (1980) on zooplankton distribution of tropical Asia.

Rotifera

Rotifers was the dominant group of zooplankton in the studied area. The result corresponds with exactly knowledge on zooplankton composition from previous studies (Fernando, 1980; Segers and Dumont, 1995). The most diverse rotifer genera are *Lecane*, followed by *Brachionus*, and *Trichocerca*. This result also concurs with studies that *Lecane* is the most diverse genus in the tropical region, especially in the littoral area (Segers, 1995, 1996). Twenty-two cosmopolitan species and pantotropical species (very common in tropical area) were : *Anuraeopsis fissa, A. coelata, Brachionus angularis, B. caudatus, B. falcatus, B. forficula, Filinia opoliensis, Hexarthra intermedia, Keratella cochlaris, K. tropica, Lecane bulla, L. hamata, L. hornemanni, L. luna, L. lunaris, L. papuna, Lepadella rhomboides, Polyarthra vulgaris, Pompholyx camplanata, Testudinella patina, Trichocerca pusilla* and *T. similis* (Dumont, 1983; Segers, 2001)

Cladocera

Most of cladocerans recorded in the study area were tropical species. Only four of them were very common, *Ceriodaphnia cornuta, Bosminopsis deitersi, Diaphanosoma excisum* and *Moina micrura*. Sanoamuang (2001) reported that these species were widely distributed in Thailand. Notably *Daphnia lumholtzi* was commonly found in both lentic and lotic habitats. Previous studies stated that more cladoceran species were found in lentic than lotic. In this study we found that most species found in both lentic and lotic habitats. However, some species presented only in lentic, i.e. *Alona eximia, Chydorus parvus, Euryalona orientalis, Kurzia longirostris, Macrothrix triserialis,* while *Chydorus reticulatus* and *Leydigia acanthocercoides* occurred only in lotic habitat.

Calanoida

Calanoid copepods were represented by only two species. *Mongolodiaptomus botulifer*, a widely distributed species in Thailand (Sanoamuang, 1999, 2001). Another species, *Phyllodiaptomus sasikumari* is the first record of Thailand, being observed only once in the ricefield during rainy season.

Cyclopoida

Cyclopoid copepods of Thailand are less known than calanoid copepods. In this study there were represented by two species that commonly found in both habitats, *Mesocyclops thermocyclopoides,* and *Thermocyclops crassus.*They are widely distributed cyclopoid copepods in the country (Sanoamuang, 1999, 2001).

Spatial variation of species composition

All water bodies generally have in common zooplankton species compostion : Protozoa, Rotifera, Cladocera, Copepoda (Calanoida, and Cyclopoida) except stations 22-23 (temporary ponds) (Fig.2). Rotifera represented by *Lecane* and *Brachionus* were the most diverse genera, followed by Protozoa represented by *Difflugia, Arcella* and *Centropyxis*. These general constitute the major component of the tropical zooplankton fauna was noted by several authors (Fernando, 1980; Dumont, 1994a,b; Segers and Dumont, 1995) *Lecane* and *Brachionus* are predominantly pelagic and littoral taxa of lentic (man-made lake/irrigation tank, swamp, temporary ponds, ricefields) and lotic localities (rivers) in this study. A few genera of Protozoa occurred at stations rich in macrofauna, especialy in temporary ponds (lotus ponds) and ricefields. On looking at the occurrence of the species in different types of habitat (Table 1), it is found that moderately deep reservoir has the highest number of species (77), followed by rivers (73), man-made lakes/irrigation tank and shallow reservoir (68 each), deep reservoir (60), swamp (50), temporary ponds and ricefields (23).

