CORRELATION BETWEEN ECOTOURISM AND THE EVOLUTION LAW OF ZOOPLANKTON COMMUNITIES IN DONGTING LAKE TOURIST AREA OF CHINA'S HUNAN

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Abstract. In order to understand the evolution of zooplankton communities in the Dongting Lake tourist area, Hunan, China, a one-year experiment was started in January 2018. Investigation of the water quality conditions and the evolution of zooplankton communities at 24 sampling points including the "three mouths" and "four waters" in the Dongting Lake area, including the incoming water section, the lake area and the exit section. The Wanshen AlgaeC type zooplankton and algae intelligent identification counter was used to obtain the relevant data of phytoplankton in the experimental water. By analyzing zooplankton diversity, water eutrophication results, zooplankton density, and the correlation between zooplankton abundance and environmental factors, conclusions are drawn. The results show that 4 phyla and 20 genera of zooplankton are detected. The density of zooplankton ranges from 5.0 to $3.4 \times 103 \cdot L^{-1}$. The dominant genera of "three-port river structure" was Difflugia. The dominant genera of "four-port river structure" is the Difflugia and Tintinnopsis. The dominant genera of lake region are the Difflugia and Polyarthra. The eutrophication degree of Dongting Lake is evaluated by comprehensive trophic state index and plankton Shannon diversity index. The results of CCA show that salinity and water temperature are the main environmental factors influencing the distribution of zooplankton community in Dongting Lake tourist area. Different zooplankton have different tolerance to temperature and salinity changes, and their species composition and quantity distribution will vary with temperature and salinity changes. Temperature directly affects the body temperature of biological organisms. The temperature of the body determines the strength of zooplankton's metabolic process and affects the growth, development and reproduction of zooplankton.
Keywords: eutrophication, plankton, diversity index, nutrition status index, ecotourism, environmental monitoring

Introduction

Since the 1990s, tourism has rapidly developed globally. The growth of ecotourism market is the most significant (Xia et al., 2017). Relevant data shows that the growth rate of global ecotourism has increased from 10% to 30% (Hu and Li, 2017). Because the development of ecotourism is based on the natural environment and natural resource, it can't exist independently without the use of resource, the development of ecotourism must premised on the natural and cultural environment (Wang et al., 2017). The ecotourism uses the natural environment to create wealth continuously, but it will bring unexpected threats to the environment, culture and economic sustainable development. In order to promote the healthy development of ecotourism in China, it is necessary to research the sustainable mechanism to develop the regional ecotourism resource.

Dongting Lake (110°40'E—113°10'E, 28°30'N—30°20'N) is located in the north of Hunan Province and the South Bank of Yangtze River. Dongting Lake stretches across Hunan and Hubei, including eighteen counties and fifteen state-owned farms in the north of Hunan Province, with a land area of 3.2×104 km^2, in which the area of cultivated land is 8.93×104 hm^2, and the population is about 1/5 of Hunan, so Dongting Lake is a famous base of commodity grain and freshwater fishery (Wang et al., 2017). It is also an ecotourism area in China (Van Dorssen et al., 2017). Dongting Lake is the second largest fresh water lake in China (Duan and Liu, 2019). It receives the water from Songzikou, Taipingkou and Ouchikou of the Yangtze River (referred to as "san kou"), the inflow of Xiangjiang, Zijiang, Yuanjiang and Lishui (referred to as "si shui") in the local drainage area of Dongting Lake, and the inflow of Xinqiang River and Miluo River around the lake. After storing water in a reservoir or lake and regulating the volume of flow in the lower reaches, it flows into the Yangtze River from the Chenglingji in the north. The relationship between rivers and lakes is very complex. Due to the long-term joint action of special geographical environment, natural conditions and human activities, the unique wetland ecotourism resource landscape is formed. In recent years, with the rapid development of social economy in Dongting Lake basin, the water body is seriously over the standard of nutrients, and the water body pollution of Dongting Lake is prominent, leading to significant changes in biological community structure and function.

Zooplankton is small aquatic organisms suspended in the water (Xie et al., 2017). They feed on phytoplankton, bacteria and organic debris in the water. Meanwhile, they are an important part of the water ecosystem. On the one hand, the feeding relationship between zooplankton and phytoplankton can regulate the density and biomass change of phytoplankton community appropriately (Ye et al., 2017). On the other hand, zooplankton can provide important food for fish, shrimp, crab and other animals in the sea, so they play an important role in the food web of marine ecosystem. To some extent, the quantity, species and distribution of plankton can be used as indexes to reflect the ecological environment of the lake. Therefore, the research on the community structure and distribution characteristics of zooplankton is very important to the lake monitoring and management of the ecological environment.

In the early 21st century, Zhang and Ye (2017) found that the zooplankton community structure of Dongting Lake is relatively complete and the diversity level is high. Ou, L. found that the increase of nutrients and eutrophication level was the direct reason of the increase of zooplankton in the water of South Dongting Lake (Ou, 2018). In recent years, there are many researches on the community structure and diversity of zooplankton, but most of them are concentrated in Tai Lake and Chao Lake. There are few studies on zooplankton community in Dongting Lake (Shelley et al., 2017). As the only inland lake that is directly connected with the Yangtze River in the middle reaches, Dongting Lake has a variety of ecological service functions and it plays an important role in the regional ecotourism environment function. Therefore, it is urgent and important to investigate the zooplankton community of Dongting Lake under the influence of human activities in recent years, so as to understand its eutrophication status. On this basis, this article researches the correlation of evolution law of zooplankton community in Dongting Lake tourism area, and thus to provide scientific basis for the monitoring of ecotourism environment and technical support for controlling eutrophication.

