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Investigation and analysis of the community structure characteristics of zooplankton in Zibo

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ABSTRACT

In order to understand the water ecological environment and the characteristics of plankton community structure in the Zibo area, a survey and study of plankton was conducted in the Zibo Basin in the autumn of 2022. By collecting zooplankton from nine major rivers within the country, a total of 122 species were collected from four phyla. Among them, rotifers are the most abundant, with a total of 77 species, accounting for 63%; Next are protozoa, with a total of 24 species, accounting for 20%; There are a total of 11 species of cladocerans, accounting for 9%; There are 10 species of copepods, accounting for 8%. The average density is 229.58/L, and the average biomass of zooplankton is 2.1997mg/L. The Shannon Wiener diversity index for zooplankton is 3.35. The survey results show that the water quality in the Zibo section is generally in a light pollution state. It is recommended to take further effective measures to strengthen the environmental governance around the watershed, reduce the discharge of domestic sewage, and reduce human activity interference.

KEYWORDS

Zibo Basin; Zooplankton; Species composition; Community structure; Biodiversity assessment

1. INTRODUCTION

Zibo City is located in the central part of Shandong Province, with geographical coordinates ranging from 117 °32 ′ E to 118 °31 ′ E and 35 °55 ′ N to 37 °17 ′ N. It is situated at the foot of Taiyi Mountain to the south, adjacent to the Jiuqu Yellow River to the north, Zibo to the west, and Weifang to the east. The shape of Zibo City is narrow from north to south, 87km wide from east to west, 151km long from north to south, with a total area of 5965km2.Surrounding the jurisdiction of Zibo City, there are 9 main rivers: Xiaoqing River, Branch River, North Branch New River, Xiaofu River, Dongzhulong River, Zihe River, Yihe River, Wuhe River, and Fanyang River. Conduct a systematic investigation and analysis of the community structure characteristics of planktonic animals. Zooplankton is an important component of aquatic ecosystems, and its community structure changes have a significant impact on ecological processes such as nutrient transformation, energy flow, and information transmission. It is an important indicator for evaluating changes in water environment quality and water ecosystem health, and its diversity index is one of the important indicators for evaluating river ecosystems [1]. Understanding and mastering the structural characteristics and diversity of zooplankton communities is beneficial for adjusting and protecting the health of river ecosystems, and better providing sustainable and high-quality ecological services for humanity. However, research on water environment quality based on plankton diversity is still limited. Based on this, a survey was conducted on the community and diversity of zooplankton in the Zibo section, in order to provide reference for the protection of aquatic biological resources and the evaluation of aquatic ecological health in the Zibo area [2]. Furthermore, it provides important basis for the

protection and restoration of biological resources in the rivers of Zibo City, and is of great significance for the protection of biodiversity in the aquatic ecological environment and the construction of a water ecological civilization city.

2. MATERIAL AND METHODS

2.1. Survey Time and Survey Location

Based on the hydrological, geological, and geomorphological characteristics of the Zibo section of the Xiaoqing River, monitoring and evaluation of the main river water ecological system in the jurisdiction of Zibo City were carried out in September 2022. According to the natural and geographical environment characteristics of the rivers in Zibo City, 50 survey stations were set (Figure 2-1), including 3 survey points (Z1-Z3) for the northern branch of the Xinhe River, 4 survey points (Z4, Z8, Z9, Z12) for the tributary river, 5 survey points (Z5, Z6, Z7, Z10, Z11) for the Xiaoqing River, and 5 survey points (Z13-Z17) for the Dongzhulong River. Five survey points were set in Wuhe (Z18-Z22), Zihe (Z23, Z24, Z35, Z36, Z37), Fanyang River (Z25, Z26, Z28, Z30, Z31), Xiaofu River (Z28, Z33, Z34, Z38, Z39), and Yihe (Z40-Z52). The longitude and latitude of 50 survey stations were measured, and the altitude was determined using two-step software (Figure 1).

