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214122 215000
210000 214122
2015 136
72 39 13 9 3
14 664 ind/L 4.903 mg/L
H' 2.26
Pearson TN NH₄⁺-N DO
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A Preliminary Study on Seasonal Change of Zooplankton Community and Its Environmental Indication in Lianhuadang River System

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Abstract: Investigation on the zooplankton of Lianhuadang River System which feeding into the Taihu Lake in Yixing in four seasons within a year were carried out in 2015. Total of 136 species of zooplankton were identified including 72 species of Protozoa, 39 species of Rotifer, 13 species of Cladocera, 9 species of Copepoda and 3 unknown species by the larvae. Community structure was mainly made up of small zooplankton, including Protozoa and Rotifer. The annual average density, biomass and biodiversity index were 14 664 ind/L (Table 4), 4.903 mg/L (Table 5) and 2.26 (Fig. 4) respectively. Annual average density and biomass reached to

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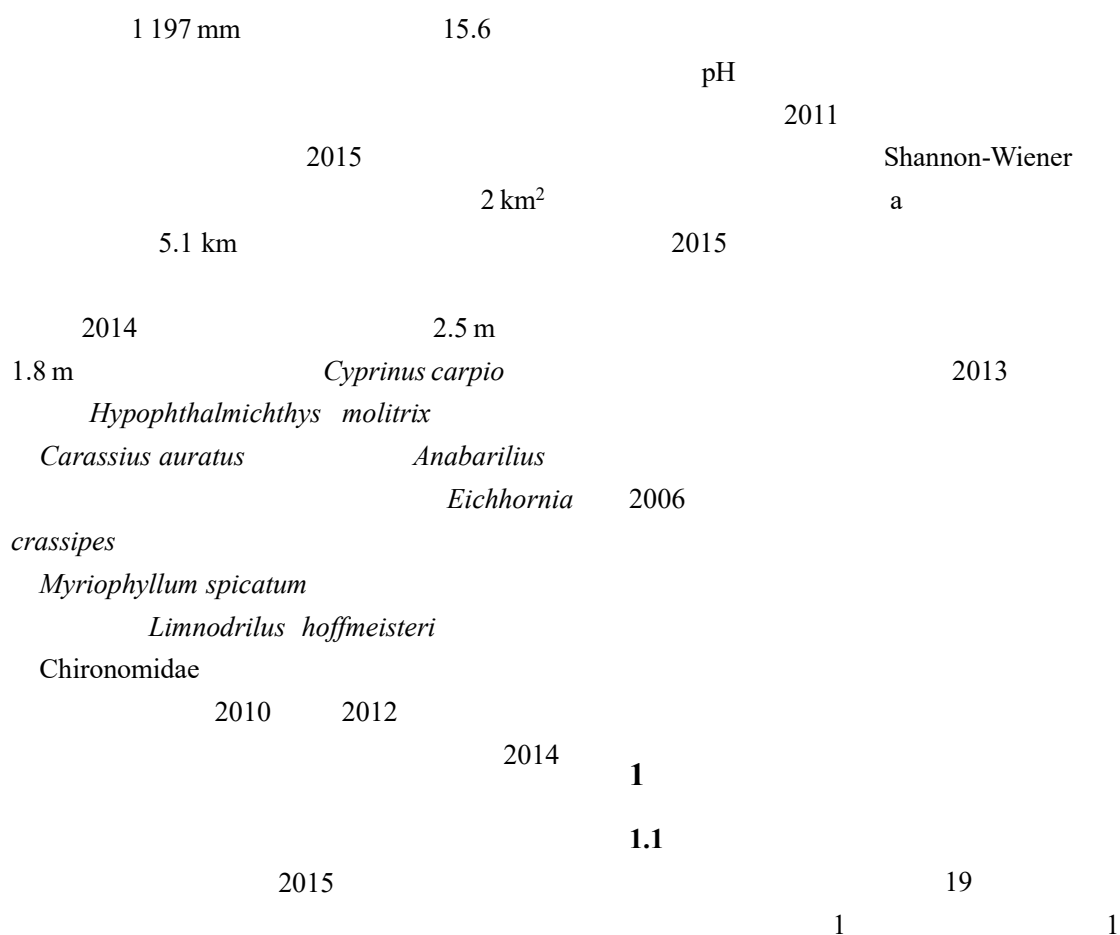
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the largest at sampling site H (32 909 ind/L) and site 9 (12.176 mg/L) (Fig. 2, Fig. 3) respectively. The density and biological amount of zooplankton varied obviously with seasons. The quantity of species found in autumn was 65 species which is the highest in the four seasons (Table 2). Total of 20 species was recognized as dominance species in the samples collected in one or more than one seasons, however, none of them appeared in the samples through out the whole year. The main dominant species were *Tintinnopsis* sp., *Diffugia* sp., *Euplotes* sp., *Keratella* sp., *Brachionus* sp., *Polyarthra* spp., *Bosmina* sp., *Sinocalanus dorrii* and *Mesocyclops* sp. (Table 3). The total nitrogen, ammonia nitrogen and dissolved oxygen were the significant factors on zooplankton density (Table 6). The evaluation based on the biological diversity index and dominant species indicated clearly that the water quality of Lianhuadang River System was moderately polluted and meso-eutrophic.

