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A Preliminary Study on the Distribution of Zoobenthos and Zooplankton in the West Lake, Hangzhou

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Abstract

Zoobenthos and zooplankton were collected at 17 stations and eight stations, respectively, in the West Lake in October 1994. Zoobenthos density in Outer Lake was 781 m^{-2}, of which chironomid larvae and oligochaetes formed 77% and 21%, respectively. Abundance of chironomid larvae especially *Procladius* and *Tanypus* increased as compared with the abundance during 1982-1983. Zooplankton density was between 149-710 l^{-1}. Dominant species were rotifers, *Asplanchna* spp. (*A. priodonta* and *A. brightwelli*) and *Schizocerca diversicornis*.

Introduction

The West Lake, Hangzhou, is a shallow lake and has been suffering from eutrophication long ago. Reduction of the inflowing amount of wastewater from households during 1970s and the introduction of river water from the Qiantang River changed the water quality of the lake (Li, 1994). However the eutrophication of the lake is still progressing and hence a cooperative research project was initiated in 1993 between China and Japan for the restoration of this scenic lake.

For shallow eutrophic lakes, interaction at sediment-water interface is an important factor affecting the nutrient cycling in lake ecosystems (Barica, 1980; Yasuno et al, 1984). In shallow lakes less than 4 m in mean depth, the productions of zoobenthos are much higher than lakes of deeper mean depths (Iwakuma, 1986).

Zoobenthos and zoobenthos fauna have been studied in the West Lake before (Wei, 1988; Yu and Yu, 1991) and after (Wei et al., 1989) the drawing of water from the Qiantang River in to the lake. The present study was performed during the joint survey in 1994. Its purpose was to clarify the distribution of zoobenthos and zooplankton and to compares it with the previous results.

Study Sites and Methods

The west Lake (surface area 5.67 km^2, mean depth 1.56 m) is divided into five basins, i.e., Beili (0.34 km^2), Outer (4.41 km^2), Yuehu (0.07 km^2), Xili (0.76 km^2) and Xiaonan (0.09 km^2) Lakes (Li, 1994). Samplings were performed on 25 and 26 October 1994. Zoobenthos were collected at 16 stations in Outer Lake (Stas. A1, A2, B1, B2, B3, B4, B5, B6, C2, C3, C5, C6, D4, D5, D6 and E6) and a station in Yueli Lake (Sta. A7) and zooplankton at a station in Beili (Sta. 3), six station in Outer Lake (Stas. A1, B5, C2, C5, D5 and E6) and a station in Yueli Lake (Sta. A7) (Fig. 1). Stas. A1, B5, A7 and C5 are respectively identical to the Stas. 1, 3, 4 and 6, where weekly-monthly survey have been conducted by the Administrative Office of West Lake in Hangzhou.

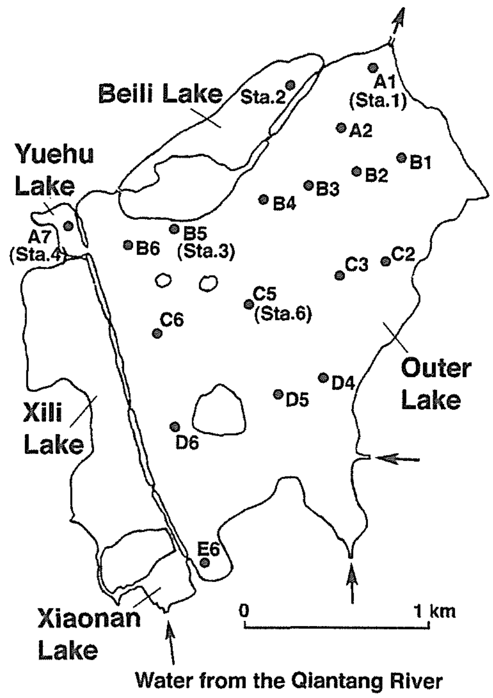

Fig. 1. Map of the West Lake showing sampling stations.

Three sediment samples were collected with an Ekman-Birge dredge (15 cm x 15 cm) at each sampling site. Each sediment sample were washed in situ with a nylon bolting net (0.3 mm opening), stored in ice box and brought to the laboratory of Faculty of Biology, Hangzhou University. Zoobenthos were picked up in the laboratory and preserved in 70% ethanol solution.

Zooplankton samples were collected with a vertical howl of a plankton net (23.5 cm in diameter and 94 μm opening) at each sampling site excepting at Sta. 2 where the net was towed 2 m horizontally from the bank. Zooplankton samples were preserved in 1% formalin solution. A subsample was taken from each sample and the animals were identified and counted under a microscope in the laboratory of the Department of Biological Science and Biotechnology, Hangzhou University.

