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Comparative Studies on Community Structure, Biodiversity of Plankton and Zoobenthos in Four Lakes of Different Trophic States in China

J. XIONG*[1], X. MEI[1] and J. LIU[2]

[1]*College of Life Science and Technology*
Huazhong University of Science and Technology
Wuhan 430074
China

[2]*Institute of Reservoir Fisheries*
Ministry of Water Resources and Chinese Academy of Sciences
Wuhan 430079
China

Abstract

Studies were conducted in four shallow Chinese lakes of different trophic states in Liangzihu water system. Results indicated that species number was negatively correlated with degree of water eutrophication, and lakes of similar trophic condition had higher similarity of species. The most significant differences of species composition were observed in rotifers and zoobenthos. The density and biomass of phytoplankton, protozoans, rotifers, oligochaetes and chironomids tend to increase with increasing nutrients. Percentage contribution of each algal class to total density and biomass of phytoplankton in lakes of different trophic states was calculated. A significant difference in dominant species was found in different waters, especially the eutrophic or hypereutrophic lakes were dominated by a few species of oligochaetes. The abundance of *Tanypus chinensis* Wang showed a highly significant correlation with the degree of eutrophication. Highly eutrophic lakes had significantly lower diversity in rotiters and zoobenthos.

Introduction

Plankton and zoobenthos play an important role in lake ecosystems as a main determinant of hydrobiological production and community structure (Sprules and Munawar 1991, Lindegaard 1994). In recent decades, numerous investigations of plankton and zoobenthos in freshwater lakes were conducted.

**Present address: Department of Biology, Ezhou University, Exhou, Hubei 436000, China*

Such studies provided basic information on the community structure and biodiversity. They showed that some biotic formation were related to lake trophic states (e.g., Beaver and Crisman 1989, Xie et al. 1996, Gong and Xie 2001). Unfortunately, biocommunity and lake-eutrophication were described separately. Many researches were undertaken on single aquatic fauna and flora (e.g., Beaver and Crisman 1982, Fuller et al. 1977, Rojo and Rodriguez 1994). Less work has dealt with the relationship between lake trophy and biota in wide ranges.

The interaction between zooplankton and phytoplankton forms an important basis of food chain in natural lakes (Jacgueline and Kenneth 1994) and the former also serves as an essential food source for macroinvertebrate (Alois Herzig 1987, Zaret 1980). These relationships among hydrobios and the impacts of lake trophic states on them should be considered in analyzing community structure and biodiversity. Therefore, the present study focused on the biocommunity, including phytoplankton, zooplankton and zoobenthos in four shallow Chinese lakes located in Liangzihu water system with the trophic gradients ranging from mesotrophic to hypereutrophic. The aim of this work was to determine if the community structure and biodiversity were related to trophic states in those lakes.

Studies were carried out in four lakes located in the south bank of the middle and lower reaches of the Yangtze River ($30^0 23^/$-$30^0 28^/$N, $114^0 38^/$-$114^0 53^/$E). All the four lakes are shallow (mean depth 1.80 m-1.85 m) with water in different trophic states. They are Lake Yanglanhu (187 hm^2), Lake Yanjiahu (200hm^2), Lake Wusihu (667 hm^2) and Lake Honglianhu (733hm^2). The later three lakes lead to a stream but are isolated from the Yangtze River by a floodgate. Lakes Honglianhu and Wusihu only receive surface runoff from cropland and submerged macrophytes are present in these two lakes. On the other hand, in recent decades, the discharge of untreated industrial and domestic wastewater has led to the increase in eutrophication and the disappearance of submerged macrophytes in Lake Yanglanhu, also a few industrial wastewater has resulted in increasing nutrient loads and destructing macrophytes in Lake Yanjiahu. Moreover, the overstocking of herbivourus carps is also a main reason for the change of the trophic status in these two lakes. All the four lakes are stocked mainly with fingerlings of silver and bighead carps every year.

