Scholar Publishing Group
Academic Journal of Environmental Biology
https://doi.org/10.38007/AJEB.2020.010106
ISSN 2789-8407 Vol. 1, Issue 1: 44-52

Benthic Animals and Establishment of Biological Benchmarks Based on Phytoplankton Biological Index Method

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Keywords: Planktonic Algae, Biological Index Method, Benthic Animals, Biological Benchmark

Abstract: At present, with the transformation and improvement of water environment management goals from water chemical quality to ecological quality (chemical, physical and biological comprehensive quality), it is urgent to establish a scientific method to select suitable benthic animals. Fit the characteristics of the river and create a biological reference point. The purpose of this paper is to investigate benthic animals through the phytoplankton index method and establish a biological benchmark. Correlation analysis was carried out on biological abundance and environmental factors, and the corresponding correlation coefficients were obtained. Multiple linear regression analysis was carried out on environmental factors and index groups. Different classification index groups had different interpretations of environmental variables. Among them, the highest correlation coefficient is 0.689, and its environmental factors include: pebble%, sand%, SS, urban area, and the second combination of environmental factors is pebble%, sand%, SS, DO, and the correlation coefficient is 0.631. These two sets of environmental factors had the greatest impact on species richness.

1. Introduction

The crisis of my country's water resources, especially freshwater resources, cannot be underestimated, and the important carrier of freshwater resources on the earth is rivers. Rivers provide important service functions for human society and are also one of the most vulnerable ecosystems to human activities. We are facing not only how to properly protect and sustainably use normal ecosystems, but also how to restore and rebuild degraded ecosystems [1]. In the current research on the impact of river aquatic organisms, macrobenthos are the most important research groups, because there are many types of macrobenthos, which are distributed in different river water

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bodies, and their migratory ability and life history are weak. It is relatively long and can respond to changes in ecological conditions in the region where it is located for a long time. Therefore, the screening of benthic animals and the establishment of biological benchmarks based on the phytoplankton bio-index method have strong representativeness and functionality, and will also play a leading role in the protection, restoration and management of river ecosystems [2].

VVarious studies have been carried out at home and abroad on the selection of benthic animals and the establishment of biological benchmarks by phytoplankton biological index method. Powell EN surveyed the area east of Nantucket to examine the northernmost tropical climate boundary of the Great South Strait. Types of benthic macroinvertebrate communities are described here, focusing on the impact of climate change on key environmental constraints and possible temporal homeostasis of benthic biomass. The study identified major community types. The shallow zone is dominated by wave cubes, with a large number of clams (>= 150 mm) and some common epiphytes, mainly associated with bare cube shells. Two areas at mid-depth, one dominated by market and small submarket epiphytes (<150 mm) and mussel mats and their accessory epiphytes, crabs, sea urchins and other active epiphytes from other plant sources. Cattle are the key element, creating hard ground in low-lying habitats that benefit other residents [3]. Eea B developed a benthic megafauna dynamics model to quantify the relationship between organic matter input and benthic megafauna biomass in coastal environments. The model compares the carbon content of three macrobenthos and their sediment food sources by comparing hydrodynamic-biogeochemical models of pelagic physics and biodynamics. The model reproduces with high accuracy a time series of macrofauna biomass measurements from 1993 to 2005 at two coastal sites in the Baltic Sea, one site with a significant increase in the bivalve Limecola (Macoma) balthica [4]. Rands PV investigates the genetic structure of two E. marthae populations in the San Sebastian Sea to contribute to the ongoing debate on microbial benthic biogeography. Based on 628 bp of the mitochondrial CO1 gene, we found that E. marthae displayed a low base in the São Sebastião channel (FST = 0.165) and found evidence of recent population growth [5]. It can be seen that the application of the planktonic algae biological index method to the screening of benthic animals and the establishment of biological benchmarks has certain innovative significance.

In this paper, the phytoplankton biological index method is used to analyze the selection of benthic animals and the establishment of biological benchmarks, to study the reference background values of water ecosystem protection indicators, to analyze the natural state that aquatic ecosystems can achieve, and to provide reference benchmarks for aquatic ecosystem management. It is the premise and foundation for the realization of water ecological protection. Under the circumstance of predicting the source and scope of future coercion pressure and the intensity of different human disturbances, complete the formulation of technical specifications for water ecological protection goals, and strive to form a breakthrough in the technical methods of water quality target management in my country's river basins.

