Investigation on Phytoplankton and Water Quality in Tiande Lake of Taizhou City in Summer

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Abstract:
Field experiment was carried out to study on the community structure and species diversity of phycophyta in Tiande Lake, 4 samples were respectively collected according to normal methods, in June and July and August, 2015. The phycophyta species composition, cell density, diversity index were analyzed. The results showed there were 209 phycophyta species (including variety) belonging to 77 genera, 37 families, 8 phyla. The dominant species were *Ankistrodesmus, A.Falcatus, Oocystis, S.granulatus, C.kesssleri, C.Vulgaris, T.Minimum，Synedra acusvar, S. Acus, C.catenata, S.pulehella, N.acicularis, Chroococcus. A.Falcatus* had the highest dominance (0.088), then *Synedra acusvar* (0.087). The cell densities of phytoplankton was in the range of 25.2×10^{6}-56.89×10^{6} with the mean value of 37.845×10^{6} ind·L^{-1} belong to middle nutrition. The pollution-indicating algae indicate the water body of Tiande Lake already belonged to meso-eutrophic type. The Margalef richness index(d) was in the range of 4.05-4.26 with the mean value of 4.76. The Shannon diversity index(H') was in the range of 3.04-3.77 with the mean value of 3.29. The Pielou evenness index (E) was in the range of 0.7-0.81 with the mean value of 0.74. The water quality of Tiande lake belonged to slightly contaminated.

Keywords: *Tiande Lake, Phytoplankton, Water quality, Diversity index*

I. INTRODUCTION

The Tiande Lake is an artificial lake which built in 2009 in Hailing district, Taizhou city, Jiangsu province, east of china. It is 1010 meters long from east to west and 1100 meters long from north to south, with a total area of about 100 hectares, include barbecue district, fishing district, beach entertainment district, catering district, accommodation district.

Phytoplankton is the most important primary producers in water ecosystem, which is the foundation of material circulation and energy flow in the whole ecosystem. As an important biological indicator of water environmental quality, the quantity and variety as well as other features of phytoplankton would be used to monitor and assess the water quality (Suikkanen, 2007). The structure characteristics of phytoplankton community were closely related to the water environment factors, they would reflect the current situation and changes comprehensively in the water body, indicating water pollution situation (Gao, 2006). The researches on water quality evaluation with the help of phytoplankton had been carried out a lot (Yan, 2009; Li, 2006; Chen, 2007). At present, there was no report about the studies on the characteristics of Tiande Lake phytoplankton community as well as the related water quality, We carried out the investigation about the phytoplankton and the community structure of phytoplankton in Tiande lake to provide scientific evidence for Tiande Lake ecological environmental assessment and comprehensive improvement, in June and July and August, 2015.

II. METHODS AND MATERIALS

A. Setup of Sample Point:

Tiande Lake (32°25'~32°26' N 、119°54'~119°55' E) is in Hailing district of Taizhou City. The sample point of this time will set up 4 times, the distribution of sample points in Table 1.

B. Sample Collection

1) Qualitative Collection:

No. 25 plankton collection network were dragged in sampling point slowly to the distance at 0.5 m from water level to salvage samples. Poured it into plastic bottles and marked the appropriate sampling point to complete the sampling, and added 15ml of 10% Lugol's solution per liter water to fix the alga immediately.

2) Quantitative Collection:

water sampler was used to collect water samples 1L from the water surface 0.5m, and then adding 15ml Lugol's solution to fix the alga. 24 hours later, an inverted siphon were use to absorb supernatant fluid slowly after standing, so that making the1 L initial sample to be concentrated to 50 ml, and then transferring 50 ml sample into a comparison tube, affixing label on the comparison tube that labeling the sampling point, time and sites. Counting adopts counting box that has 20 mm^2, 0.1

ml capacity divided into 100 small grids, with eyepiece to carry out the vision count for the random selected 20 grids, the phytoplankton classification is according to the literature (Deng, 2012). Then according to the formula $N = (AV_s / A_cV_a) \times n$ to conduct calculations. N- the number of planktonic algae per liter of water sample; A- count box area (mm^2); V_s-1L volume after concentration and precipitation of water sample (ml); A_c- counting area (mm^2); V_a- count box volume (ml); n- the obtained number from planktonic algae counting (Zhang,1991).

C. Evaluation Method

1) The Richness Indices of Margalef:

According to Margalef diversity index to obtain the formula d = (S-1) lnN, S represent the number of species of phytoplankton in the formula, N represent the total number of individuals of a variety of phytoplankton. When d value is less than 3, that is to be heavy pollution; when d value is stay at between 3 and 4, that is moderate pollution; when d value is appear between 4 and 5, that is light pollution; when d value is greater than 5, that is clean (Hu, 2003).

