Phytoplankton community in a large shallow eutrophic lake (Lake Dianchi, Southwest China)

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ABSTRACT

Monthly investigation is executed during April 2006 to May 2007, focusing on the abundance and composition of phytoplankton in a large (300 km²) shallow (mean depth 4.4m) eutrophic lake (Lake Dianchi).

The presence of phytoplankton in northern bay was the highest, while that in the southern part the lowest, and center part and northern part conditions represented an intermediate state between these two. Phytoplankton communities dominated by cyanobacteria, and *Microcystis* bloom occurred in the whole year. Annual average phytoplankton cell number was 8.7×10^7 cells L⁻¹, of which 93.6% was *Microcystis*, 4.5% were Chlorophyta and 0.3% was *Aphanizomenon*.

Comparative studies of our investigation against conditions in the past indicate that phytoplankton abundance and diversity decreased and cell miniaturization occurs in 2006 - 2007.

Key words: Lake Dianchi, lake, phytoplankton, bloom-forming cyanobacteria, biomass, temporal and spatial variation

I. INTRODUCTION

Lake Dianchi is the sixth largest freshwater lake in China and the largest in Yunnan-Guizhou Plateau. It is called "bright pearl of Plateau". With multiple functions as aquatic farming, irrigation and water supply, tourism, shipping, climate regulation, etc., Lake Dianchi plays a key role on economy and social development in Kunming. Lake Dianchi is under special geography and climate conditions, such as

location in the lowest part of Kunming Basin, small watershed area, indigent of water resources, lack of transit water recharge, concentrated waterfall in its watershed, mild climate, long sunshine time, large evaporation amount and so on. However, since 1990s, with the expanding of city and enhancing of urbanization, eco-environmental stress becomes more drastic and the ecological problem of water-pollution and eutrophication gradually stands out.

To investigate the abundance and composition of phytoplankton in Lake Dianchi and to provide scientific basis for water-bloom pollution treatment and control, monthly investigation and research on 15 sampling sites in Lake Dianchi was executed during April 2006 to May 2007.

II. METHODS

2.1 Sampling

According to cases-clustering method used to cluster 7 biotic indexes obtained in April 2006, combining with distinctiveness of water bloom in different lake areas, Lake Dianchi was divided into 4 following research parts: PART I (1-6), PART II(7-10), PART III(11-14) and PART IV (15 listed out alone).(see Table 1)

Phytoplankton samples were collected and data was obtained based on norms^{[1][2][3][4]}.

III. RESULTS

3.1. Species richness and surface abundance of phytoplankton

A total number of 185 phytoplankton taxa (including Bacillariophyta 21, Chlorophyta 85, Chrysophyta 5, Cryptophyta 2, Cyanobacteria 58, Euglenophyta 7, Pyrrophyta 3, and Xanthophyta 4) were encountered in the water samples during the period of study (See Table 1). Taxa number exceeds 106 that reported in 2001-2001^{[5][6][7]}, but Xanthophyta and Chrysophyta are found again. The community was dominated by cyanobacteria. Cyanobacteria exceeded the others almost 11 months during the whole year. In cyanobacteria, *Microcystis* increased while *Aphanizomenon* decreased compared with that in 2002.

Phytoplankton communities dominated by cyanobacteria, and *Microcystis* bloom occurred in the whole year, annual average phytoplankton cell number was 8.7×10^7 cells L⁻¹, of which 93.6% were *Microcystis*, 4.5% were Chlorophyta and 0.3% were *Aphanizomenon* (See Table 2).

Most species still are from Chlorophyta, there are 85 taxa in Lake Dianchi. Compared with the prior research in 2001-2002 (Li Yuan), the dominance of *Microcystis* water blooms in all the several sites of PART I with large area in March, just before *Aphanizomenon flos-aquae* bloomed in large scale, while euglena can caused water blooms in Lake Dianchi continue longer than 10 months in a year; the highest cell density of water bloom even reach 10^9 units/L; dominant species *Aphanizomenon flos-aquae* (early spring) and *Microcystis* (summer & autumn) in water blooms success as reported before.

