Characteristics of Benthos communities in Laoting area of Hebei Province

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Abstract. According to a survey of benthos in the Laoting sea area of Hebei Province on May 24th 2019, a total of 40 benthos species were obtained, of which mollusks have the largest number, followed by annelids and arthropods. The dominant species are *Sternaspis sculata* and *Ringicula doliaris*. The number of species obtained in this survey is much lower than the historical average. The diversity index is significantly lower than that in the April 2008 survey, and the evenness index and richness index have declined slightly, indicating that the benthic community structure in this sea area tends to be simplistic, stability tends to deteriorate.

1 INTRODUCTION

The species of benthos are far more than the total of macrozooplankton, fish and mammals in the water layer. They are the most species and the most complex ecological groups in the marine ecosystem. They play an important role in the material cycle and energy flow of the marine ecosystem. The range of activities of benthos is limited, and their ability to escape from adversity is poor, and they are more deeply affected by the environment [1]. It is often used as indicator organism to monitor and evaluate the quality and health of marine ecological environment [2].

Laoting is adjacent to Jingtang Port and focuses on the development of high-quality steel and Port chemical industry. Researchers have been paying close attention to the impact of industrial development in this sea area on marine ecology. This article aims to make up for the lack of historical data by investigating the types and biomass of benthic organisms to indirectly evaluate the impact of the sea area on offshore development activities.

2 MATERIALS AND METHOD

2.1 Sample collection and processing

The survey conducted on-site sampling of benthic organisms on May 24th 2019. A total of 3 monitoring sections and 20 monitoring stations were deployed on the site. The collection stations are shown in Figure 1. The technical requirements are in accordance with the "Marine Monitoring Specification" (GB17378-2007): Generally, the 0.1m^2 dredger is used for sampling, 3 times per station, and the 0.05m^2 dredger can be used in the harbor or on a boat without power equipment, 3 times per station. Then use the benthic vortex sorting device to screen the biological samples (the upper layer use 2.0 mm-5 mm mesh, the middle layer use 1.0mm mesh, and the lower layer use 0.5mm mesh). The samples were preserved with 5% formaldehyde and brought back to the laboratory for identification and analysis.

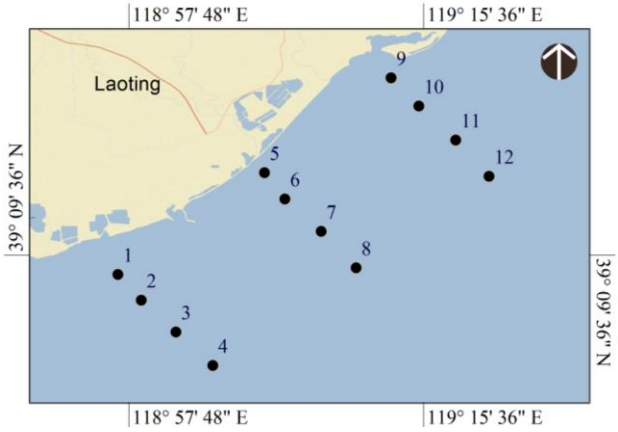

Fig. 1. Location map of benthos sampling station.

2.2 Data analysis method

2.2.1 Dominance

$$y=fi\times pi \quad (1)$$

In the formula, y is the degree of dominance, fi is the occurrence frequency of the ith in the sampling point position, pi is the proportion of the i-th species in the total number. When y>0.02, it is regarded as the dominant species.

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2.2.2 margalef's index(d) and pielou's index(J')

$$d=(S-1)/\log_2 N \quad (2)$$

$$J'=\frac{H'}{H'_{Max}}=\frac{H'}{\log_2 S} \quad (3)$$

In the formula S is the number of species, N is the total abundance, and H' is Shannon-Weiner index, $H'_{Max}=\log_2 S$.

2.2.3 Shannon-Weiner index (H')

$$H'=-\sum_{i=1}^{s} P_i \log_2 P_i \quad (4)$$

In the formula H' is Shannon-Weiner index, S is the total number of species in the sample, Pi is the ratio of the number or weight of species i to the total number of samples.

The evaluation of benthic habitat quality refers to the classification standards in "The Technical Specifications for Environmental Monitoring of Offshore Waters" (HJ 442-2008). H '≥3.0 means good habitat quality, 2.0≤H' < 3.0 means general habitat quality, 1.0≤H '< 2.0 means poor habitat quality, and H' < 1.0 means extremely poor habitat quality.