2.2. Collection and Identification of Zooplankton Samples

Take 50L of mixed water sample, filter it through the 25 # plankton net, collect it in a 100ml sample bottle, and add 4%~5% formaldehyde solution on site for fixation and storage. The fixed sample was taken back to the laboratory and allowed to stand for 24 hours before being siphoned and concentrated to 50ml. Take 1ml of the sample and count it in full under a 10 x 10x optical microscope within the counting frame. The identification is based on the "Chinese Freshwater Rotifera", "Chinese Zoology", "Freshwater Cladocerans", "Freshwater Microbial Atlas", etc. [3].

2.3. Data Processing and Analysis

2.3.1. Dominant and common species of zooplankton

The determination of dominant species adopts dominance (Y), and the calculation formula is $Y=(Ni/N)\,fi$. In the formula, Ni is the number of individuals of the i-th species, N is the total number of individuals of all species, and fi is the frequency of occurrence of the i-th species. Species with $Y \geq 0.02$ are identified as dominant species, while species with $f \geq 65\%$ are identified as common species.

2.3.2. Diversity of Zooplankton

CommunitiesShannon Weiner diversity index (H ′) and Pielou evenness index (J) were used to analyze the planktonic community. Calculation formula: $H'=-\sum Pi \log2Pi$ $J=H'/\log2S$. In the formula, Pi is the ratio of the number of individuals of the i-th species to the total number of individuals; S represents the total number of species in the sample.

