Antarctic Research, Vol. 4, No. 1, 42～49, June 1993

COMMUNITY ANALYSIS OF SHALLOW SEA BENTHOS IN GREAT WALL BAY, ANTARCTICA*

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Abstract The data used in this paper were acquired at 19 quantitative dredging stations and 4 trawling stations during the three crusies of the 4th Chinese Antarctic Research Expedition for investigating the shallow sea benthos in Great Wall Bay, in the period from December 1987 to March 1988.

Based on environmental characteristics, diversity of species composition and the eveness of interspecific distribution of individuals, cluster methods were used to divide the investigated area into three benthic community distribution areas. The structures of the various communities were further divided into 3 structure types, namely, high diversity, intermediate diversity and low diversity types. From the study of the relationship between community structure and environmental factors it was pointed out that there was an extremely close relationship between benthic communities structure and the stability of the bottom types and sediments, whereas in sea areas where the depth gradient is not large, there is no obvious relationship between benthic communities structure and depth gradient.
Key words benthic community, community structure, deversity index, eveness, types of bottom (botton soil), sediments

Introduction

Great Wall Bay is a sea area which has not been subjected to human interference and up to now there have been no reports on the analysis of benthic communities in the sublitoral zone of the bay. This study is a component part of the studies on the structure of the bay ecosystems. The authors analysed the quantitative dredging and qualitative trawling data acquired in the 4th China Antarctic Research Expedition on benthic organisms of the bay from December 1987 to March 1988.

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* This project was funded by the National Natural Science Foundation of China and the State Antarctic Committee.

Materials and Methods

1. This paper sorted out mainly quantitative grabbing and qualitative trawling materials collected at 19 stations durng three cruises , and consulted the materials of diving sampling and submarine observation of the biological distribution in cooperation with Uruguay and Wu

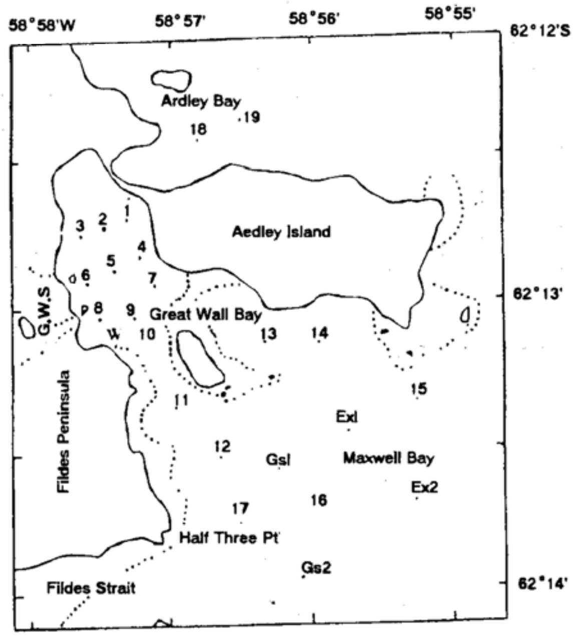

Fig. 1. Locations of sampling stations of benthos of shallow sea and Great Wall Bay during 1987—1988.

(1963)(Fig. 1).

2. Small bucket grabs (area: 0.0025m^2) were used for quantitative dredging, at each station samples were taken 1 or 2 times, the mud samples were separated and selected with a set of sieves (0.5～2mm mesh). Qualitative trawling was made by a double trawling, 3～5 minutes for each trawling according to the section within the bay with Agassiz trawl and double-blade trawls, with the actual trawled floor area of about 40m^2.

3. For the determination of the biomass of the specimens , a torsion balance with a sensitivity of 0.01 g was used. Molluscas with shells and polychaetes annelids with tubes were weighed. The shells and tubes assumed to be 1/2 of the body weight respectively.