Key words: Lianhuadang River System; Zooplankton; Water quality; Biodiversity index; Community structure

Aoyagui et al. 2004



1.2

2015 3 6 9 12 25
 4
 25
 ∞
 50 ml 4%
 5 L
 0.5 m 1.5 m
 1 L 15 ml 1.5%
 50 ml 4%
 2010 1 ml
 3 2014
 SL 167-2014
 2014 9

1990

1.3

1.3.1

$H' = \sum_{i=1}^S \frac{1}{N} \ln \frac{N}{n_i}$
 Shannon-Wiener
 H'
 i
 S
 0 ~ 1

Shannon-Wiener

Shannon-Wiener

$H' = \sum_{i=1}^S \frac{1}{N} \ln \frac{N}{n_i}$

= —

n_i

N

H'

1 ~ 2

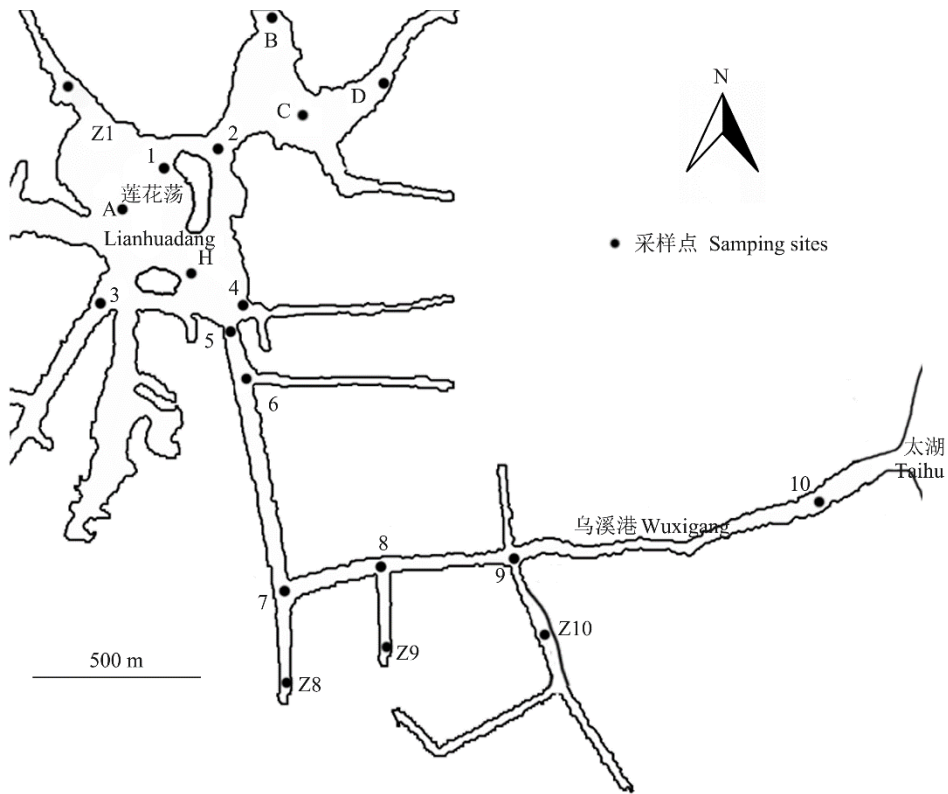
2 ~ 3

α-

β-

$H' > 3$

2002



1

Fig. 1 Sampling sites of zooplankton in Lianhuadang River System

1

Table 1 Coordinates of the sampling site of zooplankton in Lianhuadang River System

Sampling sites	Longgitude	Latitude	Sampling sites	Longgitude	Latitude
1	31°14'31"N	119°51'46"E	A	31°14'22"N	119°51'43"E
2	31°14'31"N	119°52'03"E	B	31°14'53"N	119°52'06"E
3	31°14'11"N	119°51'51"E	C	31°14'39"N	119°52'10"E
4	31°14'11"N	119°52'03"E	D	31°14'36"N	119°52'21"E
5	31°14'08"N	119°52'03"E	Z1	31°14'22"N	119°51'35"E
6	31°14'01"N	119°52'05"E	Z8	31°13'22"N	119°52'11"E
7	31°13'33"N	119°52'11"E	Z9	31°13'27"N	119°52'25"E
8	31°13'34"N	119°52'21"E	Z10	31°13'29"N	119°52'50"E
9	31°13'36"N	119°52'46"E	H	31°14'20"N	119°52'00"E
10	31°13'39"N	119°53'16"E			

1.3.2

McNaughton Y
 McNaughton 1967 $Y = (n_i/N)f_i$ N
 n_i i

f_i i
 Y 0.02

1.4

SPSS

one-way ANOVA

Pearson

Diffflugia sp.*Brachionus* sp.52 49
2

27 17