2. Screening of Benthic Animals and Establishment of Biological Benchmarks Based on Phytoplankton Biological Index Method

2.1. Benthos

Benthos are groups of animals that cannot move under a body of water through a sieve with an aperture of 500 µm. Most communities live at the bottom of water bodies and are an important part of aquatic ecosystems [6-7]. According to their way of life, they can be divided into 5 types: fixed type: living on the bottom of water or on objects in water (such as stones and aquatic plants, etc.), such as leeches of the class leech; Such as polychaete nereids, etc.; burrowing type: animals that burrow into the soil or the stems and leaves of aquatic plants, such as the cylindrical water lice of the crustacean, etc.; benthic type: living on the surface of the soil underwater, can do a little work, such as gastropods. Free-living: crawling on the bottom or swimming at the water level for a period of time, such as shrimp, crustaceans [8-9].

2.2. Planktonic Algae

Planktonic algae are the main primary producers, and their ecological characteristics such as species composition, geographical structure and quantitative distribution are important indicators for evaluating the quality of the aquatic environment [10-11].

2.3. Common Methods for Establishing Water Quality Benchmarks for Aquatic Organisms

(1) Evaluation factor method

The method of dividing and multiplying the toxicity data of some sensitive organisms by the corresponding evaluation factor or deriving the water quality standard through empirical formula is called the evaluation factor method. As long as there is a small amount of data, the corresponding benchmark can be derived by using long-term empirical formulas, so it is widely used [12-13].

(2) Species sensitivity distribution curve method

According to species sensitivity theory, different organisms have different dose-response relationships to the same amount of pollutants due to differences in physiology, behavior, geographic distribution, and habitat, and follow a specific probability distribution model. Therefore, the probability distribution function can be obtained by fitting the obtained toxicity experimental data according to its frequency distribution, that is, the species sensitivity distribution model can be used to derive water quality benchmarks according to the model [14-15].

(3) Ecotoxicological model method

The ecotoxicological model is mainly used to control aquatic ecosystems from being affected by chronic toxicity, but the acute toxicity value cannot be calculated by this method because the effect time of the model is as long as one year. This method is a result of continuous improvement, mainly by investigating changes in the biomass of populations or species to assess existing ecological risks. Its main methods include models such as CASM and AQUATOX [16-17].

(4) Ranking method of toxicity percentage

It is evolved from the Species Sensitivity Distribution Curve (SSD) method. Unlike the SSD method, which is derived by mapping, the TPR is calculated through empirical formulas to derive the benchmark, while abandoning the previous definition of a single value. The method is a comprehensive and advanced method for the derivation of water quality benchmarks through statistics by considering the two values separately [18-19]. Among them, the chronic value is expressed by the reference continuous concentration CCC. In the United States, TPR, as a new milestone, promoted the establishment of the aquatic organism benchmarking system[20].

3. Experiments and Studies on the Selection of Benthic Animals and the Establishment of Biological Benchmarks Based on the Phytoplankton Biological Index Method

3.1. Calculation of Benthic Biological Evaluation Index

(1) Shannon Diversity Index

An increase in native species in an area represents an increase in community complexity based on species responses to native species diversity.

$$H = P_i \log_2 P_i \tag{1}$$

H is the Shannon diversity index, and P is the proportion of individuals of species i in all individuals.

(2) BMWP

Family-based classification, considering the presence or absence of each species in the list, considering the sensitivity value of the species, the sum of the sensitivity values of all species represents the sensitivity of the area.

$$D = 1 - \sum (N_i / N) \tag{2}$$

N; is the number of species individuals.

(3) Uniformity Index

Show the stability of the area and use the species diversity at this time to estimate the accuracy of species distribution within the area.

$$E = H / H_{\max} \tag{3}$$

H is the actual observed species diversity.