Material and Methods
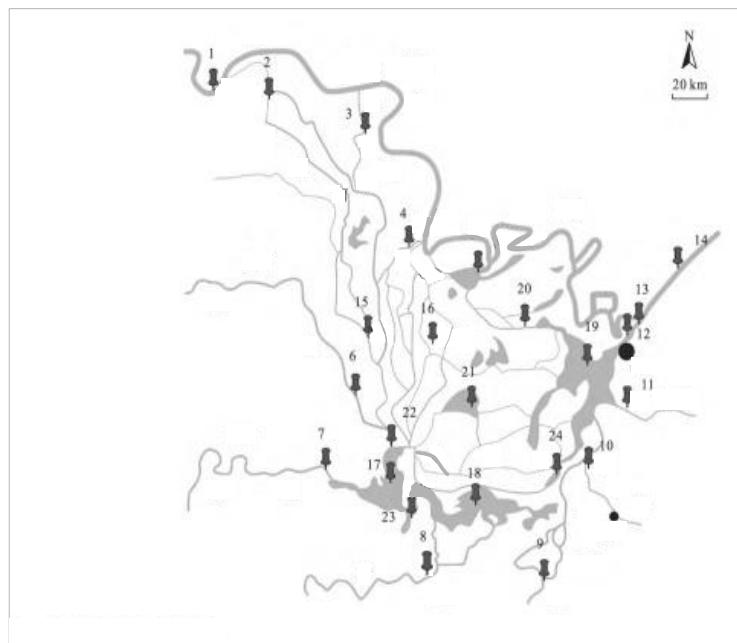
Layout of sampling points

In this survey, twenty-four sampling sections are arranged in Dongting Lake tourist area (Zheng et al., 2018). *Table 1* shows the section layout information. The actual geographical location is shown in *Figure 1* and the cross-sectional distribution is shown in *Figure 2*.

Table 1. Layout of sampling points in Dongting Lake Tourist Area

Monitoring point No.	Name of section	Longitude	Latitude	Control hydrological station	Remarks
1	Chen er kou	111°37′1.24″	30°18′16.35″	Zhicheng	Background section of the main stream of the Yangtze River
2	Da kou	111°48′24.03″	30°17′3.37″	New Jiangkou and SANDAOGUAN	Songzikou entrance
3	Taiping kou	112°7′42.99″	30°16′50.40″	Mito Temple	Taipingkou entrance
4	Lotus pond town	112°19′25.32″	29°44′31.33″	Kangjiagang, Guanjiapu	Lotus pond entrance
5	Tiao Guan town	112°37′19.80″	29°41′0.71″	Gate control	Tuning port entrance
6	Rock mountain	112°00′14.65″	29°24′1.96″	Rock mountain	Lishui entrance
7	Zhou Wen Temple	112°15′25″	28°54′45″	Zhouwenmiao (water level station)	Yuanshui entry
8	Sha Tau Village	112°29′32.69″	28°38′53.45″	Ganxi port and Shatou (2)	Water access
9	Zhangshu town	112°48′2.16″	28°34′3.28″	Baogong temple, Xiangyin	Xiangjiang entry
10	Leishishan	112°57′27.05″	28°59′58.32″	Leishishan (water level station)	Miluo River
11	Laohekou	113°6′20.40″	29°11′8.57″	-	New wall River
12	Chenglingji	113°09′3.64″	29°25′57.72″	Chenglingji	Exit
13	Lotus pond	113°12′40.18″	28°56′52″	Lotus pond	Converging the Yangtze River
14	Lo Shan	113°19′12.04″	29°37′43.28″	Lo Shan	Background of confluence of Yangtze River
15	Anxiang	112°10′16.07″	29°24′40.71″	Anxiang	Lake area
16	Nanxian	112°23′46.47″	29°21′40.825″	Nanxian	Lake area
17	Pinghu	112°13′47.69″	28°55′48.56″	-	West Dongting
18	Wan Zi Lake	112°17′6.27″	28°50′3.18″	Yangliutan	South Dongting
19	Junshan	113°0′23.17″	29°27′39.98″	Junshan	Dongdongting
20	Six door brake	112°46′16.53″	29°27′50.66″	-	East Dongting inward
21	Da tong hu	112°32′43.40″	29°10′35.07″	-	Typical Inner Lake in Lake area
22	Nan Ju	112°18′16.04″	29°03′5.78″	Nan Ju	Boundary of Dongting Lake in the West and North
23	Xiaohe Ju	112°18′37″	28°50′37″	Xiaohe Ju	Boundary between Dongting Lake in the West and Dongting Lake in the South
24	Lotus Leaf Lake	112°50′33.36″	28°36′33.35	Lotus Leaf Lake	Boundary between Dongting Lake and Dongting Lake
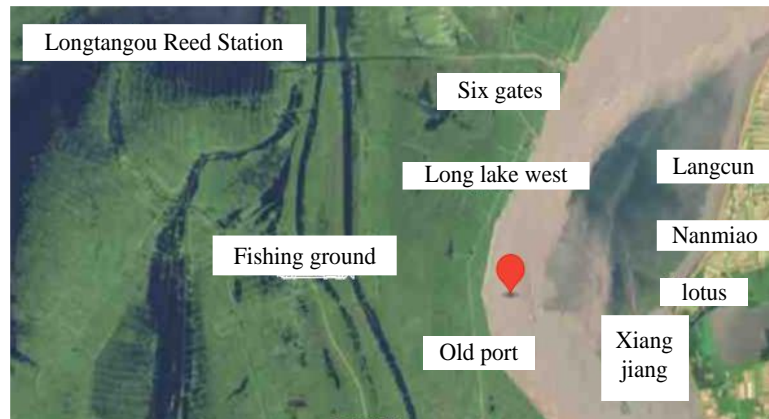
Figure 1. Actual geographic location