Euplotes sp.*Keratella* sp.*Polyarthra* spp.*Bosmina* sp.

65

51.92% 43.58%

*K. valga**K. cochlearis*

sp.

Asplanchna sp.*Filinia**Trichocerca* sp.

2

2.1

136 72
 52.94% 39
 28.68% 13 9.56%
 9 6.61% 3 2.21%

39 36

60% 73.4% *Vorticella*

sp.

*Ciliata**Amoeba* sp.*Tintinnidium* sp.

2.2

Tintionnopsis sp.

2

Table 2 The species number of zooplankton in different seasons in Lianhuadang River System

Seasons	Protozoa	Rotifer	Cladocera	Copepoda	Other larvae	Total
Spring	13	27	4	5	3	52
Summer	13	17	6	3	0	39
Autumn	39	15	6	5	0	65
Winter	36	6	3	4	0	49

7

3

3

7

Table 3 The dominant species change by seasons in Lianhuadang River System

10

Tintinnopsis

wangi

Seasons	Dominant species	Dominant degree
	<i>Tintinnopsis</i> sp.	0.04
	<i>Vorticella</i> sp.	0.20
	<i>Brachionus angularis</i>	0.03
Spring	<i>Filinia major</i>	0.06
	<i>F. longiseta</i>	0.05
	<i>Polyarthra</i> sp.	0.02
	Rotifer eggs	0.12
	<i>Diffugia</i> sp.	0.07
	<i>Diffugia avellana</i>	0.03
	<i>Ciliata</i>	0.02
Summer	<i>Tintinnopsis</i> sp.	0.08
	<i>Tintinnidium</i> sp.	0.05
	<i>Keratella valga</i>	0.07
	<i>Tintinnopsis wangi</i>	0.02
	<i>Arcella arenaria</i>	0.03
	<i>Phryganella</i> sp.	0.04
	<i>Diffugia</i> sp.	0.07
	<i>D. globulosa</i>	0.06
	<i>Ciliata</i>	0.02
Autumn	<i>Amoeba</i> sp.	0.02
	<i>Tintinnopsis</i> sp.	0.04
	<i>T. wangi</i>	0.07
	<i>Keratella cochlearis</i>	0.03
	<i>Bosmina</i> sp.	0.02
Winter	<i>Euplotes</i> sp.	0.05
	<i>Tintinnidium</i> sp.	0.04