3.2. Collection and Identification of Macrobenthos Samples

For wadable rivers, 100m is selected along the river course as the survey range, and the size of the sample frame is 0.3mx0.3m. A total of 4 parallel samples were collected. The highest quality samples were collected using a D-shaped mesh (length and width 0.4 m, mesh aperture 0.4 mm), and a total of 2 samples were collected. For the more difficult river, four parallel samples were collected on the left bank, middle bank and right bank with converted Peterson dredgers. Remove the collected liquid and wash with 400 μm nylon mesh. Add 70% alcohol to a 200 ml vial for preservation. Use microscopes and dissection areas to classify, identify, and count macrobenthos in the laboratory, and attempt to identify genus or species in specimens.

3.3. Monitoring of Physical and Chemical Indicators of Water Bodies

Water temperature (Temp), pH and total dissolved solids (TDS) were measured in situ using a thermometer, pH meter and YSI multi-parameter water analyzer (professional plus). On the day of sampling, bicarbonate (HCO3-) and alkalinity (Alk) were determined by titration, and suspended solids (SS) were determined by weighing method. The 5-day biochemical oxygen demand (BOD5) was measured by the dilution inoculation method in a biochemical incubator (LRH-250) at 20℃ for 5 days; COD rapid digestion instrument (XJ-III) was used. Use a spectrophotometer (PO43-) and silicate (SiO42-). Among them, potassium persulfate oxidation spectrophotometry was used to determine total nitrogen (TN), and molybdenum antimony anti-spectrophotometry was used to determine orthophosphate (PO4-P) and total phosphorus (TP). Sulfate (SO42-), chloride (Cl-), sodium ion (Na+), magnesium ion (Mg2+) and aluminum ion (Al3+). To reduce measurement errors, the above samples were repeated twice and averaged during data analysis.

4. Analysis and Research on the Selection of Benthic Animals and the Establishment of Biological Benchmarks Based on the Phytoplankton Biological Index Method

4.1. Analysis of Indicator Taxa and Environmental Factors

In order to find the comprehensive influence of environmental factors on the species richness, BIO-ENV analysis was carried out to reflect the relationship between environmental factors and community structure. Correlation analysis was performed on biological abundance and environmental factors, and the corresponding correlation coefficients were obtained, as shown in Table 1. The top 5 combinations of environmental variables are listed in the table, and the table shows that each combination of environmental factors has different correlations to the abundance of biological species. Among them, the highest correlation coefficient is 0.689, and its environmental factors include: pebbles%, sand%, SS, urbanland, and the second environmental factor combination is pebbles%, sand%, SS, DO, and its correlation coefficient is 0.631. These two groups of environmental factors have a greater impact on species richness.

Table 1. Indicative taxa and environmental factors

Number of Variables	Correlation p	V ariables Selections
1	0.689	1,2,6,7,9
2	0.631	1,5,6
3	0.594	1,2,4,5
4	0.584	1,3,4,6
5	0.563	1,2,6,7

Multiple linear regression analysis was carried out on the environmental factors and indicator groups, and different classification indicator groups had different interpretations of environmental variables. The regression model can be seen in Table 2. The variable pebbles% is important for all indicator groups and is included in all regression models; the variable sand is second most important, and four of the six regression models include this variable. Other variables such as DO, TN, mean flow velocity, etc. are also linearly related to species richness of taxonomic groups.

Table 2. Multiple linear regression models indicating taxa and environmental factors

Taxonomic group	R^2	F	P
All taxa	0.635	25.413	0.0005
Diptera	0.458	26.458	0.0006
Chironomidae	0.487	24.331	0.0008
Ephemeroptera	0.498	23.564	0.0007