Results and Discussion

We obtained nine taxa of zoobenthos consisting of five Chironomidae (*Tokunagayusurika, Chironomus, Tanypus, Procladius,* other Chironomidae), one Ceratopogonidae, two Oligochaeta (*Branchiura sowerbyi,* other Oligochaeta) and one Hirudinea. Yu and Yu (1991) reported five chironomid species from Outer Lake based on the seasonal bottom sampling during 1983-1984, i.e. *Tanypus punctipennis, Procladius choreus, Tokunagayusurika akamusi, Chironomus plumosus* and *Cryptochironomus conjugens. Tokunagayusurika, Chironomus, Tanypus* and *Procladius* larvae collected in the present study might correspond respectively with the species reported by Yu and Yu (1991).

Fig. 2 shows the density of zoobenthos at the 17 stations in the West Lake. The density was highest in Yuehu Lake (1178 m^{-2}) of which Procladius larvae amounted 778 m^{-2}.

The density of zoobenthos averaged for 16 stations in Outer Lake was 781 m^{-2}, of which chironomid larvae constituted 602 m^{-2} (77%) and oligochaetes 168 m^{-2} (21%). Among the chironomids, larvae of *Procladius* and *Tanypus* (tribe Tanypodinae) were predominant, constituting

44% (343 m-2) and 27% (214 m-2), respectively, of the total average density of zoobenthos. *Procladius* larvae were distributed all over in Outer Lake at densities of 207-667 m-2. On the other hand, *Tanypus* larvae were distributed densely near the outlet or along the north shore of the lake (Stas. A1, A2, B1-B5) at densities of 267-444 m-2 but at lower densities at other sites in Outer Lake (44-178 m-2). The sediment of the West Lake is rich in the content of organic matter and organic carbon (Li and Hsia, 1989; Wu *et al.*, 1990). According to Li and Hsia (1989), organic matter contents in sediment is 10%-20% at Stas. A1, A2, B1-B5 whereas it is more than 20% for most of other stations. No correlation might not exist between the density of Tanypodinae larvae and organic matter contents in sediment.

The density of two large chironomids, *Tokunagayusurika* and *Chironomus,* were 0-89 m-2 and 0-44 m-2, respectively. Fourth-instar larvae of *Tokunagayusurika akamusi* and *Chironomus plumosus* burrow to the depths of 40-80 cm in the sediment (Iwakuma, 1987). *T. akamusi* emerges once in autumn during October-early December (Wang *et al.*, 1977; Iwakuma, 1992). *C. plumosus* emerges three times at the latitudes of 30°-35°N, being the third emergence period during September-November (Wang *et al.*, 1977; Iwakuma, 1987). As for the latter species, the emergence was over at the time of the present sampling. Even we consider the low sampling efficiency of the present dredge for these species, their densities were much lower than Japanese shallow eutrophic lakes where these two species are predominant (Iwakuma *et al.*, 1988).

The larvae of the genus *Procladius* are well-known carnivores feeding on early instars of chironomid larvae and oligochaetes (Baker and McLachlan, 1979; Vodopich and Cowell, 1984). Among the predominant two chironomids, density of *Tanypus* larvae tended to be negatively correlated with that of *Procladius* larvae although the correlation was not statistically significant (Fig. 3). Further studies are necessary to clarify the role of *Procladius* larvae in the food web of the West

