Temporal and spatial patterns of macrozoobenthos community structure in the yellow river estuary: under the pressure of water and sediment regulation and natural environmental variables seasonal variation

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Abstract: The community structure of aquatic organisms is quite different in different rivers. The corresponding community structure will be formed in various ecological processes of different spatial scales. The existence of species is the result of the comprehensive influence of local environmental characteristics and geographical factors. Therefore, we can effectively predict the functions of various biological indicators according to environmental changes. Firstly, this paper analyses the methods of detecting the community structure of Macrobenthos in the Yellow River estuary. Then, the temporal and spatial patterns of water and sediment regulation and seasonal variation are analyzed.

1. Introduction

Benthic animals have the following characteristics, including weak activity, relatively stable life, environmental sensitivity and so on. Therefore, benthic fauna have always been the main research object to indicate the change of ecological environment caused by human disturbance. At present, a lot of research work has been done on the community structure and diversity of benthic animals and their roles in ecosystems. Estuary area is a special ecosystem with fast evolution and complex disturbance, which leads to the change of time and space of living organisms with the change of environment. The Yellow River is the largest river in northern China. Over the years, huge quantities of fresh water, sediment and various nutrients have been imported into the ocean. Therefore, the estuary area has formed an ecological environment suitable for the growth and development of marine organisms. Since the 1980s, the ecological environment of the Yellow River Estuary and its adjacent sea areas has been seriously threatened by various reasons, including the sharp decrease of runoff inflow, the erosion and siltation of the estuary, the development and construction of oil fields, the increase of aquaculture and fishing intensity, and so on. Based on the actual situation of marine ecological environment in China, the State Oceanic Administration organized and established the ecological monitoring area of the Yellow River Estuary in 2004, covering an area of about 2600 km². Based on the survey data of macrobenthos at 18 stations near the Yellow River Estuary from 2010 to 2015, the species, quantity, diversity index and dominant species of Macrobenthos in this area were analyzed.

2. Materials and methods

2.1 Sampling method for community composition

The sampling data of macrobenthos from 18 stations were used in this paper. Sampling area is 0.05 M² with HNM mud collector. Samples are sampled 3 to 5 times at each station. Samples are screened with
0.5 mm mesh. Sample processing, preservation and counting are all operated in accordance with the Code for Marine Investigation.

2.2 Sampling method of water and sediment regulation sea area
Sampling methods were used to investigate 18 monitoring stations in the Yellow River estuary area before (June 16-18), during (July 4-6) and after (July 16-19) water and sediment regulation in 2015. The survey ranges from 37 degrees 40’N to 38 degrees 09’N, 119 degrees 00’E to 119 degrees 40’E. There are four sections, including section I (including stations B1, C1 and D1) 5 km from the sea entrance, section II (including stations A2, B2, C2, D2 and E2) 10 km from the sea entrance, section III (including stations A3, B3, C3, D3 and E3) 20 km from the sea entrance, and section IV (including stations A4, B4, C4, D4 and E4) 40 km from the sea entrance. Details are shown in Figure 1.

Figure 1: Distribution of Yellow River Estuary Monitoring Station

3. Composition of macrobenthos community in the yellow river estuary

3.1 Biomass distribution
The annual variation range of macrobenthos biomass in the Yellow River estuary is 5.36-11.22g/m², averaging 7.425g/m². Details are shown in Table 1. There are many species of polychaetes in the past years, but most of them are small individuals, and their biomass is low. Molluscs and crustaceans are dominant benthic biomass groups in the waters near the Yellow River estuary. At the same time, there is a large proportion of echinoderms in the sea area, which leads to a higher proportion of echinoderms.

| Year | Min | Max | Average | Polychaetes | Mollusks | Crustaceans | Echinoderms | Others |
|------|-----|-----|---------|-------------|----------|-------------|-------------|--------|
| 2010 | 0.17| 48.79| 5.36 | 15.73 | 44.54 | 9.03 | 11.24 | 19.47 |
| 2014 | 0.03| 140.45| 8.94 | 4.51 | 20.06 | 11.66 | 8.09 | 55.70 |
| 2012 | 0.24| 32.95| 6.39 | 5.70 | 31.79 | 12.92 | 16.59 | 33.01 |
| 2013 | 0.07| 31.65| 6.49 | 10.80 | 14.11 | 36.12 | 23.63 | 15.35 |
| 2014 | 0.12| 64.04| 11.22 | 8.16 | 35.36 | 23.63 | 19.32 | 13.54 |
| 2015 | 0.06| 69.02| 6.15 | 1.11 | 13.01 | 13.65 | 31.61 | 40.64 |