2

20

1

3

2

1

2.3

2.3.1

14 664 ind/L

84.08%

9.26%

2.98%

3.61%

0.07%

33 670 ind/L

12 343 ind/L

11 551 ind/L

1 092 ind/L

4

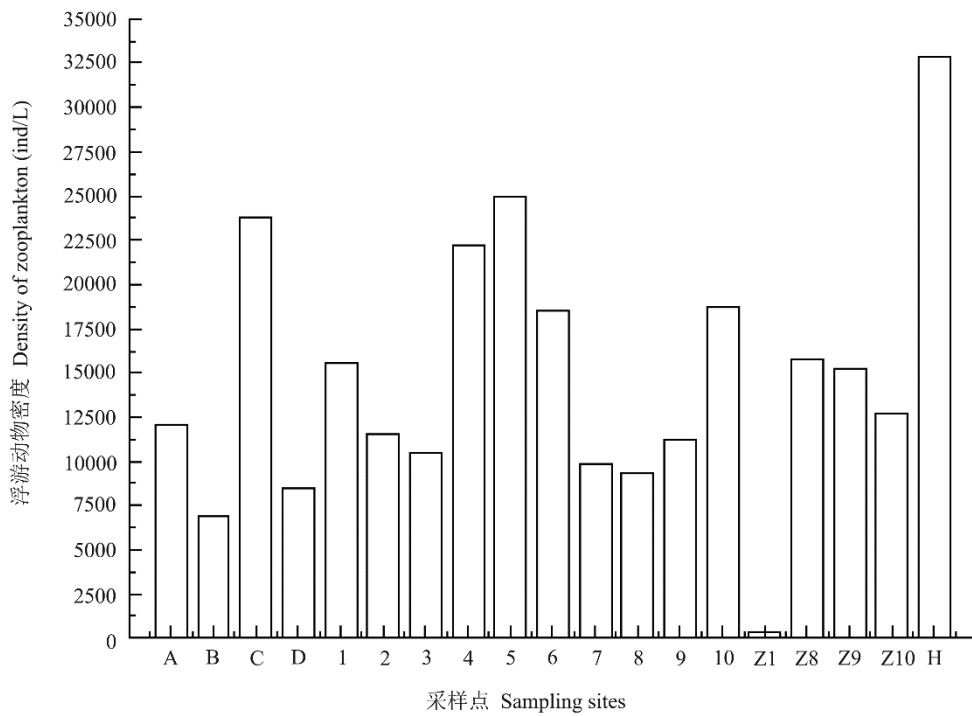
ANOVA $F = 7.809$ $P < 0.01$ H 0.968 mg/L 1.050 mg/L
 32 909 ind/L 2 57.84%
 one-way
 ANOVA 26.86% 12.38% 5
 ANOVA $F = 3.112$ $P < 0.05$

2.3.2

4.903 mg/L
 17.002 mg/L
 4 ind/L

Table 4 Seasonal variation of the zooplankton density in Lianhuadang River System

Seasons	Protozoa	Rotifer	Cladocera	Copepoda	Other larvae
Spring	543	452	19	35	43
Summer	10 715	1 583	19	26	0
Autumn	26 676	3 242	1 708	2 044	0
Winter	11 385	154	2	10	0
Average	12 330	1 357	437	528	11



2

Fig. 2 Spatial variation of the zooplankton density in Lianhuadang River System

2.4

ANOVA $F = 3.094$ $P < 0.05$ 9 Shannon-Wiener H'