The dominant species in 50s, Chlorophyta and dinoflagellate, are replaced by Chlorophyta, Bacillariophyta and Cyanobacteria at the 80s. In 80s both Bacillariophyta and Cyanobacteria are dominant but in 90s Cyanobacteria exceed the others. In 90s, Cyanobacteria dominate, of which most of them are filamentous *Planktothrix*, *Aphanizomenon* and colonial *Microcystis*. In the beginning of 21 century, the dominance of *Planktothrix* and *Aphanizomenon* are weakened but colonial *Microcystis* dominate. Dominant phytoplankton species change rather rapid. This reflects that

the water quality of Lake Dianchi is worsening under affluences of human activities.

3.2 Spatial variation of cell density phytoplankton

From the spatial variation of the percentage of the bloom-forming cyanobacteria, the presence of *Microcystis* in Part IV was the highest and that in PART I was the lowest but conditions of PART II and PART III represented an intermediate state between these two.

The temporal variation of the Phytoplankton community total wet weight, the biomass of bloom-forming cyanobacteria is accorded with *Microcystis* on the temporal variation, which is higher in summer and winter but lower in spring and winter. The presence of *Microcystis* in North bay was the highest and that in the South part was the lowest, but conditions of center part and north part represented an intermediate state between these two. The dominant, *Microcystis* population started growing rapidly with maximum abundance in late April, contributing significantly to the summer peak in phytoplankton biomass, while Chlorophyta and some other Algae contributing significantly to Spring Phytoplankton biomass. From March to May *Aphanizomenon* were highly productive in entire lake, and at at period of time, its population was the highest. In April and May, Chlorophyta and other algae like Euglenophyta and Pyrrophyta blooms, owing to their larger individuals, they take up 80% wet weight of phytoplankton.

IV DISCUSSIONS

Other abundant algae in Lake Dianchi (in spring) were *Ceratium hirundinella* (dinoflagellate, *Nitzschia closterium*, *Hormidium* sp. (Chlorophyta), *Euglena* spp. (euglena).

From the spatial variation of the percentage of the bloom-forming cyanobacteria, the presence of *Microcystis* in Part IV was the highest and that in PART I was the lowest but PART II and PART III conditions represented an intermediate state between these two.

Comparative studies on our investigation and its conditions in the past sixty years, it suggested that phytoplankton Abundance and Diversity decreased and cell miniaturization occurs. So it is really a long-term and

arduous task to control pollution and recover the ecosystem system.

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FIGURE 1. SKETCH MAP OF THE SAMPLING SITES IN LAKD DIANCHI

FIGURE 2. TEMPERAL VARIATION OF THE AVERAGE PHYTOPLANKTON WET WEIGHT

TABLE 1. THE COMMUNITY STRUCTURE OF PHYTOPLANKTON IN LAKE DIANCHI

	Qty. of families	Qty. of genera	Qty. of species
Bacillariophyta	7	16	21
Chlorophyta	16	40	85
Chrysophyta	3	4	5
Cryptophyta	1	2	2
Cyanobacteria	8	18	58
Euglenophyta	1	3	7
Pyrrophyta	3	3	3
Xanthophyta	3	3	4
Total	42	89	185

TABLE 2. SPATIAL VARIATION OF THE PERCENTAGE OF PHYTOPLANKTON ($\times 10^5$ CELL / L)

	Part I	Part II	Part III	Part IV	MEAN
<i>Microcystis</i>	557.3	827.8	900.6	985.3	817.7
<i>Aphanizomenon</i>	1.2	1.0	1.7	1.1	1.2
Cyanobacteria	565.9	834.4	908.8	994.3	825.9
Bacillariophyta	6.7	6.3	11	6.9	7.7
Chlorophyta	45.3	42.4	46.5	24.0	39.6
Others	0.4	0.2	0.4	0.4	0.3
Total	618.3	883.3	966.7	1025.6	873.5