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Research on The Community Structure And Diversity of Zooplankton in Rutai Canal

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Abstract: *In order to find out the pollution of the Rutai River, in this paper, the community structure of zooplankton including species composition, density, and total biomass were studied in Rutai river from October 2013to September 2014.The main results show as follows: A total of 56 species were identified, including 31 Rotifera (55.4%) , 9 Cladocera (16.1%),8 Copepoda (14.3%) and 9 Protozoan(16.1%).The dominant species of the zooplankton were Brachionus calyciflorus, Anuraeopsis fissa, Asplanchna priodonala, Polyarthra trigla, Diaphanosoma brachyurum, Mesocyclops leuckarti, Bosmina longirostris, Sinocalanus dorrii and Cyclops vicinus. From the rotifer and crustacean zooplankton diversity index (H), richness (M) and evenness (J) of the conclusion of view, the water quality of the river has been in moderately polluted state.*

Keywords: *Rutai River; Zooplankton; community structure; diversity*

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I. Introduction

Zooplanktons are aquatic organisms suspended in water. It has a wide variety of species, including primitive animals, coelenterates, rotifers, crustaceans, etc., and some of the higher species of tailed animals. Protozoa, rotifera, cladocera and copepod are important components of zooplankton. They are no swimming ability, or swimming ability weak, and can't be long-distance movement or not enough to resist the flow of water [1].The changes of zooplankton community structure and species diversity can be used to monitor and evaluate the degree of water pollution, which has been widely followed and applied at home and abroad [2-3]. We can use the comprehensive index of zooplankton community structure (species composition differences, the number of species changes, the number of individual changes and biomass distribution, diversity index increase or decrease) to assess the water quality and trends, and it can be analyzed by their population and the number of changes, indicators of potential, biological indicators and other indicators that can reflect the degree of eutrophication [4].Therefore, the species of zooplankton, total biomass, total abundance and dominant species can be used to analyze the health condition of the canal. It provides reference for the eutrophication governance of Rutai Canal and the surrounding ecological environment restoration.

II. Research Area And Methods

A. *Research area*

In combination with the natural condition of the water in the survey area, there are three sampling points in each section and one sampling point is set in each section, which is named RT01(32°08'44.3"N 119°55'22.0"E), RT02(32°09'01.6"N 119°56'17.3"E), RT03(32°09'06.2"N 119°56'39.4"E).

B. *Research program*

Sampling

Qualitative collection of protozoan and rotifers: with 25th plankton on the selected sampling point from the water meter to the water below the 30 cm, do "∞" type repeatedly drag and drop, the dragging time for 3-5 minutes. Then slowly lift the net, open the valve into the specimen bottle, label it, and add 4% formaldehyde to fix it immediately.The qualitative collection of zooplankton: with 13rd plankton on the selected sampling point from the water meter to the water below the 30 cm, do "∞" type repeatedly drag and drop, the dragging time for 3-5 minutes. Then slowly lift the net, open the valve into the specimen bottle, label it, and add 4% formaldehyde to fix it immediately. Quantitative collection of zooplankton: use 5L water sampler to collect 20L mixed water samples and 25 mesh plankton net to filter, and then use 4% formaldehyde solution to fix immediately.Quantitative collection of protozoa and rotifers: 2 L sampler was used to take the surface layer (underwater 0.5 meters), the middle and the bottom (0.5 meters away from the bottom) mixed water samples 2L, and the sample was mixed with water

sample, then the sample fixed by 4% formaldehyde. Shake into the 1000ml cylindrical separately funnel and shake it again after standing for 3h in order to easy easily stick wall body to sink to the bottom of the insect, then continue to settle for 24 hours, with a small siphon suction layer of supernatant until the zooplankton sediment volume less than 100 ml, unscrew the pistons in the 100 ml scale specimens of glass bottles, and then with a little supernatant fluid flushing the funnel 1 to 3 times, together put into the bottle, the capacity to 30 ml again.

Species identification

The water sample was made into a temporary patch and placed under the microscope for species observation and identification. Original animal identification refers to Levine (1980) [5]; the identification of rotifers is based on "China's freshwater rotifer"[6]; the identification of cladocera is based on the "Chinese animal Chronicles freshwater cladocera "; the identification of copepods is mainly based on the "Chinese animal records • freshwater copepods"[7].