12.176 mg/L 3 2.26 3.22

9 1.37 2.59 1.84

H' 0.95 ~

ANOVA 3.19 4 10

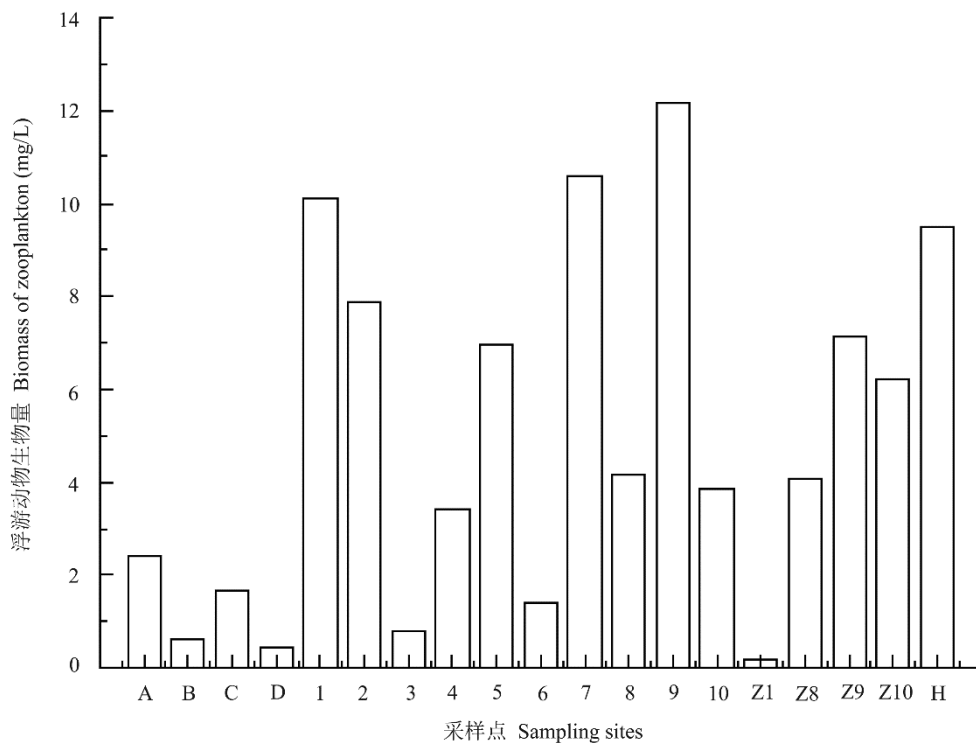
8

α - β -

5 mg/L

Table 5 Seasonal variation of the zooplankton biomass in Lianhuadang River System

Seasons	Protozoa	Rotifer	Cladocera	Copepoda	Other larvae
Spring	0.027	0.089	0.376	0.473	0.004
Summer	0.506	0.188	0.229	0.127	0.000
Autumn	1.351	0.289	4.646	10.716	0.000
Winter	0.544	0.001	0.017	0.028	0.000
Average	0.607	0.142	1.317	2.836	0.001



3

Fig. 3 Spatial variation of the zooplankton biomass in Lianhuadang River System

3

Shannon- Pearson

Wiener H'