4. The analysis of the similarities in species composition among the stations was calculated using the modified Schoener's (1968) index formula:

$$d=1-\frac{\Sigma|Xi-Yi|}{\Sigma|Xi+Yi|}$$

where Xi, Yi represents the occurrence value of the species i in the various stations

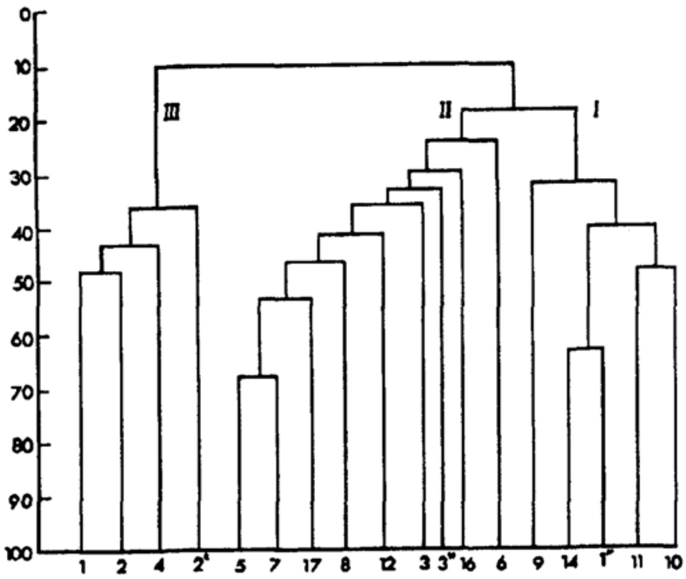

Fig. 2. Similarity cluster of species composition of benthos in shallow sea of the Great Wall Bay.

respectively. When the species and number of two stations are entirely different, than d= 0; if they are fundamentally equal, then d approaches to 1. The values of similarities of the various stations can be arranged in a matrix, then the dendrograms of the similarities among the stations were found out.

5. In addition to describing generally the various benthic communities (Jiang *et al.*, 1984, 1990; Shen, 1988), this paper adopted two indices, namely, the species diversity (H') and species homogeneity (J), to further analyse the features of the community structure (Li, 1981; Wu *et al.*, 1985). The equation for the calculation is:

$$H' = -\sum_{i}^{s} Pi \log_b Pi \quad \text{(Pielou, 1966)}$$

When $Pi \approx Ni/N$, and when using 2 as the base (b=2), the above formula is changed to

$$H = \frac{3.321928}{N}(N\log N - \sum_{i}^{s} Ni \log N)$$

where N represents the total number of specimens in the investigation: Ni represents the number of specimens of the species i;

The formula for homogeneity J is: J=H/Hmax, where Hmax is the logarithm of the species S (log S). Homogeneity is used to measure the dominant species of the information value for the various stations. When each species of that station is distributed evently, its maximum exceeds 1.

Results and Analysis

Based on the features of the many measuring stations with complete data and representation in Great Wall Bay in January 1988, results of the calculation of the similarities in species composition, the cluster model (Fig. 2) for that month was selected as the basis for demarcating the distributive area of communities. On this basis reference is made to the distributive characteristics of dominant species and characteristic species as well as the environmental characterstic. Appropriate adjustment was made to decide which category the stations belong to, with the result that the shallow sea benthic organisms in Great Wall Bay can be divided into three communities. Their inhabiting range (Fig. 3) is called as areas for short. Fig. 1 lists the composition and structural parameters of the communities of these three areas.

Area I. *Halymenia* sp. — *Distalia cylindrica* communities

This community was distributed around the nameless islands in the central part of Great Wall Bay. Its environmentaL characteristics were the bottom being constituted of rocky reef of coarse sand and gravel, and affected by tides, the transparency of the sea water and such as environment being favourable to the reproduction and growth of macroalgae and sessile animals. The benthic organisms living in this area were mainly some macroalgae, such as *Haelymnenia* sp, *Iridea obovata kuetzing*, *Gigartina papillosa Sepckell* et *GardenerM Plocamium* sp etc; the benthic animals were mainly *Distalia cylindrica*, and *Anthopleura xanthogrammica* (bevkly), which take a sessile mode of life and some amphopods which live stealthily in coarse sand gravels or alagal clumps. The characteristic species of this community were mainly *Halymenia* sp. and *Distalia cylindrica*. The structural feature of this community is that the component species are not many, but the biomass is specially large. The diversity indices being not large and the homogeneity of the distribution of individuals among the species being very small just showed that the community structure was relatively simple, and a few dominant species occupied a relatively large dominant position in quantity (Table 1).

Area II. Kidderia subquadratum Nicomache community

This community was relatively widely distributed in the southeast side of the Fildes Peninsula and the whole bay mouth area. The main environmental feature of the community was muddy silt or silty mud bottom. The community structure was quite complicated. Table 1 shows that community has the following characteristics: (1) the species number being most abundant, accounting for over 43% of the total number of the species obtained

Table 1. Community structure of shallow sea benthos in Great Wall Bay.

