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A STUDY ON THE QUANTITY OF SHALLOW SEA BENTHOS IN GREAT WALL BAY, ANTARCTICA*

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Abstract Based on the investigation material acquired during the three cruises of the 4 Chinese Antarctic Research Expedition at 19 quantitative dredging stations and 4 trawling stations from the period December 1987 to March 1988, this paper studies the quantity of the benthos in Great Wall Bay, the distributive characteristics and variations, and points out that the stock number of the benthos in the bay is extremely large and that there are two large ranged high mass area and 2 －3 low small-ranged mass area. The instability of the sediments is the cause for the low mass areas. The warm season is the vigorous reproductive period of the various kinds of the benthos and the monthly variation of the quantity is remarkable.

Key words Great Wall Bay, benthos, quantity, biomass, density of habitation.

Introduction

Great Wall Bay is located east of King George Island, the Fildes Peninsula. The Ardley Island (Penguin Island) is on the left of the Bay and the Nameless Island at the center of the bay mouth forms two outlet lanes. So the Bay is a semi-enclosed shallow water type inner bay. From March to November is winter in which June to November is the freezing period (Qin, 1991), and from December to March the warm season. The monthly mean air temperature ranges from －12～6.1℃; the monthly mean precipitation from 5.9～106.1mm; the length of day in winter (March－September) is 8.9～48.5h/month. In about early December, when the sea water temperature rises to 0.5 ～ 1℃, the coastal ice melts and the antarctic warm season begins to set in. Silt predominate in the bay sediments, but silty mud, mudly silt, coarse sand and gravel are also present. With the natural ecological condition in the sublittoral zone kept intact, Great Wall Bay is a background environment

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that has not been subjected to human interference.

Studies on benthic ecology in the sublittoral zone of Great Wall Bay have not been reported as yet. During the warm antarctic season from December 1987 to March 1988 the 4th Chinese Antarctic Research Expedition conducted quantitative grabbing and qualititative trawling during the investigations of the sublittoral benthic organisms. Altogether 19 quantitative grabbing stations and 8 qualitative trawling stations were deployed (Huang and Wu, 1992) and over 300 specimens obtained. This paper describes the quantitative composition, distribution and variations of the benthos of that bay.

Materials and Methods

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

2. Small bucket grabs (area: 0.0025 m^2) were used for quantitative dredging, at each station samples were taken 1 or 2 times, the mud samples were separated and selected through a set of sieves (0.5 — 2mm mesh). Qualitative trawling was made by trawling twice, 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 sensitively of 0.01g was used. Molluscans with shells and polychaetous annelids with tubes were weighed, the shells and tubes assumed to be 1/2 of the body weight respectively.

Quantitative Composition and Variation of Benthos

1. Composition of Total Quantity

According to the analyses of materials for 3 months of investigation, the results show that the stock number of the benthos of Great Wall Bay was extremely large, exceeding that of most of the sea areas outside Antarctica. The total biomass averaged 955.92g/m^2 with an average inhabiting density of 1757 ind./m^2 which was ten to thirty times that of the tropical and subtropical shallow waters and also 2.5 — 13 times higher (Jiang *et al.*, 1990) as compared with that of Daya Bay of China with relatively high biomass.

The total biomass and inhabiting density of the benthos of Great Wall Bay are shown respectively in Fig. 1 and Fig. 2. Obviously, the benthos of the sea area was composed mainly of polychaetous annelids, molluscans, crustaceans, echinoderms, coelenterates and algae. But the composition of the biomass is somewhat different from that of the inhabiting density : the biomass was composed mainly of that of the molluscans, polychaetes and macroalgae which was dominant over February. In the case of the inhabiting density, the