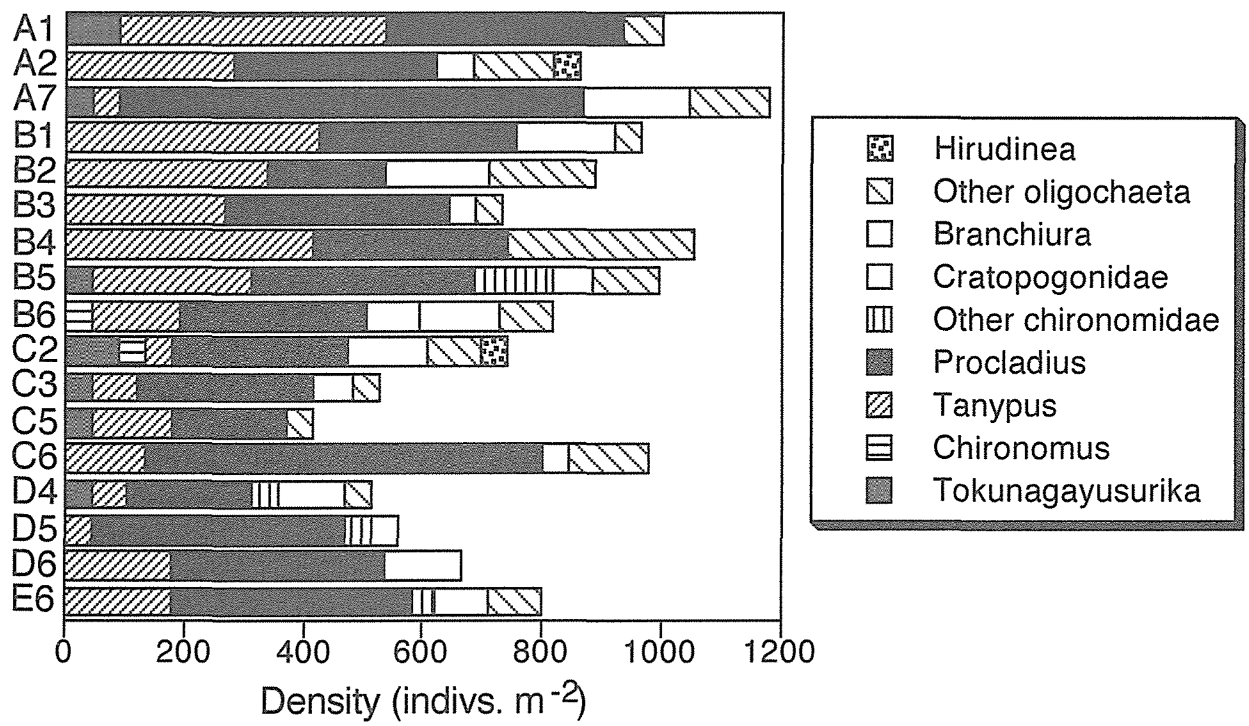

Fig. 2. Composition of zoobenthos in the West Lake on 25 and 26 October 1994

Lake ecosystem.

The density of oligochaetes differed widely among stations (44-356 m^{-2}) being low (<89 m^{-2}) in the pelagic regions of Outer Lake (Stas. B3, C5, D5). *Branchiura sowerbyi* constituted half the density of oligochaetes.

Yu and Yu (1991) studied the zoobenthos at 25 sites in the West Lake seasonally during 1982-1983. Based on their study, the annual mean density in Outer Lake was 322 m^{-2} of which oligochaetes were predominant constituting 86% (276 m^{-2}). Chironomids constituted only 14% (45 m^{-2}). Comparing with the results for 1982-1983, we recognized an increase of chironomid larvae especially Tanypodinae larvae.

Table 1 shows the density of zooplankton at eight stations. We collected four taxa of Protozoa, 11 species of Rotifera, six species of Cladocera and unidentified Copepoda. Zooplankton density was highest at Sta. E6 near the inlet (710 l^{-1}). At other stations, densities were between 149-329 l^{-1}. Dominant species were rotifers, *Asplanchna* spp. (*A. priodonta* and *A. brightwelli*) and *Schizocerca diversicornis*. The density and relative abundance were 15.6-300.5 l^{-1} and 10%-37% for *Asplanchna* and 67.0-139.3 l^{-1} and 21%-59% for *Schizocerca*. The densities of cladocerans were low.

The high rotiferan and low cladoceran abundances have also been observed in the previous studies (Wei, 1988; Wei *et al.*, 1989). The annual mean density at the center of Outer Lake in 1984 was 4369 l^{-1}, consisting of protozoans (2435 l^{-1}), rotifers (1930 l^{-1}), cladocerans (1.6 l^{-1}) and copepods (1.9 l^{-1}) (Wei, 1988). That for 1987-1988 was 1214 l^{-1} excluding protozoans (Wei *et al.*, 1989). The densities for autumn were 1534 l^{-1} for total, 1532 l^{-1} for rotifers, 0.2 l^{-1} for cladocerans and 1.3 l^{-1} for copepods (Wei *et al.*, 1989). The zooplankton density in the present observation seemed to be lower than the previous studies. In the present study, however, we used a plankton net with 94 μm opening thorough which rotifers might have passed thorough. Furthermore, reservation