Figure 2. Layout of sampling points in Dongting Lake Tourist Area

In order to conduct a more comprehensive study on the evolution of zooplankton communities in the Dongting Lake Scenic Area, they were divided into zones. There is only one Yangtze River main stream background section (1#). There are four "three-port river structure" sections flowing into the lake (He et al., 2019) (2#~5#). There are four "four-port water system" sections flowing into the lake (Hu et al., 2018) (6#~9#). There are two inflow sections such as Miluo River, Xinxiang river (10#~11#). There are ten sections in Dongting Lake region (15#~24#). In addition, the number of exit and its background section are three (12#~14#). The experiment started on January 1, 2018, including the four seasons of spring, summer, autumn and winter, and the experiment cycle was one year. Among them, the sampling interval is 8 hours, and the samples are taken 3 times a day, respectively at 8am, 16pm, and 12 midnight. Record 11 environmental parameters including water temperature (WT), salinity (Sal),

transparency (T), dissolved oxygen (DO), chemical oxygen consumption (COD_{Mn}), and active phosphate (PO^{3-}_4) at these three time points Each sample is sampled 30 times and the average value is taken as the experimental sample data.

Sampling and sample processing

Zooplankton sampling: type I shallow plankton net (length is 145 cm, net internal diameter is 50 cm, net area 0.2 m^2) trawls from the sea bottom to the sea surface vertically. The samples were put into sample bottles, and then they are fixed and preserved with 5% formalin solution (Dai et al., 2017). After that, they are brought back to the laboratory for identification and analysis. Eleven environmental parameters such as water temperature (WT), salinity (SAL), transparency (T), dissolved oxygen (DO), chemical oxygen demand (COD_{Mn}), orthophosphate (PO^{3-}_4) were investigated simultaneously at each monitoring station. All operations were in accordance with the marine monitoring specification (GB17378-2007). Using the Wanshen AlgaeC type zooplankton and algae intelligent identification counter for plankton identification.

Sample analysis

The transparency of water samples collected from Dongting Lake in Hunan was measured by the method of Secchi disc (Hou et al., 2017). The chemical oxygen demand, chlorophyll a, total nitrogen and total phosphorus were determined in laboratory. The determination method refers to the monitoring and analysis method of water and wastewater (State Environmental Protection Administration, 2002). The plankton samples were identified and counted by microscope. Olympus BX53 microscope was adopted. Based on "China freshwater algae: system, classification and ecology" and "Research methods of freshwater plankton", the samples were identified.

The protozoa and rotifers were counted by 10×20 times microscope. The branch angle and copepoda were counted in full by 10×10 times microscope (Li and Jin, 2017). Genus was identified by qualitative analysis. The amount of zooplankton per litre of water should be calculated by following formulas:

$$N = \frac{nv}{VC}$$ (Eq.1)

In *formula (1)*, *n* is the number of calculating samples, *v* is the constant volume (mL) of concentrated sample, *V* is the sampling volume (L), *C* is the volume of counting sample (mL).

Data analysis

Eutrophication calculation

The eutrophication parameters of water quality are evaluated and calculated. The calculation method refers to "environmental quality evaluation method for surface water (Trial)" issued by Ministry of Environmental Protection. The eutrophication condition of Dongting Lake is evaluated by the comprehensive trophic state index TLI ($\sum$) (Tang et al., 2019). Evaluation grade: TLI ($\sum$) < 30, oligotrophy; 30 ≤ TLI ($\sum$) < 50, mesotrophy; 50 < TLI ($\sum$) < 60, light eutrophication; 60 < TLI ($\sum$) < 70, moderate eutrophication; TLI ($\sum$) > 70, severe eutrophication.

Calculation of zooplankton diversity

The diversity of zooplankton is denoted by Shannon-Weaver diversity index (*H'*) (Xiang et al., 2017). The evenness of community is denoted by Pielou evenness index (*J*) (Zhu and Yang, 2018). The richness of community is denoted by richness index of species (*D*) (Huang, 2017). The dominant species of community is denoted by dominance index (*Y*) (He et al., 2019). The formulas of indexes are as follows:

$$H' = -\sum P_i \ln P_i \qquad \text{(Eq.2)}$$

$$J = \frac{H'}{\ln S} \qquad \text{(Eq.3)}$$

$$D = \frac{(S-1)}{\ln N} \qquad \text{(Eq.4)}$$

$$Y = \frac{n_i}{N f_i} \qquad \text{(Eq.5)}$$

In *formulas (2)-(5)*, P_i is the quantity proportion of species; S is the species quantity of zooplankton. N is the total number of zooplankton; f is the occurrence frequency of species. If the dominance index (*Y*) of species≥ 0.02, it will be selected as superior species (Yang et al., 2017). SPSS17.0 software is used to analyze the correlation between abundance, biomass and environmental factors. The Shannon-Weaver index and evenness index are calculated by Primer6 (Zhang et al., 2018). CANOCO for Windows5 is applied to CCA analysis, so that the relationship between zooplankton and environmental factors can be obtained. Google earth and MapInfo are used to draw the station distribution.