3 RESULTS AND ANALYSIS

3.1 Species composition

A total of 40 species of benthic organisms were collected in this survey (Table 1.), belonging to 4 phyla, namely echinoderms, mollusks, arthropods and annelids. Among them, Mollusks are the most common species, accounting for 42.5% of benthos; 11 species of annelids, accounting for 27.5%; 11 species of arthropods, accounting for 27.5%; 1 species of echinoderm, accounting for 2.5%. The species composition of benthic organisms in Laoting sea area is shown in Figure 2.

Table 1. List of Benthic Species

Serial number	Classification	Latin name
1	Annelid	*Neanthes succinea*
2		*Nephtys* sp.
3		*Glycera chirori*
4		*Aonides oxycephala*
5		*Sternaspis sculata*
6		*Aricidea(Aricidea) fragilis*
7		*Poecilochaetus serpens*
8		*Lepidonotus* sp.
9		*Heteromastus filiformis*
10		*Cirratulus cirratus*
11		*Capitella capotata*
12	Mollusk	*Crassispira pseudoprinciplts*
13		*Eocylichna braunsi*
14		*Neverita didyma*
15		*Ringicula doliaris*
16		*Nassarius dealbatus*
17		*Mitrella bella*
18		*Musculista senhausia*
19		*Donax kiusiuensis*
20		*Theora fragilis*
21		*Endopleura lubrica*
22		*Moerella* sp.
23		*Cycladicama tsuchi*
24		*Dosinia japonica*
25		*Ruditapes philippinarum*
26		*Moerella jedoensis*
27		*Siphonodentalium japoncium*
28		*Philine kinglipini*
29	Arthropod	*Ampelisca cyclops*
30		Melitidae sp.
31		*Ampelisca* sp.
32		*Alpheus japonicus*
33		*Leptochela gracilis*
34		*Xenophthalmus pinnotheroides*
35		*Corophium major*
36		*Philyra pisum*
37		*Iphinoe tenera*
38		*Caprellidae* sp.
39		*Diastylis tricincta*
40	Echinoderm	*Amphioplus japonicus*

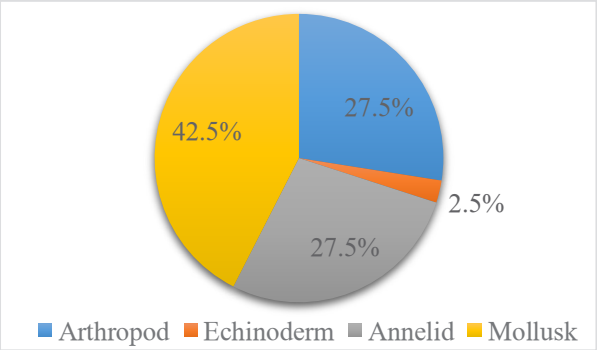

Fig. 2. Composition of Benthic Species in Laoting Sea Area.

3.2 Biomass composition and distribution

The benthic biomass of each station in the surveyed sea area varies from 0.35 to 60.77g/m^2, with an average of 9.21g/m^2. The benthic biomass composition of the surveyed sea area is dominated by mollusks, accounting for 85.47% of the total biomass. The highest value of benthic biomass appeared in Station 10, and the lowest value appeared in Station 7. The biomass composition of benthic organisms in Laoting sea area is shown in Figure 3. The biomass distribution of benthos in Laoting sea area is shown in Figure 4.

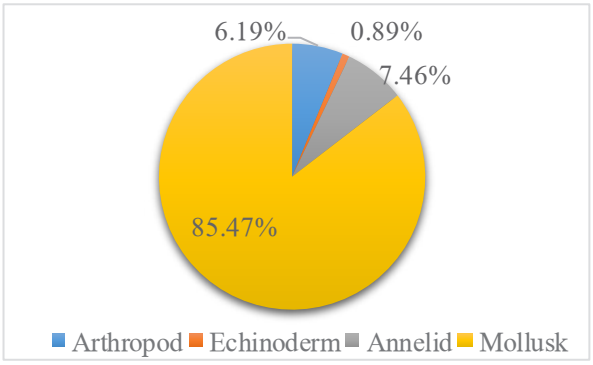

Fig. 3. Biomass composition of benthic organisms in Laoting sea area.