Fifteen species occurred in all types of habitat (Table 1). Common species were found only in permanent water-bodies : *Anuraeopsis coelata, A. fissa, Brachionus angularis, B. caudatus, B. falcatus, B. forficula, Keratella cochlearis* and *K. tropica.* In this study there were many extremely rare species that occurred only at one to three sampling locations. The noteworthy species, *Phyllodiaptomus sasikumari,* the first record species in Thailand was found only in the ricefield (Table 1). Ricefield contained many rare species which were not found elsewhere, i.e. *Lecane inopinata, L. signifera, Macrothrix triserialis* and *Euryalona orientalis*. Some species of crustacean seemed to be present at particular habitats. *Daphnia lumholzi* and *Scapholeberis kingi* were frequently observed in rivers, reservoirs (deep to moderately deep). They were not common cladoceran in Thailand (Sanoamuang, 2001) and not reported from Malaysia (Idris, 1983). Copepoda was a minor group of zooplankton in Kanchanaburi. Three out of four species found (*Neodiaptomus botulifer, Mesocyclops thermocyclopoides* and *Thermocyclops crassus*) occurred in all permanent water bodies. But copepod nauplii could be found in all types of habitat except temporary ponds (stations 24, 25).

Species composition of the main zooplankton groups was the same at all sampling stations. The difference among them is the number of each zooplankton group present. Number of species, especially protozoan might be underestimated because most ciliated protozoan could not be identified from preserved specimens. Testate amoebae is the easiest group to work with, therefore it is a major component of protozoan. Chydoridae was well presented at station 20, a shallow swamp where samples were taken near the bottom Chydorids were less frequently found from large water-bodies as samples were taken at subsurface level. Limnetic species, particularly the crustaceans that conduct vertical migration might not be caught. The absence of *Brachionus calyciflorus* from rivers coincide with the report of Boonsom (1984) but she reported the prisence of this species in the deep reservoir. *Daphnia lumholzi*, a tropical rare species was regularly observed at rivers and (station 1-6), reservoirs (stations 1, 11) and man-made lake (stations 10).

Environmental factor had impacts on species composition of zooplankton. Sampling stations with similar characteristics did not have similar number of species. For example, stations 12 on Quae Yai River had higher number (59) than that of station 13 (46), because the former received sewage effluent from local community nearby.

Biological factors also plays an important role on zooplankton community. A few species of cladoceran and absence of copepods at station 15 on Mae Klong River, the specific place where a large number of catfishs and cyprinids being cultured, confirm the suggestions of Fernando (1994) and Weber and Declerck (1997) that zooplankton is used as food for zooplanktivore fishes. Water bloom at stations 17, 21 reducing number of species of zooplankton agrees with the experiment of Infante and Rich (1984) in tropical lake of Venezuala.

In this study, the most suitable habitat for zooplankton is station 11, a moderately deep reservoir. A great diverse of aquatic plants were found in this reservoir. They were: common reeds (*Phragmites karka*), umbrella grass (*Euirena ciliaris*), *Cyperus* spp., *Scirpus* spp., hydrilla (*Hydrilla verticillata*), bushy pond weeds (*Najas gaminea*), coontails (*Ceratophyllum demersum*), *Lemna pusilla*, creeping waterprimroses (*Jussiaea raperees*), *Eichornia crassipes*, *Ipomoea aquatica*, floating mosses (*Salvinia cuculata), Pistia stratiotes, Trapa bispinosa,* water snowflakes, water lilies, lotuses,*Typha angustifolia*, *Monochoria hastata, Barringtonia acutangula, Alternanthera sessilis*, etc.