3.2 Abundance distribution
The annual variation of abundance ranged from 37.4 to 766.7 ind./m², averaging 220.863 ind./m². Details are shown in Table 2. The proportion of polychaetes, crustaceans and mollusks in abundance composition varies greatly. Crustacean abundance dominated in previous surveys, followed by polychaete.
Table 2: Abundance and composition of Macrobenthos in the Yellow River Estuary

| Min | Max   | Average | Polychaetes | Mollusks | Crustaceans | Echinoderms | Others |
|-----|-------|---------|-------------|----------|-------------|-------------|--------|
| 10  | 10.20 | 766.70  | 4.59        | 67.41    | 15.44       | 0.11        | 12.47  |
| 11  | 6.80  | 165.75  | 56.95       | 34.60    | 15.30       | 35.60       | 2.10   | 12.41  |
| 12  | 20.40 | 234.60  | 62.05       | 28.90    | 10.20       | 44.52       | 3.68   | 12.71  |
| 13  | 3.40  | 180.20  | 37.40       | 30.01    | 20.06       | 33.29       | 4.51   | 12.35  |
| 14  | 17.85 | 274.55  | 86.70       | 36.98    | 5.95        | 44.94       | 2.10   | 10.04  |
| 15  | 5.95  | 4216.85 | 315.35      | 0.68     | 11.56       | 79.28       | 9.87   | -1.39  |

4. Ecological characteristics of macrobenthos

4.1 Effects of water and sediment regulation on macrobenthos

118 species of macrobenthos belonging to 7 phyla and 86 families were identified in this survey. 73 species, 72 species and 85 species were found before, during and after the regulation of water and sediment. The average biomass was (4.31 ± 1.43), (5.57 ± 3.85) and (4.04 ± 1.38) g/m², respectively. The habitat densities were (241 ± 59), (173 ± 44) and (199 ± 40) ind. / m², respectively. There was no significant difference in biomass and habitat density among the three surveys, P > 0.05. The biomass of section I and IV fluctuated greatly during the regulation of water and sediment. Among them, the biomass of section I increased continuously in water and sediment regulation, while that of section IV only increased sharply in E4 station, but there was no significant difference in the whole, P > 0.05. For habitat density, section III showed a continuous decrease. However, the other sections increased in the later stage of water and sediment regulation. Before water and sediment regulation, the habitat density of section I, II and section III was significantly different, P < 0.05. After the regulation of water and sediment, the differences of section I and IV are significant, P < 0.05, as shown in Figure 2.

4.2 Seasonal variation of macrozoobenthos community

The density and biomass of macrobenthos show some differences in different seasons. Winter is higher, spring is next, and summer is lower, as shown in Figure 3. The biomass was higher in winter and spring, but lower in summer and autumn, as shown in Figure 4.
5. Conclusions
The spatial and temporal distribution patterns of bio-community structure may be affected by the changes of aquatic and sedimentary environments. Although the estuary environment is complex and changeable, the factors affecting benthic organisms are also different. However, the relationship between Macrobenthos Community and environmental factors is basically the same in estuary area. Silty clay, clayey silt and silt are the main types of surface sediment in the waters near the Yellow River Estuary, and they are distributed in most of the investigated areas. In this investigation, water and sediment regulation and extreme changes will affect the Macrobenthos Community Structure in the Yellow River estuary. Generally speaking, the changes of water depth and salinity in the sea area far from the estuary are on the rise, while the median sediment size decreases. The sea area of the Yellow River Estuary is flat, the hydrodynamic environment is relatively stable, and the tidal current velocity is mainly affected by the water depth. The sediment transport of the Yellow River and the diversion of tidal water by the headland formed by the old Yellow River estuary will also cause the vertical change of the sediment types in the Yellow River estuary.

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