2.5

Pearson

$P < 0.05$ 3

0.465 0.445 0.451

$P >$

0.05 H'

$P > 0.05$

$P > 0.05$ 6 2015 1994 2005

2016 2006

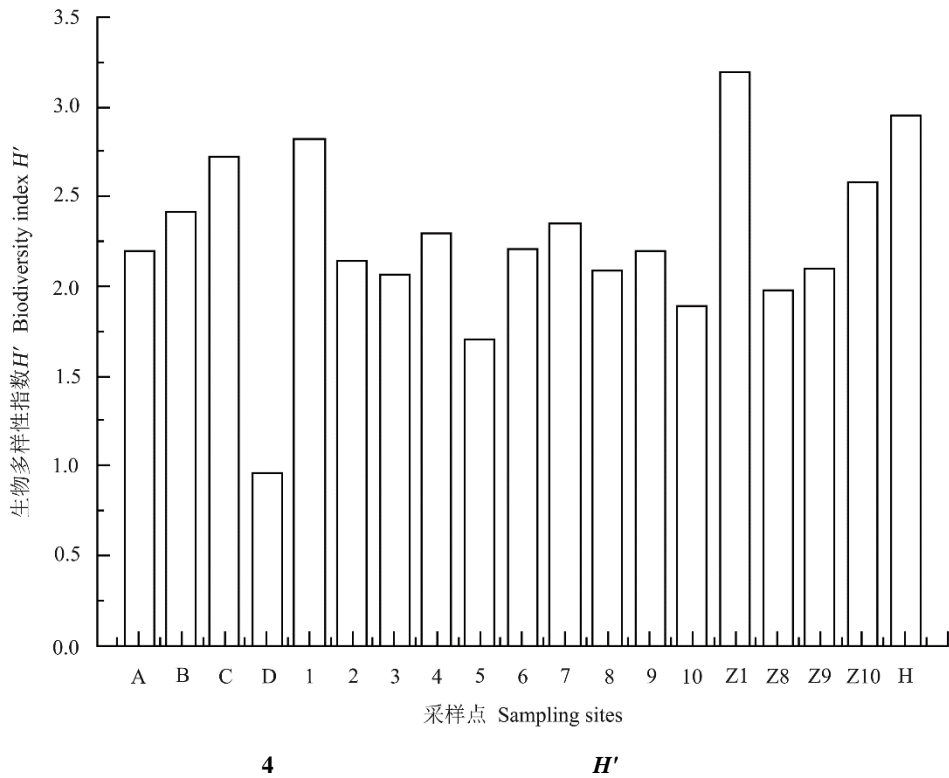


Fig. 4 Spatial variation of biodiversity index H' in Lianhuadang River System

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Appendix The species list of zooplankton in Lianhuadang River System

Number	Species	Number	Species
1	<i>Trichamoeba</i> sp.	42	<i>Spathidium</i> sp.
2	<i>Amoeba</i> sp.	43	<i>Didinium</i> sp.
3	<i>A. proteus</i>	44	<i>Askeusia</i> sp.
4	<i>Thecamoeba terricola</i>	45	<i>Hemiophrys</i> sp.
5	<i>Discamoeba</i> sp.	46	<i>Colpoda</i> sp.
6	<i>Metachaos diminutivum</i>	47	<i>Drepanonomas</i> sp.
7	<i>Plagiocampa</i> sp.	48	<i>Microthorax</i> sp.
8	<i>Coleps</i> sp.	49	<i>Chilodonella</i> sp.
9	<i>Gmnostome</i> sp.	50	<i>Sphaerophrya</i> sp.
10	<i>Heterophrys</i> sp.	51	<i>Colpidium</i> sp.
11	<i>Didinium balbiamii</i>	52	<i>Espejoia mucicola</i>
12	<i>Arcella arenaria</i>	53	<i>Glaucoma</i> sp.
13	<i>Arcella</i> sp.	54	<i>G. frontata</i>
14	<i>Centropyxis</i> sp.	55	<i>Dichilum</i> sp.
15	<i>C. aerophila</i>	56	<i>Paramecium</i> sp.
16	<i>Cyclopyxis</i> sp.	57	<i>Cyclidium</i> sp.
17	<i>Cucurbitella</i> sp.	58	<i>Vorticella</i> spp.
18	<i>Diffugia urceolata</i>	59	<i>Epistylis</i> spp.
19	<i>D. lebes</i>	60	<i>Stentor</i> sp.
20	<i>D. corona</i>	61	<i>Hlateria</i> sp.
21	<i>D. urceolata</i>	62	<i>Strombidium</i> sp.
22	<i>D. globulosa</i>	63	<i>Strobilidium</i> sp.
23	<i>D. avellana</i>	64	<i>Tintinnidium</i> sp.
24	<i>D. oblongia curvicaulis</i>	65	<i>T. fluviatile</i>
25	<i>Diffugia</i> sp.	66	<i>Tintinnopsis</i> sp.
26	<i>Heleopera</i> sp.	67	<i>T. wangi</i>
27	<i>Quadrulella</i> sp.	68	<i>T. sinensis</i>
28	<i>Lesquereusia</i> sp.	69	<i>Euplotes</i> spp.
29	<i>L. spiralis</i>	70	<i>Euplotes muscicola</i>
30	<i>Phryganella</i> sp.	71	<i>Ciliata</i>
31	<i>Nebela</i> sp.	72	<i>Cypris</i> sp.
32	<i>Cyphoderia</i> sp.	73	<i>Rotaria tardigrada</i>
33	<i>Euglypha</i> sp.	74	<i>Colurella obtusa</i>
34	<i>Actinophrys</i> sp.	75	<i>Lepadella</i> sp.
35	<i>Actinosphaerium</i> sp.	76	<i>Macrotrachela</i> sp.
36	<i>Raphidiophrys</i> sp.	77	<i>Brachionus</i> sp.
37	<i>Acanthocystis</i> sp.	78	<i>B. Calyciflorus</i>
38	<i>Holophrya</i> sp.	79	<i>B. falcatus</i>
39	<i>Plagiocampa</i> sp.	80	<i>B. angularis</i>
40	<i>Urotricha</i> sp.	81	<i>B. caudatus</i>
41	<i>Oxytricha</i> sp.	82	<i>B. bennini</i>