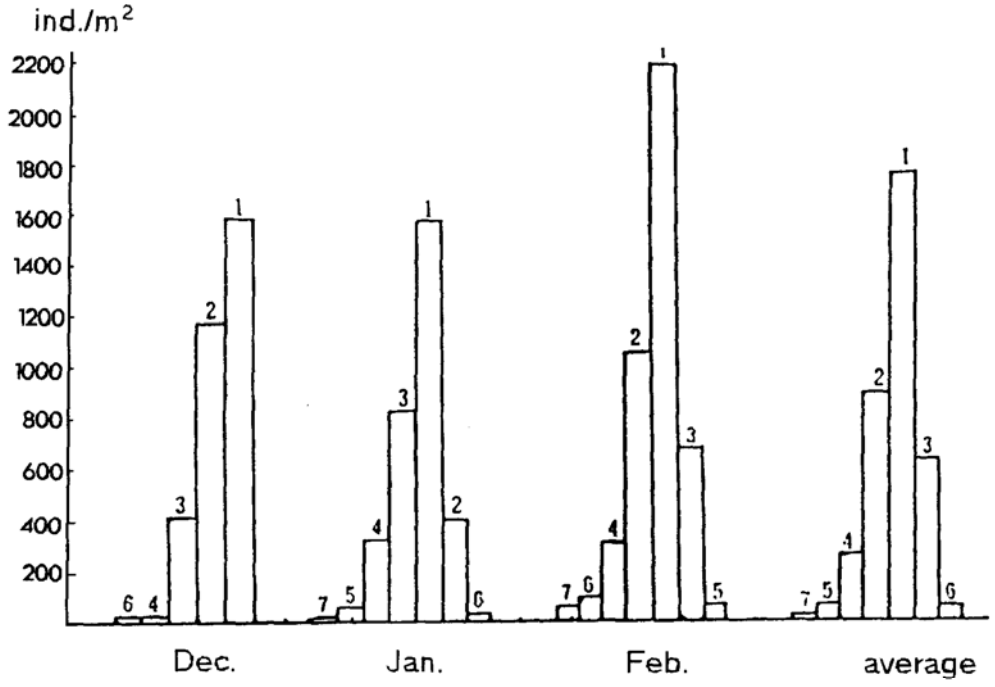

Fig. 1. Composition of inhabiting density of benthos in the Great Wall Bay, Antarctica (Dec., 1987-Feb., 1988). 1: total biomass; 2. Polychaetes; 3: Molluscs; 4: Crustaceans; 5: Echinoderms; 6: Coelenterates; 7: other animals.

polychaetes, molluscans and crustaceans were dominant.

2. The quantitative composition of the main groups of the various organisms

Polychaetes: Polychaetous annelids are relatively abundant in Great Wall Bay, their inhabiting density ranking first in the composition of the total density of the benthos, averaging 869 ind./m^2, amounting to 50% of the total density: the average biomass being only second to the molluscans, averaging 188.15 g/m^2. Both the biomass and the inhabiting density have obvious seasonal variation, those in January being low. *Nicomache lumbricalis* and *Seoloples marginatus* reached over 93% in the quantitative composition of polychaetes.

Molluscans: ranked first in the total quantity, averaging 497.5 g/m^2; the inhabiting density being only next to that of polychaetes, averaging 591 ind./m^2. The seasonal variation was evident, the maximum quantity occurring in January and low level in February (Table 2). The main species were: *Laternula illiptica*, *Yoldia* (Acquigoldia) *lights* and *Kideria subquadration.*