Data Statistics

The rotifer count is to fully shake the concentrated water sample, and then use 1000 mu l to draw 1 ml into the 1 ml counting frame, covering the cover glass, and then counting the whole slice in a 10 x 10 or 10 x 20 magnifications. Each sample counts 2 pieces, when the two pieces of error exceed 15%, the count of the third slice shall be counted and the mean value shall be taken. The biomass of rotifers is determined by volume method. Cladocerans and copepods samples concentrated liquid all count under the microscope, and the average body length of each species was measured, and the body weight was calculated according to the body weight regression equation. Nauplii each was calculated by 0.00295mg.

Evaluation methods

Dominant species evaluation method

The dominant species is the dominant species in the community, which includes the largest number of groups in each layer, the largest in volume, and the greatest environmental impact.

Diversity index evaluation method

Shannon-Wiener diversity index (H)： $H' = -\sum Pi\ (\log_2 Pi)$; Margalef richness index (M)：D=（S-1）/lnN; Evenness index (J)： $J = H' / \log_2 S$ [8]

III. Results and Analysis

A. *Community structure of zooplankton*

Species composition

A total of 56 species of zooplankton were obtained from qualitative survey, including 9 species of protozoa, and 16.1% of the total population; the rotifer 31 species, accounting for 55.4% of the total; 9 species of scallop crustaceans, accounting for 16.1% of the total; copepods 8 species, accounting for 14.3% of the total. Rotifers are the richest, accounting for more than half of the total number of zooplankton. The distribution is shown in table 1.

Table 1 zooplankton distribution in the Rutai Canal

NO.	Species	Sampling point			Occurrence Frequency
		RT01	RT02	RT03	
	Sarcodina				
1	*Arcella discoides*	+	+		+
	Ciliata				
2	*Dileptus* sp.	+			+
3	*Acineta quadripatita*	+			+
4	*Vorticella* sp.	+	+		+
5	*Epistylis* sp.	+			+
6	*Leprotintinnus fluviatile*	+	+	+	+
7	*Strombidinopsiasis*	+	+	+	+
8	*Tintinnopsis wangi*			+	+
9	*Tintinnopsis kiangsuensis*	+	+	+	+
	Rotifera				
	Philodinidae				
10	*Rotaria neptunia*	+	+		
	Barchionidae				
11	*Brachionus angularis*	+	+	+	++
12	*Brachionus calyciflorus*	+	+	+	+++

13	*Brachionus forficula*	+			+
14	*Brachionus capsuliflorus*	+	+	+	+
15	*Brachionus plicatilis*	+	+	+	++
16	*Brachionus budapestiensis*	+	+	+	++
17	*Brachionus leydigi*		+	+	
18	*Brachionus falcatus*	+	+	+	++
19	*Brachionus caudatus*	+	+	+	++
20	*Brachionus diversicornis*	+	+	+	++
21	*Platyias quadricornis*			+	+
22	*Platyias militaris*			+	+
23	*Anuraeopsis fissa*	+	+	+	+++
24	*Keratella cochlearis*		+		+
25	*Keratella valga*	+	+	+	++
	Lecanidae				
26	*Lecanee ungulata*	+	+		+
27	*Monostyla unguitata*	+			+
	Asplancchnidae				
28	*Asplanchna priodonala*	+	+	+	+++
29	*Asplanchna girodi*		+	+	++
	Trichocercidae				
30	*Trichocerca pusilla*	+	+		+
31	*Trichocerca similis*			+	+
32	*Trichocerca roussele ti*	+			+
	Synchaetidae				
33	*Polyarthra trigla*	+	+	+	+++
34	*Synchacta pectinata*		+		+
35	*Synchacta stylata*	+	+	+	++
	Testudinellidae				
36	*Testudinella patina*	+	+	+	++
37	*Filinia longisela*		+	+	++
38	*Filinia maior*	+	+	+	++
	Conochilidae				
39	*Conochiloides unicornis*		+		+
	Crustacea				
	Sididae				
40	*Diaphanosoma brachyurum*	+	+	+	
41	*D.leuchtenbergianu m*	+	+		
	Chydoridae				
42	*Alona eximia*	+	+	+	
	Daphniidae				
43	*Ceriodaphnia cornut a*				
44	*Scapholeberis mucronata*	+	+		
	Bosminidae				
45	*Bosmina coregoni*		+		
46	*Bosmina fatalis*	+			
47	*Bosmina longirostris*	+	+	+	
48	*Bosminopsis deitersi*	+	+		
	Centropagidae				
49	*Sinocalanus dorrii*	+	+	+	
	Pseudodiaptomidae				
50	*Schmackeria forbesi*	+	+		
	Oithonidae				
51	*Limnoithona sinensis*	+	+		
	Cyclopidae				
52	*Cyclops strenuus*		+	+	
53	*Cyclops vicinus vicinus*	+		+	
54	*Eucyclops macruroides*	+	+	+	