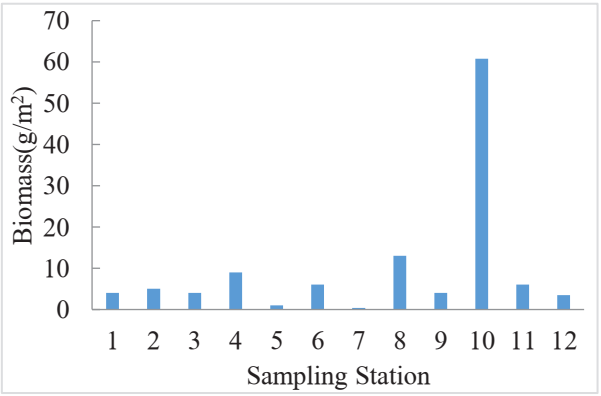

Fig. 4. Plane distribution of benthic biomass in Laoting sea area.

3.3 Density composition and distribution

The density of benthic organisms in the surveyed seas ranges from 32 to 292 ind./m^2, with an average of 105 ind./m^2. The surveyed sea area is dominated by mollusks, accounting for 51.43% of the total density. The second is annelid, which is 20.27% of the total density. The highest value of the density distribution of benthic organisms appeared at station 4, and the lowest value appeared at station 2. The density composition of benthic organisms in Laoting sea area is shown in Figure 5. The density distribution of benthos in Laoting sea area is shown in Figure 6.

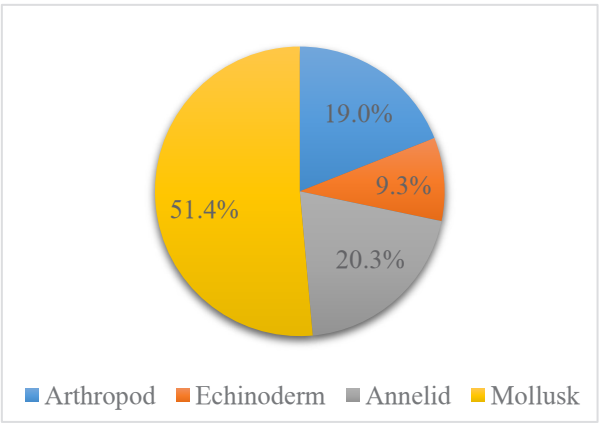

Fig. 5. Density composition of benthic organisms in Laoting sea area.

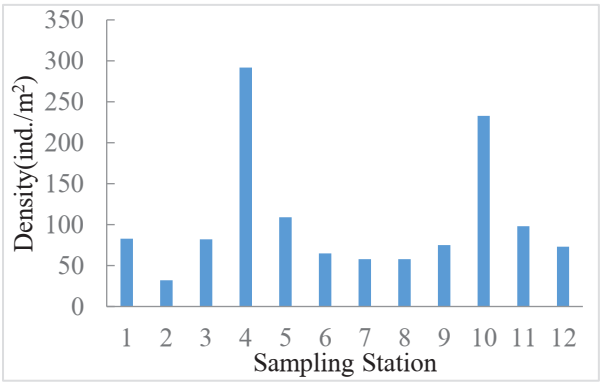

Fig. 6. Plane distribution of benthic density in Laoting sea area.

3.4 Community characteristics

Analysis with PRIMER6.0 software, the community index of benthic biodiversity at each station is shown in Table 2. The benthic biodiversity index of each station is between 0.94 and 2.04, with an average index of 1.63. In this survey, the average diversity index of benthos in the surveyed sea area was lower than 2, and the benthic community structure in the sea area was poor.

The dominant species are *Sternaspis sculata* (y=0.06), *Ringicula doliaris* (y=0.03), *Moerella jedoensis* (y=0.02) and *Amphioplus japonicus* (y=0.02).

Table 2. Index of benthic community characteristics in the surveyed sea area

Station number	d	J	H′
1	0.68	0.78	1.08
2	0.87	1.00	1.39
3	1.59	0.97	2.01
4	1.59	0.86	1.98
5	1.49	0.97	2.02
6	1.44	0.98	1.90
7	0.99	0.96	1.54
8	0.99	0.96	1.54
9	1.16	0.96	1.73
10	0.92	0.53	0.94
11	1.09	0.74	1.33
12	1.63	0.98	2.04

4 DISCUSS

4.1 Benthic community composition

A total of 40 species of benthic organisms were obtained in this survey, of which mollusks are the most, with a total of 17 species, accounting for 42.5% of the benthic species composition; 11 species of annelids and arthropods, each accounting for 27.5% of the benthic species composition. Historical surveys of the Bohai Bay have shown that there are about a hundred species of

benthos, such as 122 species in 1983[3], 128 species in 2013, and 143 species in 2014[4]. The results of this survey are far lower than the historical average. This may be due to the insufficient coverage of the survey, or it may be that the number of biological populations has declined due to excessive development and utilization in recent years.