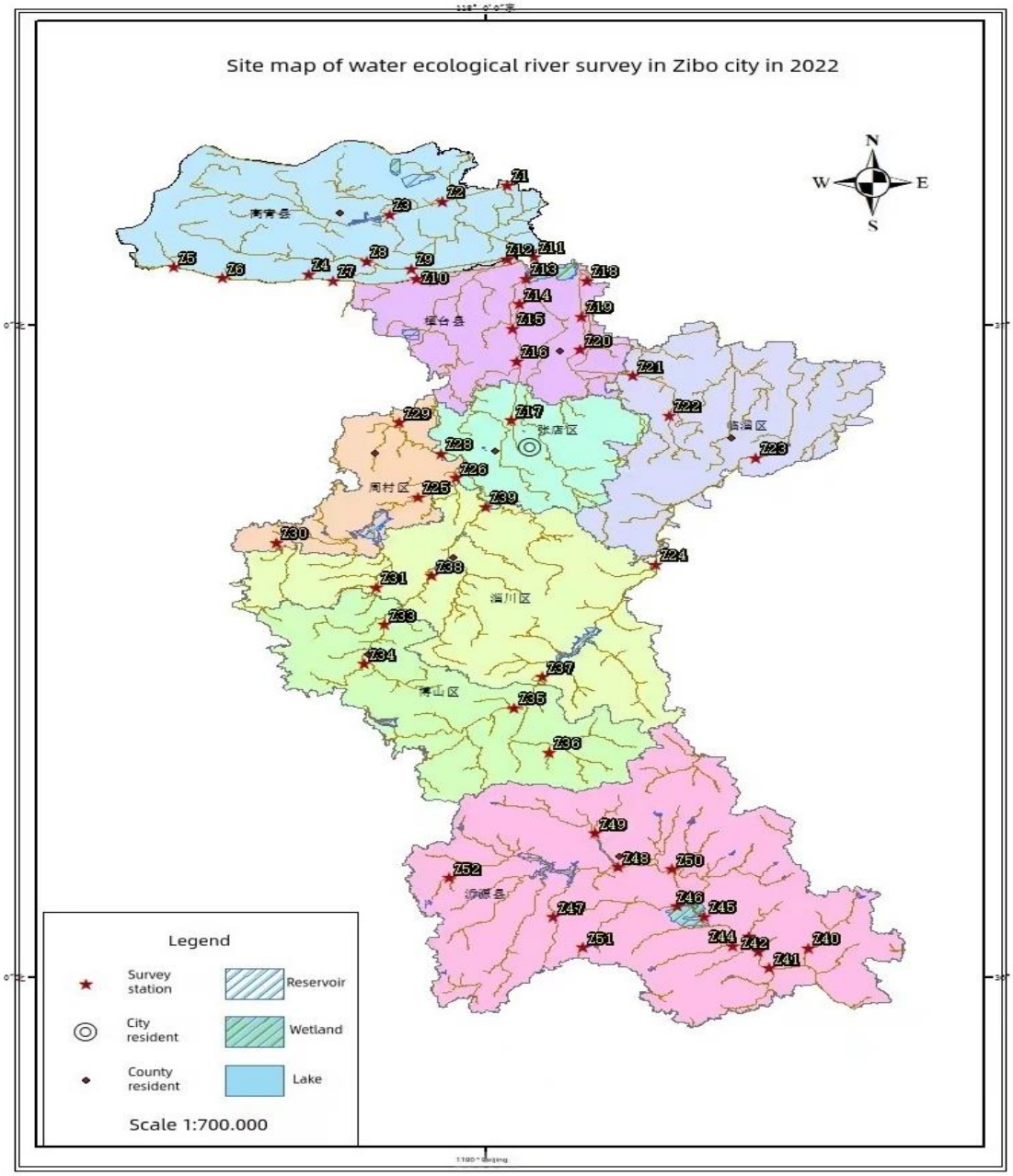

Figure 1. Site map of water ecological river survey in Zibo city in 2022

3. SURVEY RESULTS

3.1. Composition of Zooplankton Community

By collecting plankton from nine major rivers within the country, a total of 122 species were collected from four phyla. Among them, rotifers are the most abundant, with a total of 77 species, accounting for 63%; Next are protozoa, with a total of 24 species, accounting for 20%; There are a total of 11 species of cladocerans, accounting for 9%; There are 10 species of copepods, accounting for 8% (Figure 2).

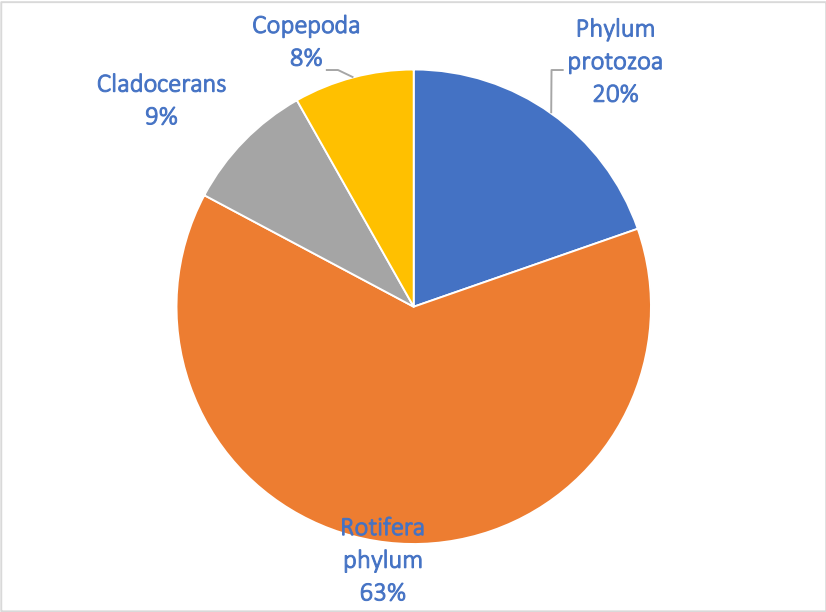

Figure 2. Distribution of Zooplankton Species in Rivers

From the composition of planktonic animal communities, the common species of planktonic animals in the Zibo River are nauplii, crown sand shell beetle, rose rotifer, and calyx arm tail rotifer, with frequencies of 38, 29, 29, and 28 occurrences, respectively; The dominant species of zooplankton in the Zibo River are Nauplius larva, Brachionus calyciflorus, Keratella valga, and Brachionus angularis (Table 1)

Table 1. Dominant and Common Species of Zooplankton

Type	Latin name	Dominance	Frequency/%
Rotifer	Rotifer		
Rose rotife	Philodinaroseola		100
Rotifer Brachionus	Brachionuscalyciflorus	0.632	100
Gondola Brachionus	Brachionusangularis	0.081	100
Rectangular arm-tailed Rotifer	Brzchionus leydigi		80
Pot-shaped arm-tail Rotifer	Brachionusurceus	0.035	100
Square arm-tailed Rotifer	Brachyonusquadridentatus		100
Rotifer with curved legs	Keratellavalga	0.060	100
Border plate tortoise shell Rotifer	Keratellaticinensis		60
Vesicular Rotifer	Monostylabulla		50
Rotifer of anterior node	Asplanchnapriodonta		100
Needle cluster multi-limb Rotifer	Polyarthratrigla		100
Nauplius	Nauplius larva	0.021	80
Foot flexure	Copepods		
Larva	Nauplius		80