55	*Eucyclops serrulatus*	+	+	+	
56	*Mesocyclops leuckarti*	+	+	+	

Note：+++ dominant species ++ common species + rare species

The dominant species of zooplankton

In this survey, nine species of zooplankton (dominance ≥ 0.1) were recorded in the canal, including 4 species of rotifers, 2 types of cladoceras and 3 kinds of copepods. The dominant species of aquatic rotifers in the Rutai canal are *Brachionus calyciflorus, Anuraeopsis fissa, Asplanchna priodonala*, *Polyarthra trigla*; the dominant species of the cladocera were *Diaphanosoma brachyurum, Mesocyclops leuckarti*, and the dominant species of the copepods were *Bosmina longirostris, Sinocalanus dorrii and Cyclops vicinus.*

Density and biomass of zooplankton

The results showed that the rotifer density of the Rutai canal was the highest at No. 3 sample (RT03), reaching 1175 ind / L, followed by the sample No. 2 (RT02) of 1150 ind / L, and the lowest density was in the No. 1 Sample point (RT01), 386.67 ind / L. The biomass of rotifers is not proportional to its density, and the highest density of sample No. 3 (RT03) its biomass was 1.39 mg/L in the middle position on the biomass of the three samples. The biomass of sample size 2 (RT02) reached the maximum of 3 sample points, 2.45mg/L, and the biomass of sample size 1 (RT01) was 0.36 mg/L, and its density was the minimum of 3 samples. The reason that the rotifer density and the biomass change were not proportional should be related to the dominant species of the species. The dominant species of No.2 sample (RT02)are the asplanchna priodonta, its individual larger, the average weight 0.01674 mg. The dominant species of No.3 sample (RT03) are the *Brachionus calyciflorus* and *Anuraeopsis fissa*. Among them, the *Anuraeopsis fissa* was a small species with an average individual weight of 0.000013 mg, which is a direct cause of the decrease of the biomass of RT03 samples with the highest density of rotifers (Figure. 1).