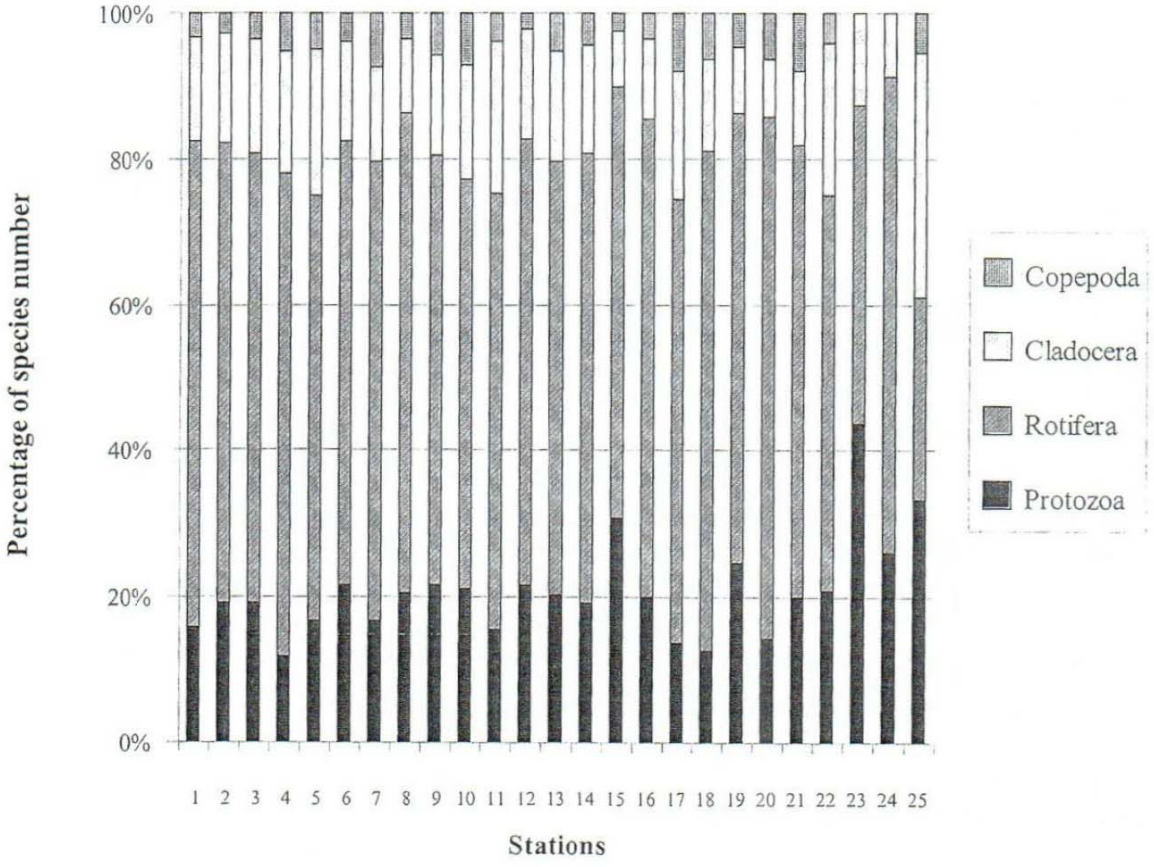

Fig. 2 Spatial variation of zooplankton in Kanchanaburi Province

Seasonal variation of zooplankton composition

Seasonal variations were analysed only at 21 sampling locations (Stations 1-21) where the water was not dried out in drying periods. Generally, number of species was highest in rainy season (June-September), followed by summer season (March-May) and winter season (October-January) (Table 2). Rotifera predominated in all localities sampled, and were the most frequent organisms observed year-round.

Perennial species were Protozoa (*Arcella vulgaris, Centropyxis aculeata, Difflugia lebes, Pyxicola affinis),* Rotifera (*Ascomorpha ovalis, Asplanchra brightwelli, Brachionus falcatus, B. forficula, Collotheca* sp., *Filinia camasecla, F. longiseta, F. opoliensis, Hexarthra intermedia, Keratella cochlearis, K. intermedia, K. tropica, Polyarthra vulgaris*), Cladocera (*Bosmina longirostris, Bosminopsis deitersi, Ceriodaphnia cornuta* and *Diaphanosom excisum*).