3.2. Density and biomass of planktonic animals

According to the identification results of zooplankton density in Zibo City (Figure 3), the density of zooplankton rotifers is the highest, accounting for 72% of the total density of zooplankton surveyed; The density of copepod planktonic animals ranks second, accounting for 21% of the total density of surveyed planktonic animals; The density of protozoa and zooplankton ranks third, accounting for 6% of the total density of zooplankton surveyed. From the distribution of zooplankton density at various stations in Zibo City (Figure 4), the density range of zooplankton at each station in Zibo City is from 1.00 to 1558.00 per liter, with an average density of 133.44 per liter. Z18 station has the highest density of zooplankton.

According to the biomass identification results of zooplankton in Zibo City (Figure 5), copepods have the highest biomass, accounting for 41% of the total biomass of zooplankton surveyed; The biomass of rotifers ranks second, accounting for 40% of the total biomass of surveyed zooplankton; The biomass of cladocerans ranks third, accounting for 19% of the total biomass of zooplankton surveyed. From the distribution of zooplankton biomass at various stations in Zibo City (Figure 6), the range of zooplankton biomass at each station in Zibo City is 0.00001-5.95679 milligrams per liter, with an average biomass of 0.4929 milligrams per liter. The Z44 station has the highest biomass of zooplankton.