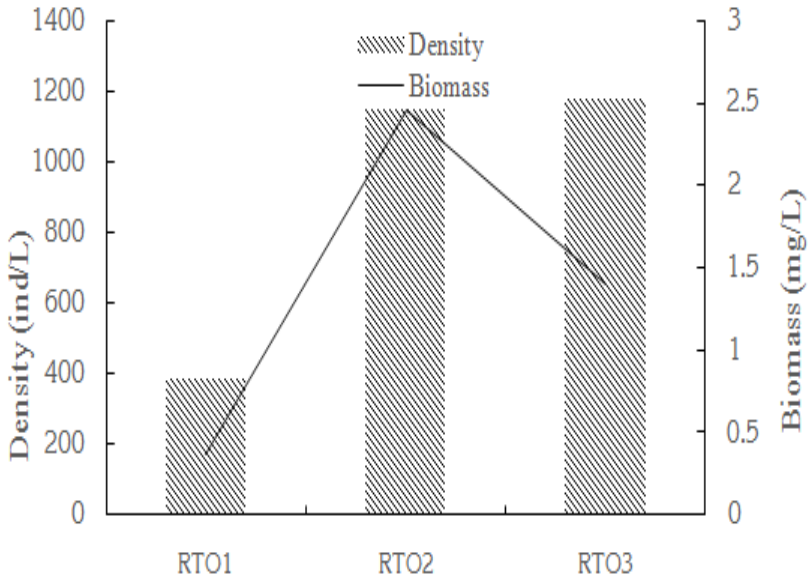

Figure 1 The density and biomass of rotifers at various points of Rutai canal

At the No. 2 sample point (RT02), the density was the highest, which was 6.1 ind/L, followed by No. 1 sample point (RT01), 4.7 ind/L, and No. 3 sample point (RT03) lowest, 2.9 ind/L. The maximum biomass is at No.1 sample point (RT01), which is 0.22 mg/L, followed by No. 3 sample point (RT03) at 0.21mg/L, and the minimum value is 0.17 mg/L at the No.2 sample point (RT02). The density of crustaceans in the water of the Rutai canal and the biomass are not positive, which should be the result of the greater density of the spherical water fleas (Figure 2).

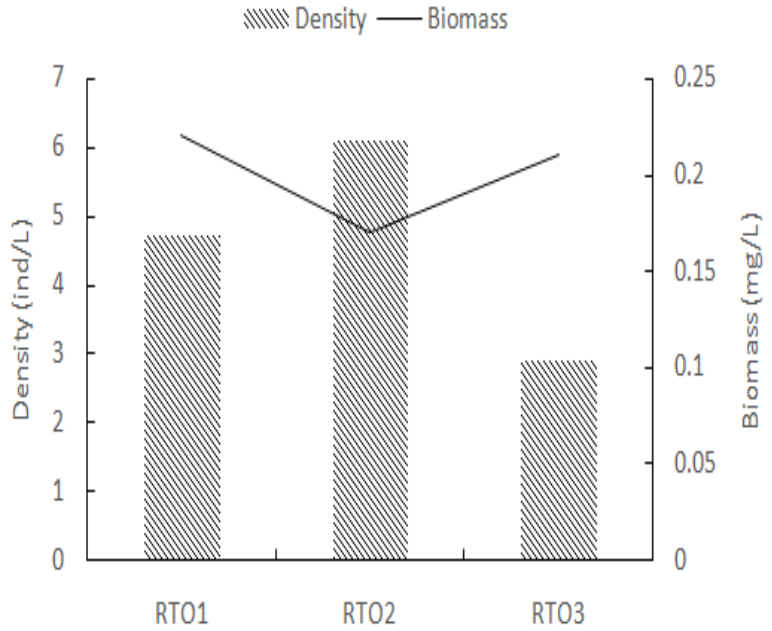

Figure 2 Density and biomass of zooplankton at various points of the Rutai canal

B. ***Analysis of protozoa functional nutrition group and water quality evaluation***

Some study found that protozoa can be divided into seven functional groups [9] (the algae - bacteria were listed single): Photosynthetic agents (group P), algae eaters (group A), rotten (group S), mushroom detritus (group B), carnivorous (group R) and non-selective omnivorous (group N). The degree of self-cultivation of clean water is high, with improvement of organic pollution in water body, heterotrophic degree increases, species number of rotten (group S)and mushroom detritus (group B) occupying the proportion of total rise as the lake nutrient levels rise. The species number of Photosynthetic agents (group P) and algae eaters (group A) occupying the proportion of total fall as the lake nutrient levels rise. In this survey, nine species of protozoa were found in the protozoa of the water of Rutai canal, among which, there are 1 type sarcodina and 8 types of ciliate. (Table 2)

Table 2 species composition and distribution of protozoa in the Rutai canal

No.	Species	functional groups	Sampling spoint		
			RT01	RT02	RT03
	Sarcodina				
1	*Arcella discoides*	A,B	+	+	
	Ciliata				
2	*Dileptus* sp.	A,B	+		
3	*Acineta quadripatita*	R	+		
4	*Vorticella* sp.	B,A	+	+	
5	*Epistylis* sp.	B,A	+		
6	*Leprotintinnus fluviatile*		+	+	+
7	*Strombidinopsiasis*	N	+	+	+
8	*Tintinnopsis wangi*	B			+
9	*Tintinnopsis kiangsuensis*	B	+	+	+