Serial No. of community	No. of Stations	No. of speices	Biomass g/m²	Inhabiting density ind./m²	Speices diversity H'	Eveness J	Main Species	Characteristic Species
I	5	29	114.53	2077	3.50	0.43	*Halymenia* sp. *Iridaea obovata*, *Gigartina papillosa*, *Plocamiaceae* sp., *Urticinopic antarcticus* *Spirorbis* (*Paralaeospira*) *levinseni*, *Amphipoda* spp., *distaplia cylindrica*	*Halymenia* sp. *Distalia cylindrica*
II	9	45	1057.00	2436	5.90	0.60	*Amphipoda* spp, *Laternula elliptica*, *Gastropoda*, *Kidderia subquadratum*, *Yoldia* (*Aequiyoldia*) *lights*, *Nicomache lumbricalis* *Urticinopis antarcticus* *Spirorbis* (*Paralaeospira*) *levinseni*	*Kidderia Subquadratum* *Nicomache Lumbricatus*
III	4	10	270.60	304	0.72	0.25	*Scoloplos marginatus* *Lumbrinereis* sp. *Aglaophamus* sp. *Urticinopis antacticus*	*Scoloplos marginatus* *Lumbrinereis* sp.

during the investigation of the shallow sea of Gereat Wall Bay: (2) the dominant species being less obvious than those of the preceding community, the species that are the main species listed therein are large in number, among which *Kidderia subquadratum*, *Nicomache* and Laternula elliptica are distributed relatively evenly. As the representative species of the community, their rate of occurence and the number are high; (3) viewed from the trophic types, the deposit-consuming species are predominant (accounting for 65% or so), a few are filter feeders or preying animals; (4) the calculation result of the indices of the community structure indicate that the species abundance of that community is very high, the distruibution of individuals among species is relatively uniform, the diversity index of species is maximum. These characteristics fully shows that community is relatively complicated in structure and is the one which has the highest diversity among the communities in shallow sea of Great Wall Bay.

Area III. *Scoloplos marginatue-Lumbrineries* community

This community was located at the bay top and on the left side of the bay mouth. The area of the distribution was very small, the sediments was silt or mud. Sometimes black mud occurred locally with the odor of HS. And empty tubes shells were found, indicating the unstableness of the sedimentary environment causing death of benthic organisms, and polluting the sedimentary environmnet. In three cruises for investigating there were only 10 species of benthic organisms discovered, namely, 5 species of polychaetes, 3 species of molluscs and one species for each amphiods and sea anemones. These species being few in quantity indicate that the unstableness of the environment caused the paucity of organisms in that community. Therefore it is the lowest diversity in Great Wall Bay.

The Distribution of Community in relation to the Environment

The structural characteristics of the different communities and their environmental characteristics were discussed above. Following is an extensive discussion on the structural characteristics of the various communities in relation to their environmental factors. A preliminary analysis shows that the structure of community is closely related to the bottom soil.

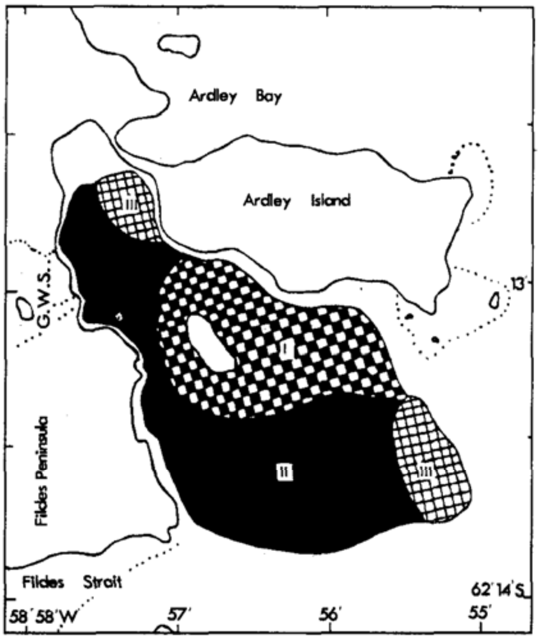

Fig. 3. Area of distribution f shallow sea benthos in the GreatWall Bay. Ⅰ. *Halymenia* sp. — *Distalia cylindrica*; Ⅱ. *Kidderia subquadratum* - *Nicomache*; Ⅲ. *Scolopos marginatue* - *Lumbrinereis*.