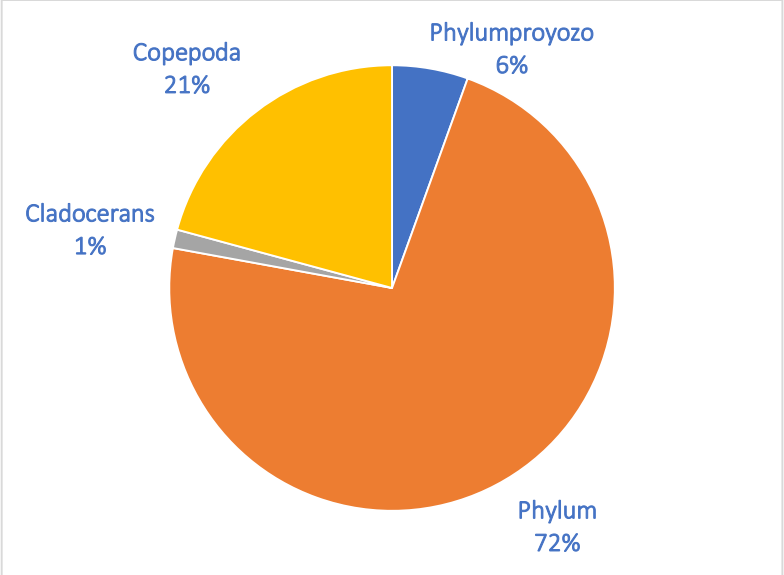

Figure 3. Distribution of Zooplankton Density in Rivers of Zibo City

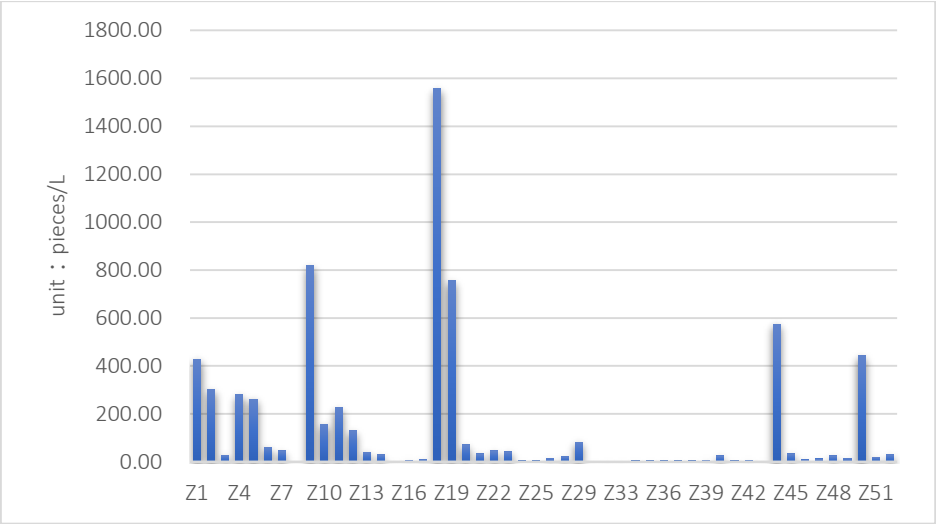

Figure 4. Density of Zooplankton at Various Points in Rivers of Zibo City

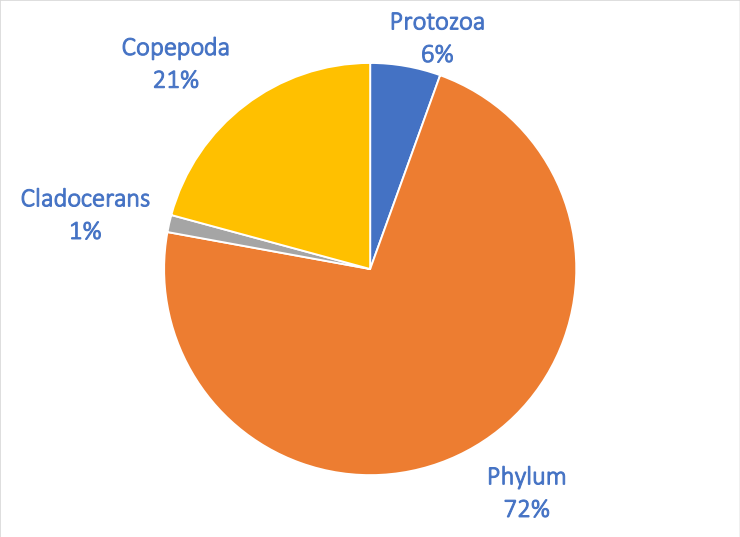

Figure 5. Distribution of Zooplankton Density in Rivers of Zibo City

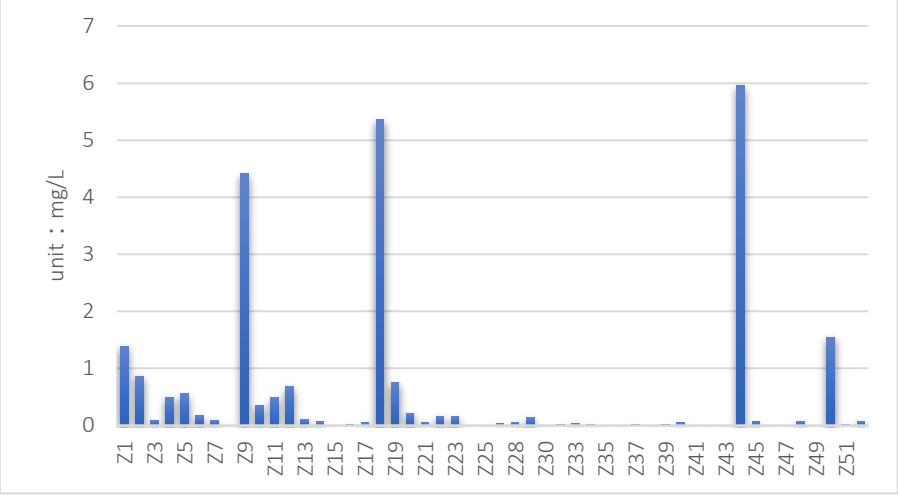

Figure 6. Biomass of Zooplankton at Various Points in Rivers of Zibo City

3.3. Diversity of planktonic animals

Through a survey of Zibo City, the average Shannon Wiener diversity index (H ') of zooplankton was 2.52, with a range of 0.92-3.63. The highest value appeared at sampling section Z48, and the lowest value appeared at sampling section Z15 (Figure 7). According to the biodiversity index water quality evaluation standard [4], the overall water quality of the Zibo section of the Xiaoqing River in autumn is in a mild pollution state.