Results

Water quality and eutrophication assessment of Dongting Lake tourist Area

Analysis of water quality

The transparency, permanganate index, chlorophyll a, total nitrogen and total phosphorus of twenty-four in Dongting Lake tourist area were measured. The results are shown in *Table 2*.

Based on the results in *Table 2*, each single factor is evaluated by the environmental quality standard for surface water (GB3838-2002), so as to understand the water quality of Dongting Lake. From the physical and chemical monitoring results, we can see that the water quality of Dongting Lake tourist area is not optimistic, and the nutrient content is high. The fluctuation range of total nitrogen in Dongting Lake tourist area is 0.81-2.00 mg·L^{-1}, with an average value of 1.49 mg·L^{-1}. The results of monitoring points of "three-port water systems" and "four water systems" all exceed the class IV water standard, so the total nitrogen pollution of Dongting Lake is relatively serious. The fluctuation range of total phosphorus in Dongting Lake is 0.06-0.21 mg·L^{-1}, and the average value is 0.09 mg·L^{-1}. The average value of total phosphorus in lake area is

0.08 mg·L^{-1}, which meets the class IV water standard. The maximum value measured by No. 7 monitoring point (Zhouwenmiao) is 0.21 mg·L^{-1}. Zhouwenmiao is the entrance of Yuanjiang River to Dongting Lake. The reason for high total phosphorus is due to the aquaculture, agricultural production, soil erosion, feces and other pollution. As an index of organic pollution, when the concentration of COD$_{Mn}$ exceeds 4 mg·L^{-1}, the water body has been polluted. The result of COD$_{Mn}$ determination in Dongting Lake is 1.9-3.9 mg·L^{-1}, and the average value is 2.6 mg·L^{-1}. Therefore, some areas of Dongting Lake are close to the stage of pollution. We should pay enough attention to these areas.

***Table 2.*** *Basic physical and chemical properties of Dongting Lake Tourist Area*

Monitoring point No.	COD$_{Mn}$/mg·L^{-1}	TN/mg·L^{-1}	SD/mg·L^{-1}	TP/mg·L^{-1}	Chlorophyll a/μg·L^{-1}
1	2.49	1.92	0.29	0.08	3.29
2	2.42	1.62	36	0.1	1.54
3	2.21	1.62	0.36	0.11	1.54
4	2.18	1.6	0.31	0.12	2.72
5	2.2	0.61	0.41	0.12	4.14
6	3.19	1.59	0.74	0.08	4.2
7	3.63	1.54	0.26	0.22	0.75
8	2.04	1.6	0.47	0.07	3.07
9	2.47	1.68	0.46	0.07	3.8
10	2.92	1.58	0.26	0.11	27.52
11	2.23	1.27	0.31	0.08	7.53
12	2.89	1.77	0.54	0.12	16.54
13	2.77	1.59	0.61	0.09	4.43
14	2.38	1.48	0.31	0.09	3.74
15	2.41	1.67	0.51	0.09	1.83
16	2.02	2.01	0.41	0.1	4.87
17	1.93	1.36	0.26	0.08	1.77
18	2.22	1.19	0.34	0.07	2.16
19	2.31	1.24	0.21	0.09	5.95
20	3.93	1.28	0.11	0.09	10.14
21	3.68	0.82	0.81	0.14	2.79
22	2.19	1.43	0.31	0.07	2.16
23	2.7	1.22	0.28	0.07	2.06
24	2.24	1.32	0.31	0.07	5.95

Eutrophication assessment

The eutrophication of Dongting Lake tourist area was evaluated according to the surface water environment quality evaluation method (Trial implementation), and the eutrophication is shown in *Figure 3*.

The transparency in the water body exceeds the average value by more than 500 px, the biochemical oxygen demand is greater than 10 mg/L, the concentration of chlorophyll a that marks the growth of algae is greater than 10 μg/L, the nitrogen content is greater than 0.2~0.3 mg/L, and the phosphorus content is greater than 0.01 mg/L, indicating that the water body is in a state of eutrophication. Through the calculation of trophic state index (TLI) of transparency, chemical oxygen demand, chlorophyll a, total nitrogen and total phosphorus, we can see that all monitoring points are in the state of eutrophication. Among all the monitoring points, TLI value in No. 20 monitoring point is the highest, 63.66, belonging to the moderate eutrophication state. This is consistent with the water bloom phenomenon found in the field sampling.