2) The Diversity Indices of Shannon-Wiener:

According to the formula H = -Σ (ni / N) • ln (ni / N) of Shannon-Wiener diversity index to obtain H value (n_i represents the total number of one kind of organism). H values: 0 <H <1 mean heavily polluted; 1 <H <2 mean α- moderately polluted, 2 <H <3 mean β- moderately polluted; H> 3 mean lightly polluted (Shen, 1990).

3) Evenness Indices of Evennes Index:

According to the formula e=H/lnS of Evennes Index to obtain e values. e values: 0 <e <0.3 mean the heavy pollution; 0.3 <e <0.5 mean the moderate pollution; 0.5 <e <0.8 mean the light pollution or without pollution (Shen, 1990). S represent the number of species; H represent the diversity index of Shannon-Wiener.

4) The Dominance Index of Mcnaughton:

The dominance index of Mcnaughton (dominance index Y> 0.02) the formula $Y= (n_i/N)\cdot f_i$. n_i represents the number of i-th algae; N represent the total number of algae in the sample; f_i represent the frequency of occurrence of the species in each sample (Xiao, 2008).

III. RESULT AND DISCUSSION

A. The Composition Structure of Phytoplankton Community：

77 genera of 8 phyla were collected in Tiande Lake. Chlorophyta, Cyanophyta and Bacillariophyta accounted for 84.42% of phytoplankton. Chlorophyta appears 93 species, Bacillariophyta appears 67 species, Cyanophyta appears 24 species, Euglenophyta, Xanthophyta, Cryptophyta, Chrysophyta, dinoflagellates were found 17, 3,3,1,1 species. They were respectively holding 44.50%, 11.48%, 32.06%, 8.13%, 1.44%, 1.44%, 0.48%, 0.48% of the total species. The detailed structural composition of Tiande Lake phytoplankton was shown in Table 2.

B. The Dominant Species of Phytoplankton:

The dominant alga in 4 sampling points were the Chlorophyta and Bacillariophyta. The largest frequency of occurrence was the S. Acus (100%) belongs to bacillariophyta, followed by the A.Falcatus (75%) of Chlorophyta, the biggest dominant degree was the Oocystis (0.088), followed by was the S. Acus (0.087) of bacillariophyta (table 3). The site1 and site2 found seven dominant alga, and five of the seven found in site3, three of them found in site4. Some studies indicated that cyanophyta were more dominant in nutrient-rich water, chlorophyta and bacillariophyta are more easily to be dominant species in middle- eutrophic water bodies (Xiao,2008; Kuang,2005). The survey found that the dominant species, such as Ankistrodesmus and A.Falcatus of chlorophyta, Synedra acusvar, S. Acus and N.acicularis of bacillariophyta are all belong to the meso-eutrophic indicator algae of β-α-ms. The C.Vulgaris of chlorophyta belongs to α-ms eutrophic indicator algae, mainly in the fishing area (Site3), feeding in fishing area increased the degree of eutrophication in a certain extent.

C. The Density of Phytoplankton:

The important indicator that evaluating water quality and ecosystem function is the density of algal cells. It can be seen from Table 4, the cell density in site1, site2, site3, site4 were respectively 25.20×10^6 ind·L^{-1}, 33.28×10^6 ind·L^{-1}, 36.01×10^6 ind·L^{-1}, 56.89×10^6 ind·L^{-1}, the average cell density is 37.85×10^6 ind·L^{-1}, cell density in site4 is the largest among in them, followed by site3, site2 and site1. The standards of evaluating water quality by phytoplankton density is that less than 1×10^6 ind·L^{-1} as poor nutrition, 1×10^6 ind·L^{-1}～9×10^6 ind·L^{-1} mean medium -poor nutrition; 10×10^6 ind·L^{-1}～40×10^6 ind·L^{-1} mean medium nutrition; 41×10^6 ind·L^{-1}～80×10^6 ind·L^{-1} mean the medium eutrophication; 81×10^6 ind·L^{-1}～99×10^6 ind·L^{-1} mean eutrophication, exceed 100×10^6 ind·L^{-1} mean highly eutrophicated (Kuang,2005). Algal cell density judges the water quality in the dining club (site1), beach (site2), fishing area (site3) belongs to medium nutrition type, hotel (site4) as medium eutrophication. The water of lake is going from the medium nutrition to eutrophication.

D. The Diversity Index of Phytoplankton:

According to table (5), the average value of *d* is 4.76; the average value of *H* is 3.29; and the Shannon-Wiener diversity index is divided into 5 levels (Chen,1994), the phytoplankton diversity of Tiande Lake was in grade Ⅳ, rich diversity. The average evenness index value was 0.74, by analysis of variance shows that the difference was not significant ($p < 0.05$). From the standard index of biodiversity to determine water pollution situation (Hu,2007; Wang,2013), the abundance index d value of phytoplankton in Tiande Lake was between 4 and 5 which belong to lightly polluted; *H* value of each sample points were greater than 3, belong to lightly polluted; the *e* values of each sample are in the range of 0.5～0.8, which are lightly polluted or non-polluting, three evaluations showed that water pollution grade belong to mild pollution.