Materials and Methods

Sampling time and site

Samplings of plankton, zoobenthos and lake water were carried out at four lakes at the same day in the last ten-day periods of Jul., Oct. 2001and Jan., Apr. 2002 along with the first ten-day period of Sep., Dec. 2001 and Mar., Jun. 2002. Four sampling sites were set up in each lake. A total of eight sampling times were taken at each station. Hydrobios samples were taken concurrently with water samples at each station. Water temperature was between 8-35^{0}C during July 2001 to June 2002.

Environmental parameters

At each sampling site, water temperature, Secchi depth, pH and conductivity were estimated during field survey. Water chlorophyll-a content was determined by standard acetonum extraction method. Chemical properties were estimated based on methods in the Examination of Water and Wastewater (American Public Health Association 1985). Quantitative assessment of trophic states of lakes was determined by comprehensive trophic level index (Jin et al. 1990).

Phytoplankton

Sampling and measurement of phytoplankton were done by routine methods (Zhang and Hang 1991). Each water sample was a mixture of several subsamples collected from the lake surface to the bottom at 0.5 m intervals with a 5L Patelas' plexiglass sampler, from which a liter of water was taken for quantitative purpose and preserved immediately in Lugol's solution. After depositing in the laboratory, quantitative samples were concentrated to 50 ml and counting of phytoplankton was made under an inverted light microscope. Phytoplankton density was then computed with the mean of three replicates. The wet weight of phytoplankton was estimated based on the volume and number of cells (Liu 1990). The qualitative samples were taken by using a 60 μm mesh plankton net. The phytoplankton was identified to species level (Hu et al 1980, Zhang and Huang 1991).

Zooplankton

Collection, sedimenting, concentration and counting of protozoans and rotifers samples were identical to that of phytoplankton, except that the fixed solution was 5% formalin. Protozoans and rotifers were collected alive for the identification of species. Three replicates of 0.1 ml from 30 ml concentrated samples were counted. Biomass of protozoans and rotifers were calculated by applying mean abundance and cell biovolume (Zhang and Huang 1991). Protozoans and rotifers were identified according to the keys of Levine (1980) and Koste (1978). Unidentified species of protozoans were prepared for microscopic examination using silver-staining methods. Qualitative protozoan samples were taken simultaneously using PFU method (Shen et al. 1985). For cladocerans and copepods, 10 L of lake water was strained through a 60 μm mesh plankton net and counted totally. The wet weight of the animals was estimated by using regression equation based on geometric figures of their shapes (Zhang and Huang 1991). Cladocerans and copepods were identified according to Jiang and Du (1977), and Shen (1979).

Zoobenthos

Duplicate quantitative samples were taken at each station with a 0.025 m^2 modified Peterson grab, also qualitative samples were obtained from random collection. All samples were sieved through a 450 µm mesh net. Animals were separated according to taxonomic groups and fixed in 70% alcohol. The taxonomic classification was based on Morse et al (1994), Liang and Wang (1999), Liu (1979). Individuals of each taxon were counted and weighed.

Biodiversity, community similarity and trophic state index

The Shannon-Wiener index (H') and Margalef index (d) were applied to estimate biodiversity:

$$H' = -\sum_{i=1}^{3} (p_i)(\log_2 p_i)$$

$$d = S-1/\ln N$$

where s is the number of species, Pi is the proportion of total sample belonging to the i-th species, N is the total density and S is the total number of all species.

The Jaccard similarity coefficient (S_j) was used to compare community structure between two lakes:

$$S_j = c/(a+b+c)$$

where a is the number of species in lake A, b is the number of species in lake B and c is the number of species common to both lakes.