During field sampling, cyanobacteria bloom was found in No. 20 monitoring point (Liumen floodgate), and the water body of the monitoring point was green with odour. The causes of water bloom in Liumen sluice are analyzed. Firstly, the concentration of nutrients such as nitrogen and phosphorus is high. When the total nitrogen and total phosphorus are more than 0.5 and 0.02 mg·L^{-1} respectively, cyanobacterial blooms may occur. During the lake eutrophication, as the limiting factor of algal growth, the increase of phosphorus will lead to a large number of algal growths. Liumen sluice is in the state of moderate eutrophication. Respectively, the total nitrogen and total phosphorus of this monitoring point are 1.27 mg·L^{-1} and 0.08 mg·L^{-1}. The high nitrogen and phosphorus content and eutrophic water create conditions for cyanobacteria bloom. The second is the impact of hydrological conditions. Generally, the cyanobacteria are difficult to gather effectively to form water bloom if the water retention time is too short. The longer the water retention time is, the greater the possibility of water bloom is. When the flow velocity is low, the flow velocity is the key regulating factor of nutrient concentration and transparency. When the flow velocity is low, the nutrient concentration increases and the transparency decreases. The average velocity at Liumen sluice is only 0.02 m·s^{-1}. If the water retention time is too long, the high concentration of nutrients will provide sufficient nutrition for the mass propagation of algae, leading to water bloom. Therefore, the interaction of environmental factors and hydrological conditions led to the outbreak of cyanobacteria bloom.
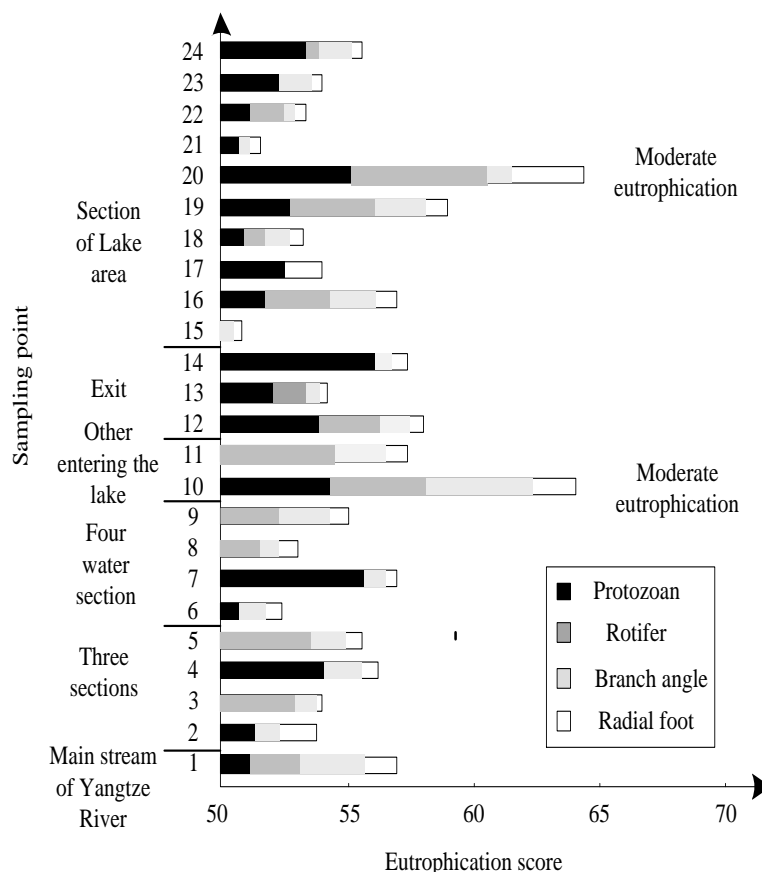

***Figure 3.** Eutrophication in Dongting Lake Tourist Area*

### Evolution law of zooplankton community in Dongting Lake tourist area

Composition of zooplankton

In this article, four phyla and twenty genera of zooplankton are found in Dongting Lake tourist area, in which six species are protozoa, and they account for 30.00% of the total number of zooplankton. Seven species are rotifers, accounting for 35.00%. Four species are Cladoceran, accounting for 20.00%. Three species are Copepoda, accounting for 15.00%. Nauplius is detected form all monitoring points, Cyclopoidea and Difflugia are more than 70% detection rate. Keratella and Bosmina are more than 50% detection rate. The composition of zooplankton is shown in *Figure 4*.
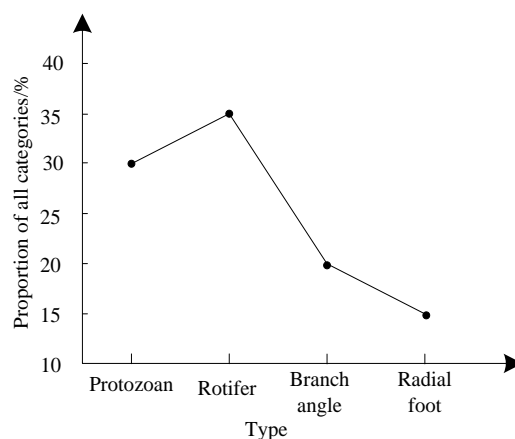
Figure 4. Species composition of zooplankton

The spatial distribution of zooplankton species is shown in *Figure 5*.
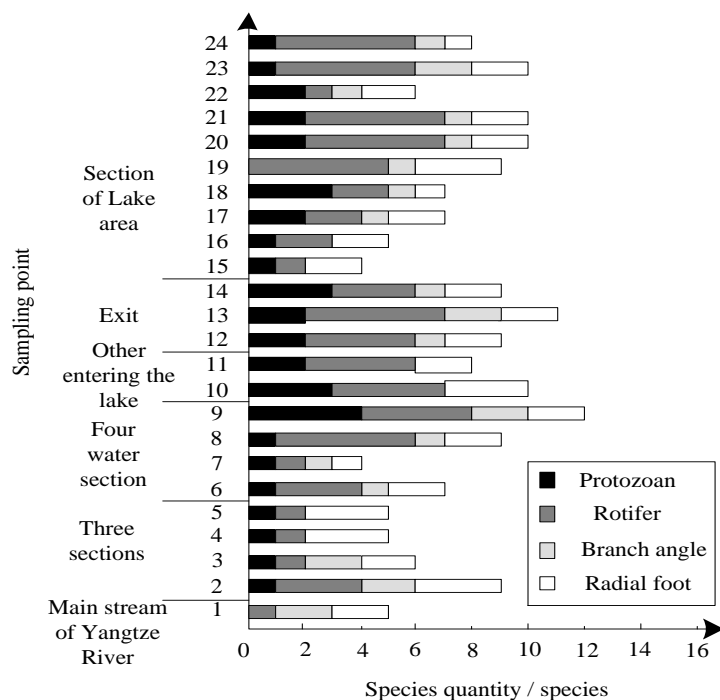
Figure 5. Spatial distribution of zooplankton species composition

Figure 5 shows that the number of zooplankton species in No.9 monitoring point is the most abundant, with a total of twelve species. No. 7 monitoring points and No.9 monitoring points have the least species. Only four species of zooplankton can be detected. There are ten species of zooplankton in the "three diversions river system" and there are fourteen species in the "four diversions river system". There are seventeen species in the lake area.