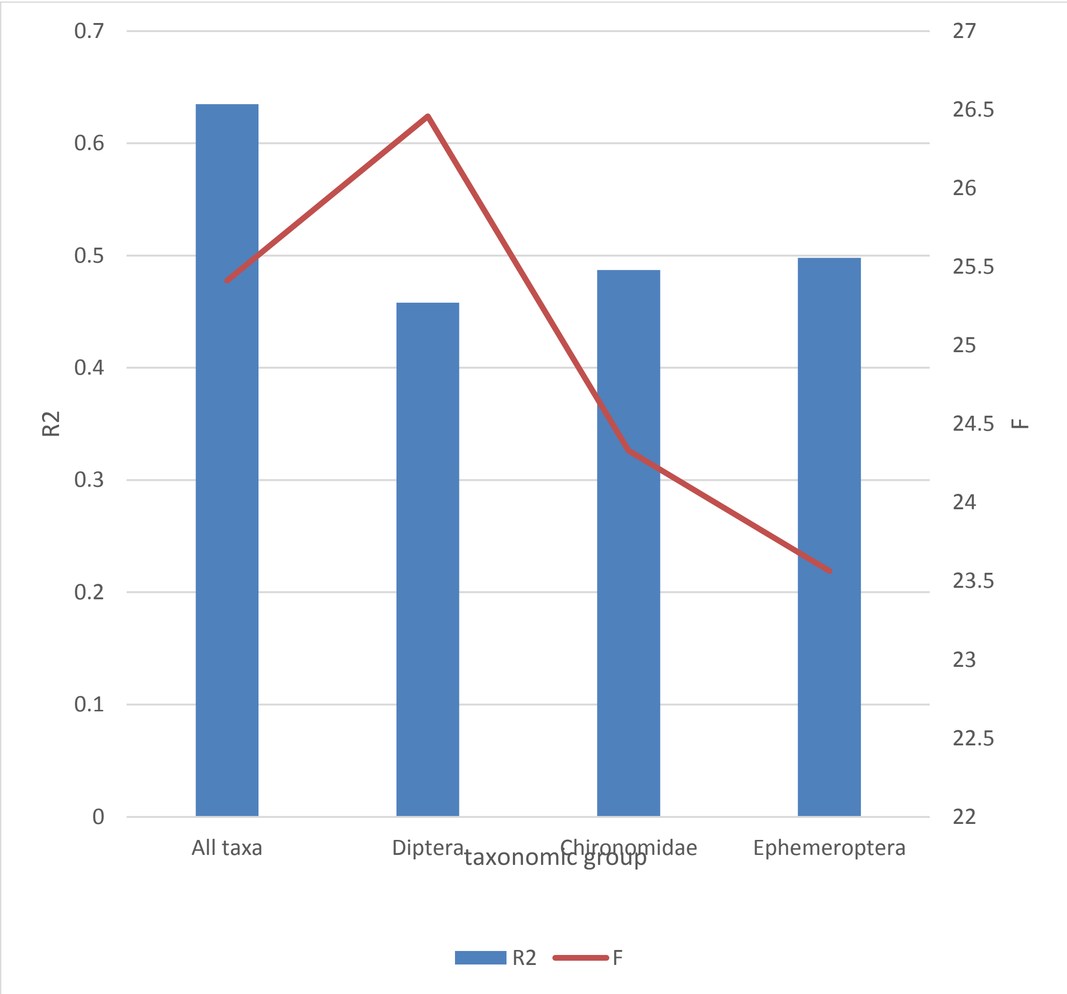

Figure 1. Regression models indicating taxa and environmental factors

According to Figure 1, the P values in the linear regression model of the index group and environmental factors are both less than 0.01, showing significance; the value of R2 shows that the linear regression relationship is good, all greater than 0.5.

4.2. Reference Continuous Concentration

In general, CCC takes the minimum value of FCV, FPV and FRV. However, in general, low-concentration ammonia nitrogen is a nutrient for aquatic plants, and there is basically no enrichment in organisms. Therefore, the ammonia nitrogen benchmark Take the FCV value directly from the continuous concentration of CCC, and get the reference continuous concentration of 2.569 mgTAN/L when the water temperature is 18 ℃ and pH is 6.0, which is 73.4% less than the minimum chronic toxicity value. From this, the formula of CCC about pH and temperature is obtained. The coefficient is 0.245. The specific expression is shown in formula (4).

$$CCC = 0.245 \times \left(\frac{0.0278}{1+10^{7.688-pH}} + \frac{1.1994}{1+10^{pH-7.688}}\right) \times MIN[12.188, 12.188 \times 10^{0.028 \times (20-T)}] \quad (4)$$

In the formula; T is the temperature of the water body (℃); the CCC value under different water quality conditions can be calculated using the above formula, as shown in Table 3.