The comprehensive trophic state index (TSIc) was calculated according to the formula:

$$TSIc = \sum W_j TSI_j \qquad W_j = r_{ij}^2 / \sum r_{ij}^2$$

where r_{ij} is the correlation coefficient between chlorophyll-a and some physicochemical variables (total phosphate, total nitrogen, Secchi disk transparency), W_j is weight of each evaluating parameter, TSI_j is trophic state index converted from the value of some physicochemical variables. TSI_j is calculated according to method of Jin, X. et al.(1990).

Results and Discussion

Quantitative assessment for the trophic state of lake

Some major physicochemical variables of the four lakes are listed in table 1. Since these variables were very commonly included in water monitoring and treated as key factors for environmental assessment, Carlson (1997) presented a numerical trophic state index (TSI) for the trophic classification of lakes. He hypothesized that all the dissolved substances in lake water could be comprised entirely of phytoplankton, and as such Secchi disk transparency be regarded as a reference parameter. Aizak (1981) introduced chlorophyll-a as a reference parameter and applied his modified Carlson's trophic state index (TSIm) to Japanese lakes of different depths. But weight allocations for evaluating parameters were not determined in these two methods. Consequently, the comprehensive trophic state index (TSIc) based on TSIm was more appropriate for evaluating the trophic state of Chinese shallow lakes (Jin et al. 1990). To ascertain the corresponding relationship between TSIc and trophic categories, we applied the trophic classification for lakes proposed by Cai (1995). Table 2 shows the trophic level of study lakes.

Species composition

Species number of the plankton and zoobenthos in the four lakes are presented in figures 1 and 2. There were significant differences in species composition among the four lakes of different trophic states. The results indicated that species number was negatively correlated with state of eutrophication ($r = -0.993, P<0.01$). The greatest species number (226) was observed in the mesotrophic Lake Honglianhu, which was considerably greater than that in the hypereutrophic Lake Yanglanhu(174) and the eutrophic Lake Yanjiahu (184). The small difference of species number between Lake Honglianhu and Lake Wusihu (214) might be due to their approximate trophic level. The significant difference in species number among lakes was substantially originated from rotifers and zoobenthos. Of course, this difference should be attributed to the disappearance of the organisms that are sensitive to water pollution from both

Table 1. Physicochemical conditions of four lakes

Variables	Lake Yanglanhu	Lake Yanjiahu	Lake Wusihu	Lake Honglianhu
Chlorophyll-a (μg•L)	46.8	17.7	3.5	5.2
PH	8.47	8.31	8.33	8.31
Secchi depth(m)	0.405	0.590	0.916	1.164
Water temperature(¡æ)	20.6	20.5	20.8	20.6
Conductivity(us•cm)	465	470	298	304
Total nitrogen(mg•L)	3.7155	4.7212	2.1925	1.3553
Total phosphate(mg•L)	0.2879	0.1111	0.0593	0.0138
$NH4^+$-N (mg•L)	2.5661	3.1148	1.2845	0.8979
NO_3^--N (mg•L)	0.2950	0.4246	0.5276	0.1426
NO_2^--N (mg•L)	0.0114	0.0048	0.0074	0.0043
COD (mg•L)	11.783	8.288	9.087	7.137
SiO_2(mg•L)	8.507	4.159	2.808	2.163
Hardness(mg•L)	3.775	3.592	2.566	3.216
PO_4^--p(mg•L)	0.1344	0.0549	0.0364	0.0019

Table 2. Comprehensive trophic state indices for four shallow Chinese lakes

Lake	TSI(chla)	TSI(TP)	TSI(SD)	TSI(TN)	TSIc	Trophic level
Lake Yanglanhu	66.77	74.14	68.72	76.76	71.06	Hypereutrophic
Lake Yanjiahu	56.21	58.68	61.42	80.83	62.34	Eutrophic
Lake Wushihu	38.61	48.47	52.47	67.83	49.57	Meso-eutrophic
Lake Honglianhu	42.90	24.80	48.23	59.68	41.76	Mesotrophic