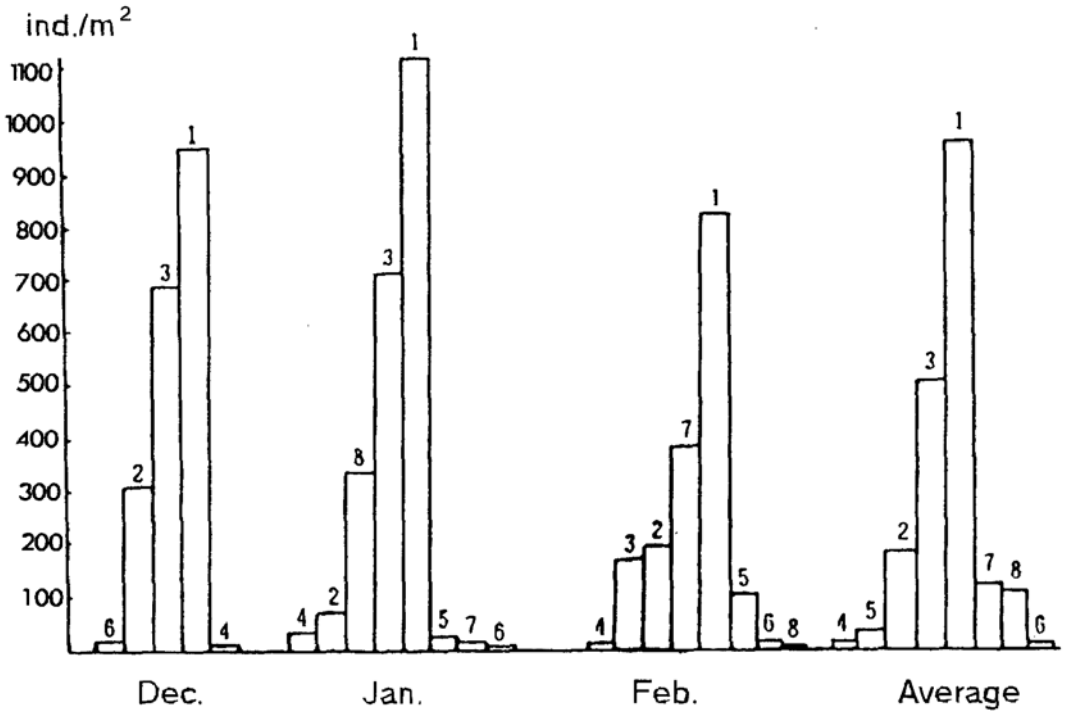

Fig. 2. Composition of biomass of benthos in the Great Wall Bay, Antarctica (Dec., 1987—Feb., 1988). 1: total biomass; 2. Polychaetes; 3: Molluscs; 4: Crustaceans; 5: Echinoderms; 6:Coelenterates; 7:Other animals; 8:Marine algae.

Table 1. Number of Polychaetes and Molluscs in the sublittoral zone of Great Wall Bay.

	Polychaeta				Mollusca			
month	12	1	2	average	12	1	2	average
Biomass(g/m²)	280.48	72.97	211.01	188.15	655.10	675.15	162.38	497.54
Inhabiting density(ind./m²)	1165	352	1091	869	353	777	642	591

Crustaceans, Macroalgae and compound tunicates: The crustaceans were small, with low biomass but with high inhabiting density, averaging 212 ind./m². They were mainly several species of amphipods. The macroalgae and compound tunicates were both sessile species on rocky seafloor or gravelly bottom. The average biomass of the seaweed of Great Wall Bay was 125.74 g/m², mainly consisting of brown, red or green algae, of which the brown algae had the maximum biomass, amounting to 64%. The main species constituting the brown algae were: *Halymenia* sp; *Desmarestia menziesii* and the red algae *Iridaca obovata*, *Gigartina papillosa* and *Plocamium* sp. The compound tunicates were mainly *Distaplia cylindrica* whose biomass reached as high as 1602.4 g/m² at one or two stations in January.

3. Quantitative variation during the warm season

During the warm season obvious seasonal variation exists in the quantity of the benthos in Great Wall Bay (Fig. 1 and 2), which characteristic is rarely seen in other sea areas. The variation in biomass set off in a short period of time is the result of the reproductive activities of the antarctic organisms themselves. The warm season of Great Wall Bay is the flourishing period of the reproductive activities of benthos, during which there is a period of variation for the birth of the new life of many benthic species and for the rapid growth and development and the death of the parents after reproduction. But the reproductive periods of different species are somewhat different from one another: Molluscans: the biomass in January produces a peak, February is the vigorous reproductive period and the biomass markedly reduces; Polychaetes: the vigorous reproductive period is in January and the biomass markedly reduces, doubly increasing in mid February and the inhabiting density increasing three times. Most prominent was the macroalgae, whose average biomass was only 7. 03 g/m^2 in January, and increased by 52 times in February with rapid growth of vegetative mass after reproduction. and reached 370. $2g/m^2$. The quantitative variations of other groups of organisms such as echinoderms, crustaceans and nemerteans were generally identical, all had somewhat reduced biomass during the vigorous reproductive period, but showed the tendency to increase rapidly soon after the growth and development of the offsprings.