Number	Species	Number	Species
83	<i>B. varibilis</i>	110	<i>Notholca</i> sp.
84	<i>B. leydigi</i>	111	<i>Eosphora</i> sp.
85	<i>B. diversicornis</i>	112	<i>Disparalona</i> sp.
86	<i>Euchlanis</i> sp.	113	<i>Moina micrura</i>
87	<i>Keratella</i> sp.	114	<i>Limnosida</i> sp.
88	<i>K. valga</i>	115	<i>Bosmina</i> sp.
89	<i>K. cochlearis</i>	116	<i>B. longirostris</i>
90	<i>K. quadrata</i>	117	<i>B. coregoni</i>
91	<i>K. ticinensis</i>	118	<i>B. fatalis</i>
92	<i>Colurella</i> sp.	119	<i>Daphnia</i> sp.
93	<i>Ascomorpha</i> sp.	120	<i>Daphnia cucullata</i>
94	<i>Monostyla</i> sp.	121	<i>Diaphanosoma leuchtenbergianum</i>
95	<i>M. bulla</i>	122	<i>Bosminopsis</i> sp.
96	<i>M. lunaris</i>	123	<i>Daphnia hyalina</i>
97	<i>Proale</i> sp.	124	<i>Chydorus</i> sp.
98	<i>P. sordida</i>	125	<i>Mesocyclops leuckarti</i>
99	<i>Lecane</i> sp.	126	<i>Mesocyclops</i> sp.
100	<i>Testudinella mucronata</i>	127	<i>Thermocyclops taihokuensis</i>
101	<i>Diurella</i> sp.	128	<i>T. kawamurai</i>
102	<i>Polyarthra</i> spp.	129	<i>Cyclops</i> sp.
103	<i>P. trigla</i>	130	<i>Schmackeria</i> sp.
104	<i>Filinia longiseta</i>	131	<i>Sinocalanus</i> sp.
105	<i>F. major</i>	132	<i>Sinocalanus dorrii</i>
106	<i>F. brachiata</i>	133	<i>Neutrodiaptomus</i> sp.
107	<i>Asplanchna</i> sp.	134	Rotifera eggs
108	<i>Asplanchna priodonta</i>	135	Nauplius
109	<i>Cephalodella</i> sp.	136	Copepodite