domestic and industrial sources. Rotifers were considered to be good indicators of trophic conditions (Fuller et al. 1987, Sladecek 1983). The data clearly states that the presence of oligosaprobiotic rotifers differed obviously in different trophic condition. Oligosaprobiotic rotifers in four lakes are listed in table 3. The number of oligosaprobitic species could be arranged in the following order: Lake Honglianhu (18) >Lake Wusihu(17)>Lake Yanjiahu (8) >Lake Yanglanhu (6). The species number of molluscans was also negatively correlated with lake trophy (r=-0.940 $P<0.01$). Contrarily, a positive relationship was found between the proportions of oligochaetes and trophic level(r=0.823 $P<0.01$). It seems that the qualitative composition of zoobenthos may be influenced greatly by an increase in trophy (Wang 1996, Gong and Xie 2001). As resulted from hypereutrophic environment, no molluscan was found in Lake Yanglanhu. The present results support the assertion of Wiederholm (1974) who claimed that lake entrophlication first influences the composition of zoobenthos and the proportions of its component. In our research, no significant difference on species number in protozoan and copepod was found among the four lakes ($P>0.05$), but the composition of ciliates in protozoan species gradually declined from hypereutrophic to mesotrophic lakes (87.2%, 79.5%, 76.2% and 63.2% respectively), which is similar to the conclusion of Finlay (1986) and Beaver (1990) that species richness of ciliates was coupled with trophic state.

The Jaccard coefficient (S_j) is applied to evaluate the similarity of community structure. Table 4 shows S_j between every two lakes. It indicates that the plankton and zoobenthos in the mesotrophic lake showed lowest similarity compared to that of the hypereutrophic lake, while lakes having similar trophic state render a higher similarity of species. Although phytoplankton had conspicuously high similarity between compared lakes, it exhibited different percentage contribution of each algal class to the total density and biomass (Table 5).

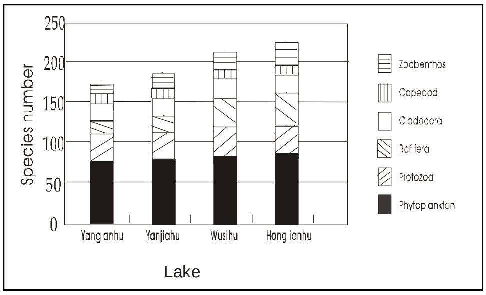

Fig. 1. Composition of taxonomic groups of hydrobios in lakes

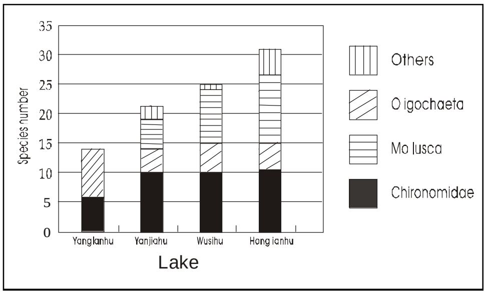

Fig. 2. Distribution of taxonomic groups in zoobenthos by lake

Density and biomass

Density and biomass of plankton and zoobenthos in four lakes are given in table 6. It shows that the density and biomass of phytoplankton, protozoans, rotifers, oligochaetes and chironomids increased significantly with increasing trophic state. The difference was especially apparent between eutrophic, hypereutrophic lakes and mesotrophic, meso-eutrophic lakes. The least number of species and the highest density, biomass all occurred in the hypereutrophic lake, while the mesotrophic lake appears to have an reverse status. It is interesting that the portion of Cyanophyta and Chlorophyta in density or biomass increased with the development of lake eutrophication. Conversely, Bacillariophyta and Pyrrophyta decreased with increasing degree of eutrophication (Table 5). In Lake Yanglanhu, the phytoplankton comprised mainly of Cyanophyta and Chlorophyta (81.20% of the total density). Their absolute density was also high (263.3 x 10^4 ind•L). Generally, the eutrophic lakes are year round dominated by blue-green algae, which occupy an advantageous position