Table (1) The Sample Points' Location of Tiande Lake

sample point	The name of sample point	The longitude-latitude of sample point
site1	dining club	32°25'35.29"N、119°54'51.58"E
site2	beach	32°25'33.21"N、119°55'13.79"E
site3	Fishing district	32°25'46.37"N、119°55'18.71"E
site4	hotel	32°25'49.51"N、119°55'01.68"E

Table.(2) The Distribution of Phytoplankton in Tiande Lake

phyla	genera	Genus number ratio	species	Species ratio
Bacillariophyta	23	29.87%	67	32.06%
Chlorophyta	30	38.96%	93	44.50%
Cryptophyta	3	3.90%	3	1.44%
Xanthophyta	2	2.60%	3	1.44%
Euglenophyta	5	6.49%	17	8.13%
Cyanophyta	12	15.58%	24	11.48%
Chrysophyta	1	1.30%	1	0.48%
Pyrrhophyta	1	1.30%	1	0.48%

Table.(3) The Dominant Species and Dominant Degree of Phytoplankton in Tiande Lake

The dominant phylum	The dominant species	Site1	Site2	Site3	Site4
Chlorophyta	*Ankistrodesmus*	0.078	0.056	—	—
	Oocystis	0.05	0.088	—	—
	S.granulatus	0.031	—	—	—
	A.Falcatus	0.027	—	0.021	0.165
	C.kesssleri	—	—	0.031	—
	C.Vulgaris	—	—	0.022	—
	T.Minimum	—	—	0.027	—
Bacillariophyta	*Synedra acusvar*	0.075	0.058	—	—
	S. Acus	0.087	0.035	0.102	0.185
	C.catenata	0.024	—	—	—
	S.pulehella	—	0.053	—	0.021
	N.acicularis	—	0.023	—	—
Cyanophyta	*Chroococcus*	—	0.034	—	—

Table.(4) The Amount Distribution of Phytoplankton 10^6 ind·L^{-1}

Phylum	site1	site2	site3	site4
Chlorophyta	12.908	14.588	18.18	23.42

Cyanophyta	2.405	5.48	1.87	0.11
Bacillariophyta	9.25	13.108	14.45	24.45
Cryptophyta	0.598	0.015	0.33	4.97
Xanthophyta	0.02	0.08	0.27	0.15
Euglenophyta	0.02	0.01	0.83	3.5
Pyrrhophyta	—	—	0.08	0.05
Chrysophyta	—	—	—	0.24
total	25.2	33.28	36.01	56.89

Table (5) The Diversity Index of Phytoplankton

sampling point	*d*	*H*	*e*
site1	4.05	3.22	0.76
site2	4.79	3.10	0.70
site3	5.92	3.77	0.81
site4	4.26	3.04	0.70
average	4.76	3.29	0.74

IV. CONCLUSION

All the data results of survey indicated that the phytoplankton of Tiande Lake mainly consists of Chlorophyta, Bacillariophyta, Cyanophyta, Xanthophyta, Euglenophyta, Chrysophyta, Pyrrhophyta and Cryptophyta. The Chlorophyta, and Bacillariophyta are the dominant species. According to the general correspondence relationship between the dominant species and nutritional status (Xiao, 2008), the nutritional status of Tiande Lake belongs to β-α-ms -meso-eutrophication water body.

The average cell density of phytoplankton cells was 37.845×10^{6} ind·L^{-1}, the average trophic level was in the medium-nutrition. The water quality of dining club (site1), beach (site2) as well as fishing area (site3) belong to the mesotrophication; hotel (site4) was in meso-eutrophication.

According to biodiversity index, the phytoplankton diversity of Tiande Lake was in grade, rich in diversity, According to Margalef richness index d, Shannon-Wiener diversity index H and Evennes Index e judge that water quality in Tiande Lake are within mild pollution. There was no significant difference in each region ($P < 0.05$).

The water quality of Tiande Lake was generally in good condition, it was benefits from the more covering of aquatic higher plants, and the reasonable control of exogenous sources. But the nutritional station of the water in fishing area and nearby the hotel were higher than the others, which accelerated the process of eutrophication. Therefore, the writer suggest that strictly control the input of external nutrient source at the existing reception capacity, strengthening propaganda and guidance. Furthermore, it should appropriately stock silver carp bighead carp, snails, mussels and other filter-feeding animals to control algae density, and increasing coverage area of aquatic higher plants, as well as strengthening management to help improve water quality indicators.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGMENT

This work is supported by Research Foundation of Jiangsu Agri-animal Husbandry Vocational College which program of “Water quality monitoring and assessment in Tiande Lake (Grant No. NSFPT1401; Grant No.00010113012)”

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