The following zooplankton that occurred in particular times of the year and only at some localities, summer season were : *Lecane hornemanni, L. obtusa, Lepadella acuminata, Alona eximia, A. karua, Chydorus parvus, Dunhevedia crassa, Ilyocryptus spinifera* and *Kurzia longirostris.*

The species found in rainy season were : *Arcella discoides, Lesquerusia spiralis, Brachionus calyciflorus, B. dichotomus, B. donneri, B. patulus, B. ungulatus, B. urceolaris, Lecane bacillifera, L. blachei, L. ovalis, L. quadridentatus, L. tenuista, Trochosphaera equalis, Camptocercus uncinatus, Chydorus reticulatus, Macrothrix laticornis* and *M. triserialis*. During this time, *Daphnia lumholzi* was observed at station 4 (Quae Noi River). *Mongolodiaptomus botulifer, Phyllodiaptomus sasikumari.*

The species frequently observed in winter season were : *Difflugia acuminata, Colurella unciata, Heterolepadella ehrenbergi, Lecane closterocerca, L. pyriformis, Scaridium* sp., *Trichocerca capucina, T. cylindrica, Daphnia lumholzi*. Copepods, especially cyclopoids tended to occur in this season compared to other seasons.

Species number of zooplankton in various types of water body increased in wet season and decreased in dry season agree with the results of Tait *et al* (1994), and Smirnov (1994). In eutrophic water bodies where dense bloom of phytoplankton always occur inhibit filter feeders (Acifa, 1994) and could influence the taxonomic composition of zooplankton (Magadza, 1994). This phenomena decreased species number at some sampling locations in this study.

Table 2 Seasonal variation of species number in Kanchanaburi Province (- : No water)

Station No.	Type of Habitat	Summer(Mar.-May) Max No./Month	Rainy(June-Sept.) Max No./Month	Winter(Oct.-Jan.) Max No./Month
1	River	27/April	27/Spet.	22/Dec.
2	River	25/April	28/Spet.	23/Dec.
3	River	26/April	28/Spet.	23/Nov.
4	River	28/April	28/Spet.	20/Nov.
5	Reservoir (deep)	23/April	24/June	15/Nov.
6	River	18/Mar.	10/Sept.	12/Dec.
7	River	/May	16/Sept.	16/Nov.
8	River	29/Mar.	19/June	6/Nov.
9	Reservoir (deep)	23/Mar.	20/Sept.	16/Dec.
10	River	24/April	24/June	24/Dec.
11	Reservoir (moderately deep)	24/April	26/Sept.	32/Nov.
12	River	20/April	19/June	10/Jan.
13	River	17/May	21/Sept.	23/Nov.
14	Reservoir (shallow)	28/Mar.	22/July.	19/Nov.
15	River	13/Mar.	13/July	15/Dec.
16	Man-made lake	25/Mar.	25/Aug.	15/Jan.
17	Man-made lake	12/May	23/Sept.	16/Dec.
18	Man-made lake	24/April	23/Sept.	25/Nov.
19	Irrigation tank	25/April	26/Sept.	16/Nov.
20	Man-made lake	17/Mar.	27/Sept.	24/Dec.
21	Swamp	24/Mar.	27/June	15/Nov.
22	Temporary pond	6/May	18/June	-
23	Temporary pond	9/May	10/June	-
24	Rice field	-	13/Aug.	10/Oct.
25	Rice field	18/May	-	-
	Total maximum period	**5**	**15**	**4**

Acknowledgements

This work was supported by TRF/BIOTEC Program for Biodiversity and Training grant BRT

References

Acifa, M.S. 1994. Zooplankton composition of ten reservoirs in southern Brazil. *Hydrobiologia* 113 : 137-145.

Apstein, C. 1907. Das plankton in Colombo See and Ceylon. *Zool. Jb. Syst. Okol. Georgra. Tiere* 25:201-244.

Boonson, J. 1984. The freshwater zooplankton of Thailand (Rotifera and Crustacea). *Hydrobiologia* 113:223-229.

Chittapun, S. and Pholpunthin, P. 2001. The rotifer fauna of peat-swamps in southern Thailand. *Hydrobiologia* 446/447 : 255-259.

De Ridder, M. and Segers, H. 1997. Monogonont Rotifera recorded in the world literature (except Africa) from 1960 to 1992, Studiedocumenten van het Koninkliijk Belgisch Institut voor Natuurwetens chappen, Brussels, 481 p.