Table 3. Oligosaprobiotic rotifers in four lakes

Species	Lake Yanglanhu	Lake Yanjiahu	Lake Wusihu	Lake Honglianhu
Anuraeopsis fissa	+	+	+	+
Colurella obtuse				+
Lepadella cuminta			+	+
Asplanchnopus multiceps	+			
Monommata ongiseta			+	
Notommata sp.	+	+	+	+
Cephalodella exigna			+	+
Gastropus yptopus				+
Ascomorpha saltans			+	+
Trichocerca rousseleti	+	+	+	+
T. stylata			+	+
T. dixon-nuttalli			+	
T. cyclindrica			+	+
T. capucina				+
T. elongata				+
T. pusilla	+	+	+	+
Ploesoma truncatum		+	+	
Polyarthra euryptera	+	+	+	+
Synchaeta pectinata			+	+
Collochilus unicornis		+	+	+
C. hippocrepis			+	+
Conochiloides assuarius		+	+	+

Table 4. The similarity of species composition between every two lakes

Compared lakes	Jaccard similarity coefficient (%)					
	Phytoplankton	Protozoa	Rotifera	Cladocera	Copepod	Zoobenthos
Lake Yanglanhu Vs Lake Honglianhu	28.9	22.2	20.6	20.0	27.8	16.6
Lake Wusihu Vs LakeHonglianhu	30.0	25.9	26.0	24.0	26.5	29.1
Lake Yanjiahu Vs Lake Yanglanhu	29.9	27.1	29.1	25.6	26.7	22.2
Lake Yanjiahu Vs Lake Wusihu	28.2	26.4	25.3	24.4	27.6	58.6

(such as pollution resistibility) in extreme environmental conditions (Rojo and Rodriguez 1994). However, *Bacillariophyta* were significant components in total algae density and biomass in Lake Honglianhu or Wusihu, accounting for about 60% of the total phytoplankton. Hence, it should attribute the presence of blue-green algae to the highly eutrophic waters and consider Diatoms to be mesotrophic. In these two lakes, there were obvious dominance of molluscan taxa in zoobenthos community, either abundance or biomass. These characteristics are typically possessed by cleaner water bodies (Wang 1996, Liang and Wang 1999). It is also shown that water pollution appears to be the most serious threat to the survival of molluscan (Savage 2000, Thorne and William 1997). An extreme abundance of protozoan and chironomids was found at Lake Yanglanhu and Yanjiahu. Numerically, protozoans contributed substantially to the zooplankton of these two lakes, and the ciliates formed an amount up to 90% of annual protozoan biomass. In general, these taxa were frequently numerically dominant in eutrophic lake (Bay and Crisman 1983, Beaver and Crisman 1982). No correlation existed between density or biomass of planktonic crustaceans and lake trophy, which is similar to that in the Midwestern waterbodies (Canfield and Jones 1996).

Dominant species

In general, each lake was characterized by some dominant species of phytoplankton, but the annual mean abundance and percentage of these species were different from lake to lake (Table 7). The relative differences were more

Table 5. Percentage contribution of each algal class to total density (D) and biomass (B) in the four lakes

Lake		*Cyanophya*	*Chorophyta*	*Bacillariophyta*	*Euglenophyta*	*Pyrrophyta*	*Chrysophyta*
Yanglanhu	D(%)	24.35	56.82	17.98	0.65	0.20	-
	B(%)	28.92	50.64	16.94	2.71	1.79	-
Yanjiahu	D(%)	14.46	51.01	33.99	0.32	0.22	-
	B(%)	24.25	37.92	35.45	2.17	0.78	-
Wusihu	D(%)	11.35	20.94	60.60	5.47	1.43	0.21
	B(%)	10.81	7.21	64.51	13.34	2.51	1.62
Honglianhu	D(%)	1.99	17.78	61.81	2.55	5.35	10.52
	B(%)	2.14	6.45	55.11	3.51	11.52	21.27