Zooplankton density

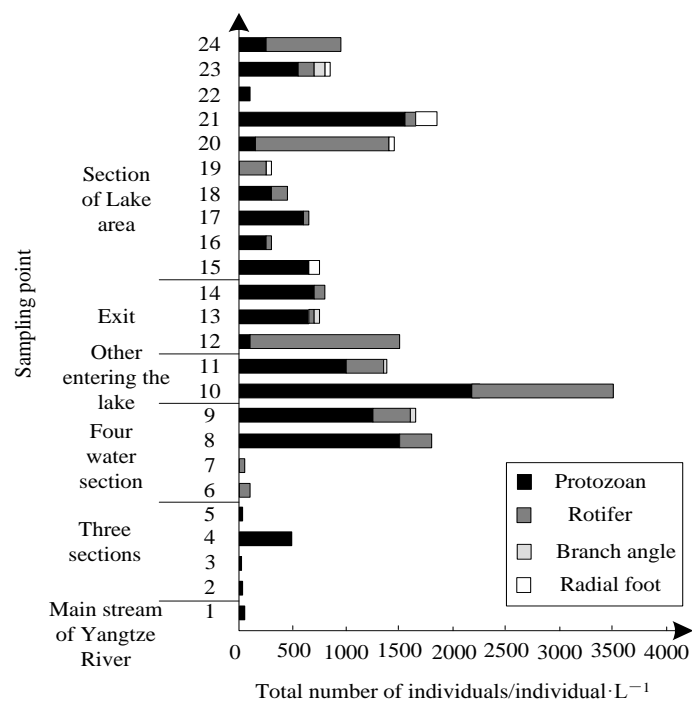The spatial distribution of zooplankton is shown in *Figure 6*.

Figure 6. *Spatial distribution of zooplankton density*

The monitoring points in this paper are all equidistant, and the selection positions are random. *Figure 6* shows that the density of zooplankton changes from $5.0 \sim 3.4 \times 10^3 \cdot L^{-1}$, and the average density is $802 \cdot L^{-1}$. The density of No. 3 monitoring point is only $3.2 \times 10^2 \cdot L^{-1}$, almost no zooplankton can be detected. The distribution rule of density of zooplankton in Dongting Lake: three-port water system < lake area < four-water system. The average cell density of "three-port water system" is $140 \ L^{-1}$. The average cell density of "four-water system" is $853 \ L^{-1}$. The cell density of "four-water system" flowing the lake is 6.1 times of that of "three-port water system". The average cell density of Dongting Lake area is $791 \ L^{-1}$. The distribution rule of density of zooplankton in lake area: East Dongting Lake < South Dongting Lake < West Dongting Lake. The dominant genera identified by zooplankton in Dongting Lake are as follows: the dominant genera of "three-port water system" are Difflugia; the dominant genera of "four-water systems" are Difflugia and Tininnidium; the dominant genera in lake area are Difflugia and Polyarthra. In addition, Difflugia are dominant in the whole Dongting Lake. *Figure 5* shows that Dongting Lake is dominated by protozoa and rotifers. Small

zooplanktons are dominant in species number and individual number, while Cladocera and copepod are less, and the trend of miniaturization is obvious. Some researches show that the community structure of zooplankton changes from large to small with the improvement of water nutrition level, and the eutrophication degree of water body in Dongting Lake is more serious, which is not conducive to the feeding of large zooplankton such as Cladocera. That is the main reason why the small zooplanktons in Dongting Lake become dominant. Meanwhile, some researches show that the filter-feeding way of silver carp and variegated carp will lead to the reduction of macro zooplankton. It will show a miniaturization trend. Due to the high culture rate of silver carp and variegated carp, the filter-feeding way of silver carp and variegated carp leads to the miniaturization of zooplankton. In addition, the cyanobacteria in Dongting Lake are the dominant species, which are not conducive to the feeding of Cladocera and other macro zooplankton. The rotifers can use Cyanobacteria for growth and reproduction, leading to the dominance of micro zooplankton in water.

Assessment of zooplankton diversity and eutrophication

The Shannon diversity indexes of zooplankton were calculated at 24 monitoring points in Dongting Lake. The spatial distribution of H-value measurement results is shown in *Figure 7*.
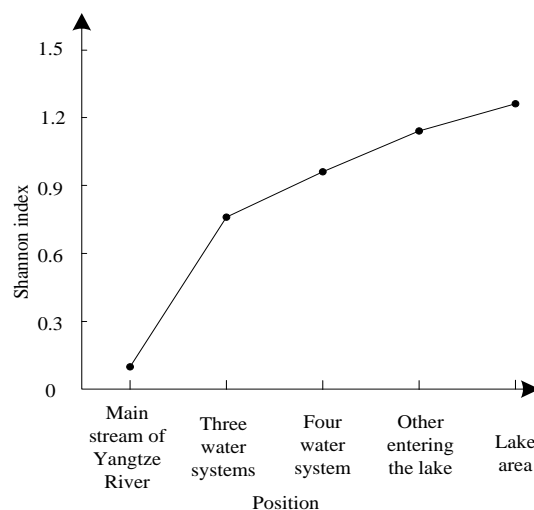
Figure 7. Spatial distribution of Shannon diversity index and Margelef index