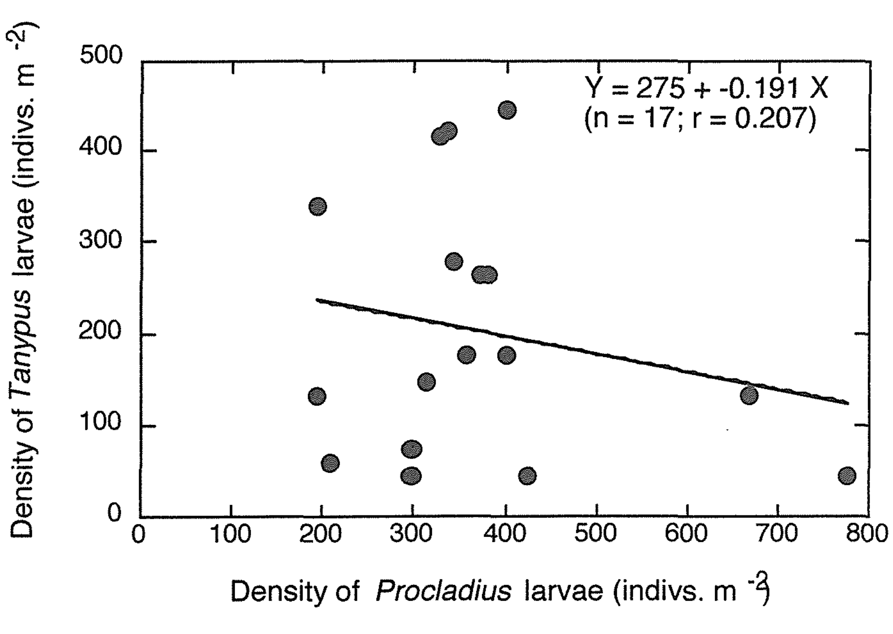

Fig. 3. A relationship between larval densities of *Procladius* and *Tanypus*.

in formalin solution made it difficult to enumerate protozoans. Therefore we cannot compare the zooplankton densities between present and previous studies.

The dominant rotifers were *Brachionus budapestiensis, B. angularis, Polyarthra trigla* and *Schizocerca diversicornus* in 1984 and *Polyarthra trigla* during 1987-1988 (Wei, 1988; Wei *et al.*, 1989). The most striking difference was that *Asplanchna* spp. become dominant among zooplankton community in the present study. Therefore, both zooplankton and zoobenthos communities of the West Lake were dominated by carnivores.

Table 1. Density (indivs. l^{-1}) of zooplankton in the West Lake

Species	Station							
	A1	2	B5	A7	C2	C5	D5	E6
Protozoa								
Arcella sp.	-	-	-	-	-	-	1.0	3.5
Ciliaeta	-	-	-	1.4	-	1.6	-	3.5
Carchesium sp.	-	7.2	-	20.5	-	-	-	37.6
Epistylis sp.	-	-	-	-	-	4.0	-	15.6
Rotifera								
Asplanchna spp. (*priodonta & brightwelli*)	57.1	15.6	59.2	57.2	105.8	91.3	123.1	300.5
Brachionus calyciflorus	18.6	18.9	11.3	14.6	40.1	34.3	32.3	102.1
B. angularis	-	-	-	-	0.9	1.1	1.0	-
B. forticula	0.9	-	-	-	1.5	-	2.0	-
B. quadridentatus	-	3.0	-	3.0	-	-	-	-
Filinia longiseta	8.4	-	1.4	1.0	4.8	1.6	2.0	1.4
Filinia sp.(*terminalis*?)	-	-	0.4	-	0.9	1.1	-	0.7
Polyarthra vulgaris	3.9	-	6.4	5.4	6.0	10.4	-	7.8
Schizocerca diversicornis	37.7	89.0	75.3	69.4	67.0	88.6	139.3	132.5
Synchaeta stylata	-	-	-	-	0.9	-	-	1.4
Cladocera								
Alona guttata	-	0.6	-	-	-	-	1.0	-
Bosminopsis deitersi	-	-	-	-	-	-	-	1.4
Diaphanosoma brachyurum	2.5	1.1	7.3	6.4	3.9	-	2.3	12.0
Moina micrura	-	0.3	-	1.0	-	2.4	-	-
Pleuroxus sp.	-	1.1	-	-	-	-	-	-
Scapholeberis mucronata	-	0.6	-	-	-	-	-	-
Copepoda								
Nauplius	37.7	8.1	27.8	15.6	46.3	25.8	16.1	51.0
Calanoida	1.4	-	-	2.0	1.5	-	1.3	21.3
Cyclopoida	10.4	3.9	9.3	3.0	19.4	4.5	7.2	17.0
Total	179.0	149.0	198.0	201.0	299.0	267.0	329.0	710.0

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