Table 6 Density (ind.•L, nd.•©O), Biomass (mg•L,mg•©O) of plankton and zoobenthos in four lakes[a]

Taxon	LakeYanglanhu		Lake Yanjiahu		Lake Wusihu		LakeHonglianhu	
	Density	Biomass	Density	Biomass	Density	Biomass	Density	Biomass
Phytoplankton($x10^4$)	324.31	4.309	145.78	1.977	26.49	0.668	16.01	0.661
Protozoa	33656	3.185	33038	1.548	9750	0.473	5250	0.204
Rotifera	5250	0.419	3628	0.306	1538	0.640	1181	0.232
Cladocera	1.9	0.045	16.7	1.272	5.0	0.047	9.1	0.081
Copepod	28.1	0.152	100.7	0.411	18.4	0.059	34.1	0.109
Mollusca	-	-	33	30.24	225	84.27	203	38.28
Oligochaeta	545	2.19	68	0.84	43	0.31	45	1.30
Chironomidae	1270	3.7	2298	12.78	190	0.41	145	0.24
Other zoobenthos	-	-	8	0.09	3	0.03	15	0.05
Total		14.00		49.46		86.91		41.16

[a] Biomass of molluscan is wet weight shell free.

prominent in the species except *Strombidium viride, Strombidium gyrans, Polyartra trigla, Branchiura sowerbyi* which were found to dominate in all lakes. It seems that, to some extent, trophic state affects the hydrobiotic composition probably through the stress of physicochemical habitat conditions and food availability (Song Biyu 2000, Zhijun Gong et al. 2000). In Lake Yanglanhu, zoobenthos was confined to species that are tolerant of the existing

Table 7. The dominant plankton and zoobenthos species in four lakes[a]

Species	Lake Yanglanhu	Lake Yanjiahu	Lake Wushihu	Lake Honglianhu
Phytoplankton				
Merismopedia glauca	45.8	21.8	15.2	1.7
Scenedesmus acuminatus	16.1	15.2	4.0	4.6
Synedra acue	9.5	12.1	7.1	20.8
Ankistrodesmus convolutus	9.9	24.2	57.0	7.8
Melosira granulate var	<1	<1	4.4	13.9
Dinobryon bavarium	-	-	<1	11.1
Navicula sp	2.7	8.7	3.3	17.4
Ciliata				
Strombidium viride	13.0	36.5	31.9	33.2
Strombidium gyrans	13.3	9.0	29.4	24.6
Didinium nasutum	27.7	4.7	2.9	1.1
Bodo compressus	-	14.8	-	-
Thylakidium truncatum	16.8	<1	-	-
Mesodinium pulex	1.8	2.4	8.5	3.9
Tinfinnidium fluviatile	<1	<1	4.1	25.0
Rotifera				
Anuraeopsis fissa	12.9	11.4	3.4	2.0
Keratella cochlearis	<1	<1	<1	11.6
Asplanchna priodonta	<1	1.4	15.7	2.6
Diurella rousseleti	5.1	7.9	3.2	2.0
Trichocerca pusilla	23.2	18.8	1.7	3.7
Polyarthra euryptera	<1	3.0	5.1	7.6
Polyarthra trigla	12.9	29.4	34.9	21.1
Filinia maior	10.1	14.0	8.8	<1
Brachionus angularis	3.5	1.5	2.1	4.2
Proales daphnicola	21.7	<1	-	-
Pedalia mira	-	<1	<1	13.5
Cladocera				
Diaphanosoma brachyurum	7.3	3.4	14.5	19.3
Daphnia hyalina	65.2	71.8	7.5	<1
Bosminopsis deitersi	3.3	-	1.8	58.9
Chydorus sp	3.3	<1	30.9	<1
Moina micrura	4.0	1.6	20.5	2.5
Chironomidae				
Tanypus chinensis	86.5	39.3	46.6	-
Tokunagayusurika akamusi	1.0	50.3	6.6	15.5
Einfeldia sp	-	-	<1	25.9
Chironomus plumosus(Linne)	2.9	2.0	26.3	15.5
Oligochaeta				
Limnodrilus hoffmeisteri	25.7	18.4	5.8	-
L. clapparedianus	36.3	-	-	5.6
Branchiura sowerbyi	23.5	62.5	40.7	88.9
Mollusca				
Cipangopaludina chinensis	-	15.2	6.7	6.4
Bellamya aeruginosa	-	60.6	37.8	14.8
Semisulcospira cancellata	-	-	4.4	12.3
Bithynia fuchsiana	-	-	8.9	24.6
Alocinma longicornis	-	15.2	15.6	16.0