When the Shannon diversity index in a water body exceeds 0.95, the water body is in a state of eutrophication. The range of H value in Dongting Lake is 0.02-1.59. The average value is 0.99. The average value of H in three diversions river systems is 0.75. The average value of H in four diversions river systems is 0.88. The average value of H in the lake region is 1.08. The distribution rule of zooplankton biodiversity is three diversions river system < four diversions river system < Lake region. The distribution law in lake region is West Dongting < South Dongting < East Dongting. The state of eutrophication in Dongting Lake was evaluated by Shannon index. All the results show that Dongting Lake is in the state of eutrophication.

Correlation between zooplankton abundance and environmental factors

The correlation of eleven physical and chemical factors such as zooplankton abundance, water temperature, salinity, nutrient salt and transparency is shown in *Table 3*.

Table 3. *Correlation coefficient between zooplankton abundance and environmental factors*

Correlation coefficient	2018		
	May	July	November
NO_2^-	0.134	-0.363	-0.099
NH_4^+	-0.318	-0.324	0.195
NO_3^-	-0.102	-0.248	0.347
PO_4^{3-}	0.017	-0.427	-3.433
T	-0.741**	0.080	-2.210
WT	0.611*	-0.082	-0.734**
Sal	0.611*	-0.452	0.589*
DO	-0.525	-0.079	0.481
pH	0.030	0.437	-0.472
COD	0.132	-0.118	-0.531
H	0.23	0.534	0.223

From *Table 3*, the zooplankton abundance has a significant negative correlation with water transparency in spring (P < 0.01) and a significant positive correlation with water temperature and salinity (P < 0.05). In summer, the zooplankton abundance does not have significant correlation with the monitored chemical parameters (P > 0.05). In autumn, the zooplankton abundance has a significant negative correlation with water temperature (P < 0.01) and a significant positive correlation with salinity (P < 0.05). There was no significant correlation between zooplankton abundance and other chemical parameters (P > 0.05). Therefore, the water temperature and salinity are important environmental factors influencing the community structure of zooplankton.

Discussion

Since the 1980s, a trend of thought has gradually emerged, which calls for strengthening the management of tourism resources in the process of tourism activities. Meanwhile, it calls for formulating a draft plan that can be generally agreed and abided by the relevant parties. This trend of thought developed in the late 1980s, and then the concepts of "Science to tourism", "Natural to tourism" and "E-tourism" appeared. The ecotourism has become the trend of tourism development in the world, but there is no clear definition of ecotourism. Mesfin et al. (2017) studied emerging zooplankton conservation methods in shallow tropical lakes supported by large aquatic plants. From January 2016 to August 2016, monthly monitoring of a large large-scale gushing plant, including monitoring of physical, chemical and biological parameters. Sampling points were selected to represent areas of large plant vegetation and open waters of the lake. Sites with large plants were found to be homes of more dense and diverse zooplankton communities. Based on this, the related methods are optimized, the experimental period is extended, and the research area is enlarged. The evolution of zooplankton community during this period is studied, and the following conclusions are drawn:

In this article, the evolution law of zooplankton community in Dongting Lake tourist area of Hunan Province is researched. Four phyla and twenty genera of zooplankton are found in Dongting Lake tourist area, in which six species are protozoa, and they account for 30.00% of the total number of zooplankton. Seven species are rotifers, accounting for 35.00%. Four species are Cladoceran, accounting for 20.00%. Three species are Copepoda, accounting for 15.00%. There are ten species of zooplankton in the "three diversions river system" and there are fourteen species in the "four diversions river system". There are seventeen species in the lake area. The average H value of zooplankton biodiversity is 0.99. The average D value of species richness is 1.02. The distribution rule of Shannon index of zooplankton is: three diversions river system < four diversions river system < lake region. The result of water quality evaluation by plankton Shannon diversity index shows that the water body is already in the state of eutrophication.

The composition and distribution characteristics of zooplankton are related to the ecological factors such as water temperature, salinity, dissolved oxygen, chlorophyll a, pH and nutrient content, in which temperature and salinity are the most important factors affecting zooplankton distribution. Different zooplanktons have different tolerance to the change of temperature and salinity, and their species composition and distribution will be different with the change of temperature and salinity. The temperature directly affects the body temperature of organisms, and the body temperature determines the intensity of the metabolism process of zooplankton and affects the growth, development and reproduction of zooplankton. When Jiang Huichao et al studied the community structure of zooplankton in Jincheng sea area of Laizhou Bay, they found that the species of zooplankton was positively correlated with the water temperature in the range of 2.2~27.4℃ (P < 0.01). The salinity is another important factor affecting the community structure of zooplankton, which is negatively related to the distribution of species. The cumulative contribution rate of selected environmental factors to explain species variables of zooplankton is as high as 90%, so the temperature and salinity are the main environmental factors affecting the distribution of zooplankton.

According to the resource characteristics of "particularity, diversity and fragility" of Dongting Lake tourist area and the current situation of utilization, the development of Dongting Lake tourist area should be positioned as a kind of protective resource development, which should develop towards the direction of ecotourism. The ecotourism can be used to improve and restore the quality of natural environment in lake area, so as to promote the virtuous cycle of ecosystem and sustainable development.