4. ANALYSIS AND DISCUSSION

4.1. Characteristics of Zooplankton Community Structure

This survey identified 122 species of planktonic animals in the Zibo River Basin, with rotifers being the dominant species. The dominant species are mainly Brachycephalus separius, Brachycephalus angularis, Brachycephalus ampullatus, Tortoise beetle, and Rotiferus longus. Their species composition has typical characteristics of the community structure of planktonic animals in northern rivers [5]. The number of planktonic animal species is 20 more than that of the planktonic animal species in the Jinan section of the Xiaoqing River [6], but there is not much difference compared to the survey results of planktonic animal species in other lakes, reservoirs, and wetlands in Jinan [7]. The main difference in species composition is that different water bodies may inherit different biological community structures during specific periods. This survey shows that the main contributor to the density and biomass of zooplankton in the Zibo Basin is rotifers, indicating that the individual size of zooplankton tends to miniaturize and the composition structure tends to simplify, which is related to changes in the aquatic ecological environment. In aquatic ecosystems, small plankton have a short growth cycle and fast reproduction speed. Under suitable temperature and nutrient supply conditions, their large-scale reproduction inhibits the growth and reproduction of large plankton, ultimately occupying an absolute advantage in the aquatic niche [8]. The changes in the community structure and composition of planktonic animals directly reflect the environmental quality and aquatic ecological status of their living water bodies. Their community structure and dynamics are widely used as indicators of aquatic ecosystem health in various aquatic ecological research evaluations.

4.2. Diversity of Zooplankton and Water Quality Evaluation

This survey shows that the average diversity index of zooplankton in the Zibo section is 2.52, with a range of 0.92-3.63, which is relatively high overall. The spatial variation of the diversity index is not significant. According to the water quality evaluation standards for zooplankton, the water quality in Zibo is in a lightly polluted state. In 2005, Song Shangbo evaluated the water environment quality of the Zibo section as inferior to Class V by using physical and chemical indicators. The results of this survey showed a significant improvement in water quality compared to it. From the time series of water environment quality in the Zibo section, the current water quality in the Zibo section has improved compared to before 2019. This indicates that measures such as continuously strengthening hydrological connectivity, replenishing water in the Zibo basin, reducing domestic sewage discharge, and reducing human interference have played a positive role in improving the pollution situation in the Zibo section to a certain extent. The stability of biological communities is generally measured by population diversity. This article uses the Shannon Weiner diversity index to analyze and study the diversity of zooplankton in the Zibo section, which can better provide data support for the evaluation of the water ecological environment in Zibo.

4.3. The Significance Of Ecological Protection In The Zibo River Basin

To make reasonable use of the water environment in Zibo, carry out comprehensive environmental management, coordinate the relationship between humans and nature, and strive for harmonious

coexistence between humans and nature. To prevent pollution and damage to the natural environment, green mountains and clear waters are like mountains of gold and silver. Protecting the ecological environment is like protecting productivity, allowing green mountains and clear waters to fully unleash economic and social benefits, and leaving a home with blue skies, clear land, and green water for future generations. Protecting the ecological environment of Zibo is to protect people's livelihoods. There is no substitute for water ecological environment, which is difficult to survive without realizing it. The environment is a fundamental issue related to human survival and social development. Protecting the ecological environment is a cause that benefits the present and the future. The mountains, rivers, forests, fields, and lakes are a community of life. The lifeline of humans lies in the fields, the lifeline of fields lies in the water, the lifeline of water lies in the mountains, the lifeline of mountains lies in the soil, and the lifeline of soil lies in the trees. The important thing is that it is closely related to human life. Protecting the water environment of Zibo, the functions of river wetlands have been restored, biodiversity has significantly improved, and the value of water ecological services has achieved significant growth. The improvement of water environment quality provides support for the improvement of the ecological environment in the basin and also guarantees the improvement of the quality of life of the regional people. Therefore, studying the structure and diversity of aquatic communities in rivers can provide support for water ecological protection and high-quality regional development in Zibo City.

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