Among the protozoan of Rutai canal, there are 2 types of AB group, 1 type of N group, 1 type of R group, 2 types of B group, 2 types of BA group. It can indirectly reflect the degree of self-care in water body by investigating the number of the species. If the quality of the water is high, the number of carnivores (P group) and A group of algae will be more in the functional group of the organism. If the water quality is poor, the number of scavengers (S group) and mushroom detritus (group B) will be higher. This shows that the water of the Rutai canal has been polluted. (Figure 3)

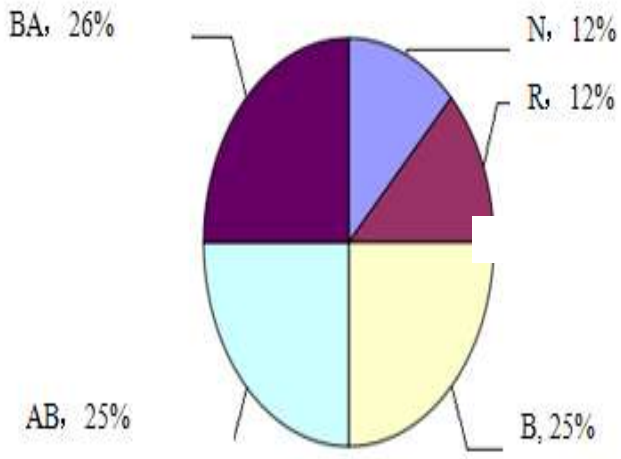

Figure 3. The functional nutritional groups of the protozoa of the Rutai canal

C. *Zooplankton diversity index and water quality evaluation*

The variation of the Shannon diversity index (H'), Pielou uniformity index (J) and Margalef abundance index (D) of the three sampling points of the Rutai canal is shown in table 3.

Table 3 changes in the diversity index of various points of water in the Rutai canal

Water quality evaluation index	RT01	RT02	RT03
H′	3.084	2.203	2.396
M	5.823	4.983	5.208
J	0.810	0.579	0.756

Zooplankton are sensitive to changes in the environment in which they live, and any change in water quality may affect the community structure, species richness, and population density of plankton. It can be seen that the quality of water bodies is very much related to the community structure, richness and biodiversity of plankton, which can be used to evaluate water quality and nutrition. In order to avoid the deviation of the results caused by the single diversity index, the water quality evaluation of Rutai canal uses three kinds of index, the Shannon-Wiener diversity index (H′), which is based on the information theory, Margalef abundance index (M),which is established by probability theory, and the evenness index (J).

Table 4 criteria for biological diversity index and water quality

diversity index	discriminant indicators				
H′	0 - 1 serious pollution	1-2 α- moderate pollution	2-3 β- moderate pollution	>3 light pollution and clean	
M	0 - 1 serious pollution	1-2 α- moderate pollution	2-3 β- moderate pollution	3-4 ignoreprobity	>4 clean water
J	0-0.3 serious pollution	0.3-0.5 moderate pollution	0.5-0.8 light pollution		

Data from the table 3 and table 4, the water body of No.1 sample point (RT01) is in clean, No. 2 (RT02) in a mild polluted state, No. 3 (RT03) in the transition state of clean water - light polluted water.

IV. Conclusion

Through the qualitative sampling of zooplankton in the canal, 56 species of zooplankton were found, including 9 species of protozoa, 31 species of rotifers, 9 species of rotiferas and 8 species of copepods. Rotifers are the most abundant, accounting for 55.4% of the total zooplankton population. From the analysis of the functional types of protozoa in the Ritai canal[10], the pathogens - the detritus (group B), the algae and the chrysanthemum (AB) and the edible fungi - BA group) have an absolute advantage, which suggests that the canal water body water quality has been a certain degree of pollution.

From the diversity index (H′), the richness index (M) and the evenness index (J) of the rotifers, planktonic crustaceans and copepods, it can be concluded that the Taihe River water body is already in moderate pollution state. Comprehensive biological evaluation: the species diversity of zooplankton in the Rutai canal is not high, and the water quality is currently in moderate pollution. The comprehensive management of water quality should be strengthed, and it is recommended to reduce the discharge of sewage, take some biological measures to strengthen the water self-purification capacity, and adjust the species structure of water species to improve water quality.

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