Table 3. CCC values of ammonia nitrogen at different temperatures and pH values

	5	10	20	30
7.0	2.897	2.954	2.915	1.541
7.5	2.145	2.235	2.154	1.243
8.0	1.198	1.197	1.189	0.635
8.5	0.524	0.542	0.564	0.345
9.0	0.225	0.225	0.225	0.145

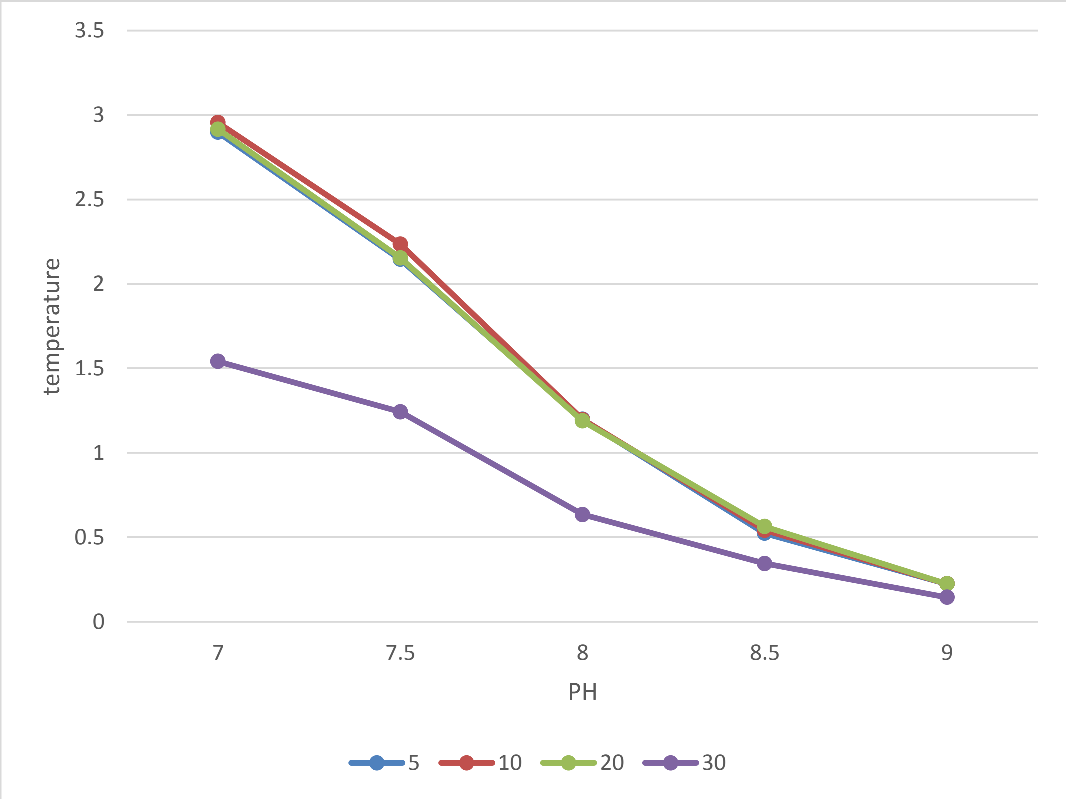

Figure 2. Line chart of CCC values

Figure 2 shows the line graph of the CCC value change of ammonia nitrogen under different temperature and pH conditions. On the one hand, the higher the PH index, the smaller the CCC value; on the other hand, the higher the temperature, the larger the CCC value.

5. Conclusion

This paper studies the selection of benthic animals and the establishment of biological benchmarks based on the phytoplankton biological index method. First, the analysis of aquatic organisms in water can provide reference for the reference research of water pollution organisms in water; second, acute and chronic ammonia nitrogen for juvenile fish Poisoning experiments to understand the toxicity. Basic information on the toxicity of ammonia nitrogen to aquatic organisms; Finally, studying the effects of ammonia nitrogen on aquatic organisms in Qinglu River can provide data support for the scientific management of ammonia nitrogen in Qinglu River. Provide data support for reference research on aquatic organisms in different periods and different regions;

Provide scientific support for scientific and rational protection of watershed water resources and aquatic ecosystem health.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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