1. *The biomass, inhabiting density and species number of community in relation to bottom sediments*

Based on the available investigation data, the bottom sediments of Great Wall Bay can be divided into six types. i. e. silt (sludge, ooze) mud, muddy silt, silty mud, coarse sand gravels and rocky reef. According to these 6 types of bottom sediments, the results of the statistics of the biomass, inhabiting density and number of species of community composition indicate (Fig. 3); (1) the inhabiting density is the highest in coarse sand gravels and lowest in rocky reef bottom and silty bottom, which indicate that the composition of the bottom and slity bottom disfavors for propagation of benthos; (2) the biomass being the highest in rocky reef bottom indicate that the biomass of the rocky reef bottom plays an important role; (3) the number of species being most abundant in silty mud bottom, next in silty mud and coarse and gravel bottom and least in rocky reef and silt indicate that the bottom sediments with complicated composition are advantageous to the propagation of many species of benthos.

2. The major parameters of the community structure in relation to bottom sediments

Based on the six types of bottom sediments, three main parameters of the community structure were calculated: the diversity index of the species composition of the community, the index of the eveness of the distribution of the individuals among species and the size of the individuals of the species. The results indicate that the diversity index of the species composition of the community and that of the eveness of the distribution of individuals among species are relatively large in the bottoms with complicated composition; conversely, in the bottoms with simple composition, the diversity indices of the community and the eveness are both relatively small, this indicates that the complicated bottom composition is relatively advantageous to the propagation of many species of benthos; and moreover, the size of the species constituting the community is negatively correlated with the grain size of the sediments. In rocky reef zones, apart from algae and a few macro sedimentary benthos, the benthos are mainly species or small individuals.

The above results fully show that the community structure of the benthos in Great Wall Bay is very closely related to the bottom sediments. On the basis of the study on community structure in relation to bottom sediments, stations with completely identical bottom types were selected to exclude the factor of bottom sediments, and the relationship between the depth of sea area and the community structure of benthos was studied. The results indicated that there is not any relationship between the two. This has given as an enlightenment that there is no practical significance to study the relation of distribution of benthos to the depth in the sea where depth gradient is not large.

Discussions and Conclusions

1. The shallow sea benthic communities in Great Wall Bay and in the Fildes Peninsula can ben divided into three distributive area: Area I, *Halymenia* sp. — *Distalia cylindrica* community; Area Ⅱ, *Kidderia subquadratum-Nichomache* community; Area Ⅲ, *Scoloplos marginatue- lumbrinereis*. Based on their environmental characteristics, the communities can be groupes as hard bottom communities and soft bottom communities, and on the basis of the stability of their bottom sediments and their obvious difference in the characteristics of community structures the soft bottom communities can be further divided into two structural types, i. e. high diversity type ($H' > 5$) and low deversity ($H' < 1$) type.

Area Ⅰ, i. e. hard bottom comminities. The benthos were mainly some macroalgae and ones taking the sedentary mode of life. The community has highest biomass and belongs to the intermediate diverity(H=3—4).

Area Ⅱ, i. e. high diverity community. The benthos was mainly composed of animalswith the greatest number of species and also the muddy silt. *Kidderia subquadratum* and *Nicomache*; and *Laternula elliptica* were the characteristic species of the community.

Area Ⅲ, i. e. low diversity community. The benthos was poor in species composition. The bottom consisted of oozy mud, the environment of the sediments was unstable, or siltation and erosion caused death of organisms. Empty tubes or empty shells were often found locally.

2. A close relationship exists between the benthic community structure and the characteristics of the marine environment in Great Wall Bay (Rauschert, 1984). The investigation results indicate that the community structure is most closely related to the characteristics of marine environment. The biomass was highest in hard bottom soil; the inhibiting density and species number were highest in bottom soil with complicated composition; the diversity index of the species composition of the communities and the homogeneity index of the interspecific distribution of individuals were all largest in bottom soil with complicated composition. All this shows that the complicated composition of the bottom soil is an important factor constituting the complex structure of the benthic community structure. The size of individuals correlated negatively with the grain size of the sediments, apart from the algae and a few sessile macroalgae, the study on the distribution of benthos in relation to depth gradient has no practical significance; and there is no obvious relationship between benthic community structure and distribution in Great Wall Bay with the depth gradient of sea areas (Zhou and Zhang, 1989; Wu *et al.*, 1981).

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