[a]The data are expressed as percentage of the number of individuals belonging to a species in phytoplankton, protozoan, rotifers, cladoceran, chironomids, oligchaetes, mollusc abundance. More than 5% percentage was ascertained as dominant species.

high trophic levels. In terms of abundance, the most important species was *Tanypus chinensis* Wang, which accounted for 86.5% of the total abundance of zoobenthos. In lake Yanjiahu, the dominant species were *Tokungayusurika akamusi* and *Tanypus chinensis* Wang both contributing 89.6% of the total abundance of zoobenthos. Mollusca tended to be dominant in Lakes Honglianhu and Wushihu. The abundance of *Tangpus chinensis* Wang was 1098, 903, 89 and 3 ind./m respectively from hypereutrophic to mesotrophic lakes, showing a high positive relation between chironomids and state of lake eutrophication ($r=0.973$ $P<0.01$). Relationship between abundance of dominant species and trophic state of water body was well documented (Reynolds 1984, Shei, et al 1993, Thorne and William 2000). The common characteristic of the eutrophic ecosystems is known to be the presence of few dominant species with high biomass. *Tanypus chinensis* Wang is an indicator species of eutrophication, mainly due to its ability to tolerate low dissolved oxygen in eutrophic environment. An extreme abundance of *Tanypus chinensis* Wang has been found at hypereutrophic area in a Chinese shallow lake Donghu (Gong and Xie 2001). Many convincing evidence have shown that there is strong relation between *Tangpus chinensis* Wang and the trophic level of lake.

Biodiversity

A comparison of two biodiversity indices of plankton and zoobenthos in four lakes suggested that the diversity indices were higher in lower trophic lake (Table 8). A negative relationship was apparent between Margalef index and trophic state of lakes. Both biodiversity indices of rotifers and zoobenthos appear to show a downward tendency when the lake water changed from mesotrophic to hypereutrophic. Hence, the result indicates that eutrophication could result in a remarkable decline in diversity of rotifers and zoobenthos. Other studies in Chinese shallow lake also demonstrated that the more eutrophic the lake, the lower the rotifers and macrozoobenthos species diversity (Xie et al 1996, Gong and Xie 2001). But the fact that the Shannon-Wiener index of phytoplankton, protozoan and cladoceran did not distinctly decrease in the eutrophic lake was likely a notable difference. The low biodiversity of the eutrophic lake may easily be explained by the presence of few dominant species, since sensitive organisms are incapable of surviving in extreme environment.

Table 8. Mean value of biodiversity indices in four lakes

Lake	Biodiversity Index	Phytoplankton	Protozoa	Rotifera	Cladocera	Zoobenthos
Yanglanhu	H'	2.45	3.65	1.98	2.03	1.76
	d	5.07	3.65	1.13		0.81
Yanjiahu	H'	2.15	3.33	1.96	1.25	1.57
	d	5.43	3.56	1.24		1.26
Wushihu	H'	1.95	2.94	2.74	2.70	2.96
	d	6.73	4.47	2.18		1.81
Honglianhu	H'	2.67	2.55	2.77	1.70	3.43
	d	7.01	4.32	2.26		2.30

Refereces

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