De Smit, W.H. and Pourriot, R. 1997. Guides to the identification of the microinvertebrates of the continental waters of the world, Rotifera Volume 12 : The Dic ranophoirae (Monogononta) and the It uridae (Monogononta). SPB Academic Publishing, Amsterdam. 344 p.

Dumont, H.J. 1983. Biogeography of rotifers rotifers. *Hydrobiologia* 104:19-30.

Dumont, H.J. 1994a. The temperate-tropical gradient of planktonic Protozoa and Rotifera. *Hydrobiologia* 272:13-26.

Dumont, H.J. 1994b. On the diversity of the Cladocera in the tropics. *Hydrobiologia* Electricity Generating Authority of Thailand, (EGAT). Report of environmental and ecological investigation for Upper Quae Yai Project, Kanchanaburi province. 272:27-38.

Fernando, C.H. 1980. The freshwater zooplankton of Sri Lanka, with a descussin of tropical freshwater zooplankton composition. *Int. Revueges Hydrobio*. 65:85-125.

Fernando, C.H. 1994. Zooplankton, fish and fisheries in tropical freshwaters. *Hydrobiologia* 272:105-123.

Gannon, J.E. 1972. Effects of eutrophication and fish predation on recent changes in zooplankton Crustacea species composition in Lake Michigan. *Trans. Am. Micros. Soc.* 91 : 82-85.

Infante, A. and Riehl, W. 1984. The effect of Cyanophyta upon zooplankton in a eutrophic tropical lake (Lake Valencia, Venezuala). *Hydrobiologia* 113 : 293-298.

Idris, B.A.G. 1983. Freshwater zooplankton of Malaysia (Crustacea : Cladocera). Penerbit Universiti Pertanian Malaysia. 153 p.

Klie, W. 1935. Die Ostracoden der Deutschen limnologischen Sunda-Expedition. *Arch. Hydrobiologia*, Suppl. 11:447502.

Korovchinsky, N.M. 1996. Guides to the identification of the microinvertebrates of the continental waters of the world 3 : Sididae & Holopedidae (Crustacea) : Daphniiformes). SPB Academic Publishing, Netherlands. 82 p.

Koste, W. 1975. Uber den Rotatorienbestand winer Microbiozönose in einer Microbiozönose in einem tropischem aquatischen Saumbiotop, der *Eichernia crassipes* –Zone in Littoral des Bung-Boraphet, einem Stausee in Zentralthailand. Gewässer und Abwässer 57/58:43-58.

Lai, H.C. and C.H. Fernando. 1981. The freshwater Calanoida (Crustacea : Copepoda) of Thailand. *Hydrobiologia* 76 : 161-178.

Maas, S. 1993. Introduction to the Copepoda. International Training Course : Lake zooplankton, a tool in lake management guide. University of Ghent, Belgium. 218 p.

Magadza, H.D. 1994. Evaluation of eutrophication control in Lake Chivero, Zimbabwe, by multivariate analysis of zooplankton. Hydrobiologia 272 : 277-292.

Mamaril, A.C. and Fernando, C.H. 1978. Freshwater zooplankton of the Phillippines (Rotifera, Cladocera, and Copepoda). *Natural and Applied Science Bulletin* 30: 109-221.

Nogrady, T. 1993. Rotifera. Vol. 1 : Biology, ecology and systematic. Guides to the identification of the microinvertebrates of the continental waters of the world. No. 4 SPB Academic Publishing bv., The Hague.

Pennak, R.W., 1989. Fresh-water invertebrates of the United States, John Wileys and Sons, New York.

Pholpunthin, P. 1997. Freshwater zooplankton Rotifera, Cladocera and Copepoda) from Thale-noi, south Thailand. J. Sci. Soc. Thailand 23:23-34.