Zhou ran [5] reported that the relationship between benthos and environmental factors in Bohai Bay was large, and it was significantly negatively correlated with water depth. With the decrease of water depth, the species of benthos increased correspondingly. In this survey, the average water depth of the nearshore is 6.5 meters, and the average water depth of the farthest end is 18.6 meters. A section near the north is consistent with the reported law. The other two sections are contrary to the report. The field survey belongs to the bathing area or artificial breeding area. It can be seen that human intervention has a great impact on the benthic environment. The influence of topography and hydrodynamic conditions on the benthic population structure needs more in-depth research.

4.2 Benthic community characteristics and dominant species

A survey of benthic animals was conducted at 21 stations in the coastal waters of the Bohai Bay in April 2008 [6]. The average total habitat density of benthic animals in the survey area was 228.8 per m^2, and the average total biomass was 36.03 g/m^2, the average benthic diversity index is 2.99, the average richness index is 1.71, and the average evenness index is 0.84. The diversity index of the surveyed sea area (mean value 1.63) was significantly lower than that of the April 2008 survey, and the evenness index and richness index decreased slightly, indicating that the benthic community structure in the sea area tends to be simplistic and its stability tends to be poor. It has been reported [7] that lower values of species number, density, biomass, and diversity index are concentrated in the most severely disturbed areas such as main estuaries, estuaries and ports. This survey supports this view.

The community structure of benthic organisms is closely related to the structure of the seafloor. Among them, hard substrate groups and biomass are more, mainly filter-feeding fragile marine ecosystem groups, and soft sediments are mainly sediment eaters. Mollusks and annelids with short life cycles are the main areas in this survey, which account for 51.43% and 20.27% respectively. *Sternaspis sculata* and *Ringicula doliaris* are the main dominant species in this survey, and their dominance is 0.06 and 0.03 respectively, of which *Sternaspis sculata* is a typical organism with fine sediments. Similar to the 2017 survey [8], the dominant species are *Moerella iridescens* and *Sternaspis sculata*. The traditional benthic species of larger individuals, such as echinoderms and bivalves, have been rarely found, and have been replaced by smaller individual mollusks and annelids, showing miniaturization and low quality. It is inferred that the benthic community structure in this sea area is relatively fragile. In recent years, affected by human activities, the benthic community structure in the Bohai Sea has changed.

In recent decades, due to coastal engineering, chemical and domestic pollutant discharge, and aquaculture, the structure of many marine ecosystems has undergone major changes. Although coastal areas have obvious ecological and economic importance, they lack in-depth and systematic research. Foreign research shows that benthic communities show significant structural changes, and the sensitivity of marine polychaete species to water temperature rise has decreased.

There is growing evidence that the seaward continental slope ecosystem is one of the major reservoirs of benthic marine biodiversity [9]. We need to increase research on benthic biodiversity and latitude, vertical and depth patterns, and improve our understanding of the biodiversity, drivers and mechanisms of its potential loss in the topography of open slopes at continental margins.

5 CONCLUSIONS

Based on the investigation of macrobenthos in the Laoting sea area of Hebei Province on May 24th 2019. 40 species of benthos were found, of which 17 species were found in mollusk, accounting for 42.5% of the species composition, next are Annelid and arthropod. The biomass varied from 0.35 g/m^2 to 60.77g/m^2 with an average of 9.21 g/m^2. The biological density varied from 32 to 292 $ind./m^2$, with an average of 105 $ind./m^2$. The biodiversity index ranged from 0.94 to 2.04, and the average index was 1.63. The dominant species in this study were *Sternaspis sculata* and *Ringicula doliaris*, and their dominance was 0.06 and 0.03, respectively.

Compared with the historical data, the number of benthos species in this survey was low, and the benthic diversity index, evenness index and richness index decreased slightly. The structure of benthic community tends to be unitary and its stability tends to be poor. Marine exploitation activities in the Laoting sea area are the main reason for this trend.

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