(1) return farmland to lake and ensure the area of natural ecosystem

The ecosystem of Dongting Lake belongs to the inland wetland ecosystem, including natural ecosystem and artificial ecosystem. According to its landscape, the natural ecosystem can be divided into river ecosystem, fresh water lake ecosystem, freshwater swamp ecosystem, wetland ecosystem dominated by trees, marsh wetland ecosystem dominated by reed. The artificial ecosystem mainly contains fish and shrimp pond, irrigation ditch, paddy field, irrigation land, seasonal flood farmland and other agricultural ecosystems. Zooplankton is one of the main biological groups in the natural ecosystem, and it is also the basic material element of forming the ecotourism landscape. Meanwhile, it is an important component of the ecological function of Dongting Lake.

To maintain natural ecosystem is the premise of developing Dongting Lake ecotourism and the fundamental guarantee of virtuous cycle of ecosystem. In the past, there were more people and less land in the lake area. In order to solve the problem of grain, the area of constructed wetland was expanded and the area of natural ecotourism resource was reduced. That is a problem of economic benefit between the whole and the part, the near term and the long term. The lake is reclaimed, leading to the sharp reduction of the flood storage capacity of the lake. Therefore, it is necessary to adjust the agricultural structure and promote "the avoiding calamity agriculture ", and develop "sightseeing agriculture". For example, reclaiming wetlands on low floodplain not only destroys the original eco-tourism resource, but also loses the proper benefits. It is necessary to return farmland to lakes and marshes, restore the original natural eco-tourism landscape, and make it play a variety of ecological functions. In conditional areas, it is necessary to build a pilot demonstration area of sightseeing agriculture and develop a sustainable sightseeing agriculture that adapts to the alternation of drought and flood. Aiming at shallow water, surrounding lakes, low lake waterlogged land and specific areas with more than one year of flooding, it is necessary to establish a variety of suitable composite and efficient tourism agricultural ecological engineering modes, so as to make overall arrangements for planting and breeding industries.

(2) restoration, reconstruction, standardization and expansion of nature reserves

According to the principle of ecology, the restoration and reconstruction of ecosystem is to change and eliminate the disadvantageous factors restricting the development of ecosystem, so as to restore the degraded ecosystem as soon as possible. Finally, it develops healthily. For a degraded ecosystem, it is necessary to establish a series of ecological sustainability indicators and conduct long-term monitoring before and after restoration to restore its ecological rationality and achieve its sustainability ultimately.

The primary task for the restoration and reconstruction of Dongting Lake ecosystem is to standardize and expand the nature reserve. The practice proves that the establishment of nature reserves is the most effective way to protect ecotourism resource. Dongting Lake Nature Reserve, established in Yueyang City since 1982, which has been listed in the list of international important wetlands, with an area of about 19×104 hm². The protected objects mainly include rare birds, wetlands and lakes. In 2000, World Wide Fund For Nature decided to take Qingshan Lake as the first implementation project of returning farmland to Lake, wetland restoration demonstration and "river of joint protection of life" in Qingshan Lake of Hanshou, West Dongting Lake. It is listed as a world wetland restoration demonstration area, with a total area of about 1100 hm². In the demonstration area, there are six functional areas. In South Dongting Lake, Dongting Lake environmental protection monitoring station of Hunan Province is established. In the past, some works had been done and great achievements have been made in the construction of wetland nature reserves, but it is far from the actual requirements. The number of protected areas (demonstration areas) is too small. The existing nature reserves still can't effectively protect the ecotourism resources. It is necessary to strengthen the management and play a role in the established nature reserves. Meanwhile, we should increase the number of ecotourism resource reserves and increase the investment. Combined with scientific research institutes, the ecosystem research network is built. Based on "3S" technology, we should strengthen the monitoring of ecotourism resources, especially the monitoring of dynamic system and biodiversity change after the use of ecotourism resources, and then

prepare the ecotourism resource information management system, so as to promote the continuous improvement of reserve system. These provide scientific basis for scientific management and rational use of ecotourism resources. Moreover, it is necessary to establish a comprehensive planning and management organization of eco-tourism resources in lake area, study and formulate relevant laws and regulations, strengthen the management for the utilization of ecotourism resources, unify the planning, implement the environmental impact assessment system, and enforce the approval procedures for the development and utilization of ecotourism resources. In addition, the blind development and destruction of ecotourism resources are strictly prohibited, so that the tendency of paying attention to production function but neglecting its ecological function is completely changed. The comprehensive economic and ecological benefits are fully exerted and thus to achieve the sustainable utilization of ecotourism resource.

Conclusions

Dongting Lake in Hunan is one of the three major wetland resource areas in the middle and lower reaches of the Yangtze river. Under the long-term action of special geographical environment, natural conditions and human activities, the unique ecotourism resource landscape, obvious saucer-shaped basin landform, typical subtropical monsoon climate, rich animal and plant resources and other ecotourism resources. Zooplankton plays a bioindication role in the distribution of many important ocean currents and water masses and the climate change. Zooplankton is very sensitive to the changes of various hydrological factors due to their special life style. They often swim with the stream. The distribution and quantity change of species is corresponding to the hydrological conditions, water masses, ocean current and climate. To master the change dynamics of zooplankton community structure is an important content to understand the structure and function of the reservoir ecosystem. This article researches the evolution law of zooplankton community in Dongting Lake and analyzes the characteristics of zooplankton community structure, so as to provide basic data and theoretical basis for the rational construction and sustainable development of Dongting Lake.

In the future, this paper will use the results of this research to rationally plan the protection of the ecosystem and obtain a better ecological environment.

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