Reddy, Y.R. 1994. Copepoda : calanoida : Diaptomidae. Key to the genera *Heliodiaptomus, Allodiaptomus*, *Neodiaptomus*, *Phyllodiaptomus*, *Eodiaptomus*, *Arctodiaptomus* and *Sinodiaptomus*. Guides to the identification of the microinvertebrates of the continental waters of the world. No. 5 SPB Academic Publishing bv, The Netherlands. 221 p.

Sa-ardrit, P. 2002. Diversity and distribution of freshwater Cladocera in Trang Province. Master of Science Thesis in Ecology, Prince of Songkla University. 97 p. (in Thai)

Sanoamuang, L. 1998. Contributions to the knowledge of the Cladocera of north-east Thailand. *Hydrobiologia* 362:45-53.

Sanoamuang, L. 1999. Species composition and distribution of freshwater Calanoida and Cyclopoida (Copepoda) of northeast Thailand. *In* : Schram, F.R. and Klein, J.C.V. (eds.) Crustaceans and Biodiversity Crisis, Brill Academic Publishers, Leiden. Vol.I. pp.217-230.

Sanoamuang, L. 2001. Diversity of freshwater zooplankton in Thailand. pp.1-16. *In* : Baimai, V. and Kumhom, R. (eds.). BRT Research Reports 2001. Biodiversity Research and Training Program, Jirawat Express Col, Ltd., Bangkok.

Sanoamuang, L. and Kanla, P. 1995. Diversity of freshwater plankton in Thailand (Rotifera). Pp.1-9. *In* : Baimai, V. *et al* (eds.) BRT Research Report 1995.

Sanoamuang, L. and Savatenalinton. 2001. The rotifer fauna of Lake Kud-Thing, a shallow lake in Nong Khai Province, north east Thailand. *Hydrobiologia* 446/447:297-304.

Sanoamuang, L. and S. Athibai. 2002. A new species of *Neodiaptomus* (Copepoda, Diaptomidae) from temporary waters in northeast Thailand. *Hydrobiologia* 489:71-82.

Segers, H. 1995. Rotifera. Vol.2 : The Lecanidae (Monogononta). Guides to the identification of the microinvertebrates of the continental waters of the word 6. SPB Academic Publishing bv, The Netherlands. 226 p.

Segers, H. 1996. The biogeography of littora *Lecane* Rotifera. *Hydrobiologia* 323:169-197.

Segers, H. 2001. Zoogeography of the Southeast Asian Rotifera. *Hydrobiologia* 446/447:233-246.

Segers, H. and H.J. Dumont. 1995. 102+rotifer species (Rotifera : Monogononta) in Broa reservoir (SP., Brazil), on 26 Aug. 1994, with description of three new species. *Hydrobiologia* 316:183-197.

Smirnov, N.N. 1974. Fauna of the U.S.S.R. : Crustacea 1. Keter Press, Jerusalem. 644 p.

Smirnov, N.N. 1992. Guides to the identification of the microinvertebrates of the continental waters of the world 1 : The Macrothricidae of the world. SPB Academic Publishing, Netherlands. 143 p.

Smirnov, N.N. 1996. Guides to the identification of the microinvertebrates of the continental waters of the world 11 : Cladocera : the Chydorinae and Sayciinae (Chydoridae) of the world. Dumont, H.J. co.ed. SPB Academic Publishing, Netherlands. 197 p.

Segers, H. and Pholpunthin. 1997. New and rare Rotifera from Thale-Noi Lake, Pattalung province, Thailand with a note on the taxonomy of *Cephalodella* (Notommatidae). *Annals. Limnol.* 33:12-21.

Tait, R.D., R.J. Shiel, and W. Koste. 1984. Structure and dynamics of zooplankton communities, Alligator Rivers Region, N.T., Australia. *Hydrobiologia* 113 : 1-13.

Vijverberg, J. and Boersma, M. 1997. Long-term dynamics of small-bodied and large-bodied cladocerans during the eutrophication of a shallow reservoir, with special attention for *Chydorus sphaericus*. *Hydrobiologia* 360 : 233-242.