The Characteristics of Quantitative Distribution of the Benthos in relation to the Sedimentary Environment

1. Distributive features

The investigation results of the three cruises indicate: the distribution of the quantity of the benthos of Great Wall Bay was very uneven, reaching the maximum of 2846 g/m^2 (5840 ind. $/m^2$) and the minimum of 4. 8 g/m^2 (40 ind. $/m^2$), which indicate that the gradient of the quantitative distribution of the benthos of Great Wall Bay was large. But the range of the low mass area was small (amounting to 20% of the stations), while that of high mass area was large (amounting to 61% of the stations). As seen from the general distribution tendency, in the aspect of inhabiting density there occurred two high density areas and two low density areas; while in the biomass there occurred only one big-ranging high biomass area and three small-ranging low biomass areas. But Station 6 and Station 8 of the nearby waters of Great Wall Bay were the highest areas of either biomass or inhabiting density (Figs. 3—6). Following is the respective description:

High density area The two areas are both located on one side of the Fildes Peninsula. But one is located at Station 6 and Station 8 of the nearby waters of Great Wall Bay. Here water depth is 4 — 9m, with silty mud bottom and relatively stable sedimentary environment, fairly poor selectivity of the sediments, highest inhabiting density of the benthos (reaching 5840 ind. $/m^2$) and also very high biomass. The benthos consisted mainly

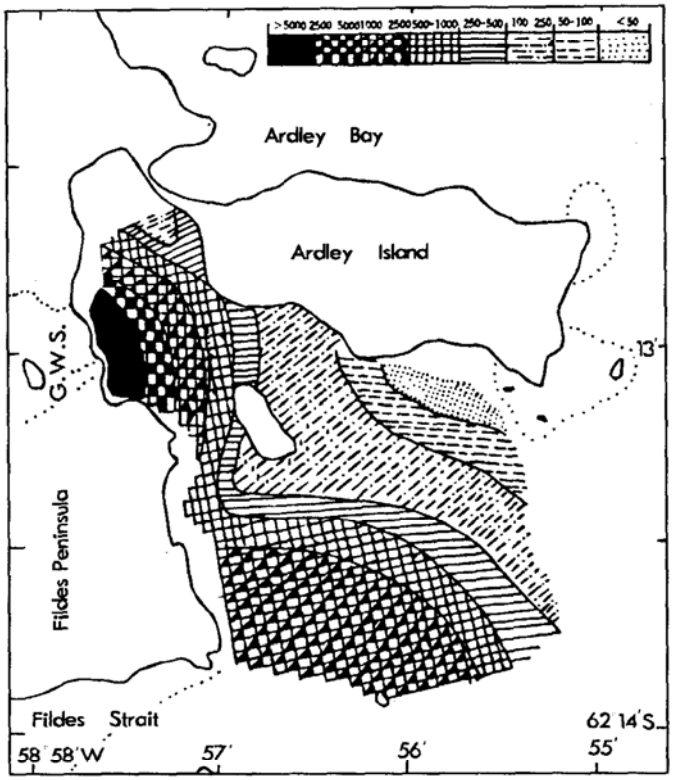

Fig. 3. Distribution of inhabiting density of benthos in Great Wall Bay (Dec. ,1987—Feb. ,1988).

of bivalves such as *Kideria subquadratum* and the polychaete *Nicomache lumbricalis*; the other high density area is located at Station 7 outside of the bay, where water is fairly deep (40—142m), with relatively stable silty mud or muddy silt and fairly poor selectivity. The benthos were mainly the molluscans such as *Laternula elliptica* and *Kederia subquadzatum* and the polychaete *Scoleplos marginatus*.

Low density area The two areas are both located on one side of Ardley Island, but one is near the bay top, the other near the bay mouth. The one near the bay mouth had a rocky bottom and mainly seaweed, few animal species and low density. The other one near the bay top had black silt with H_2S odor, thus showing that the sedimentary environment is unstable and the organisms cannot survive, and resulting in poverty of organisms. This area was also a low biomass one.

High biomass area This area occupies most parts of the waters of the investigated areas of Great Wall Bay (amounting to 61% of all the stations). The bottom sediments were complicated, consisting of muddy silt, silty mud, gravel and rocky floor. The benthos were not only abundant in species but also relatively large in quantity. The composition of the biomass of this area may be roughly divided into two types: soft facies and hard facies. The biomass of the soft facies type was mainly composed of Yoldia (Aequigoldia) lightis, *Laternula elliptica* and *Kideria subquadratum* and the polychaete *Nicomache lumbricalis* and *Scoloplos marginatus*; the hard facies type was mainly composed of the seaweed *Halymerica*

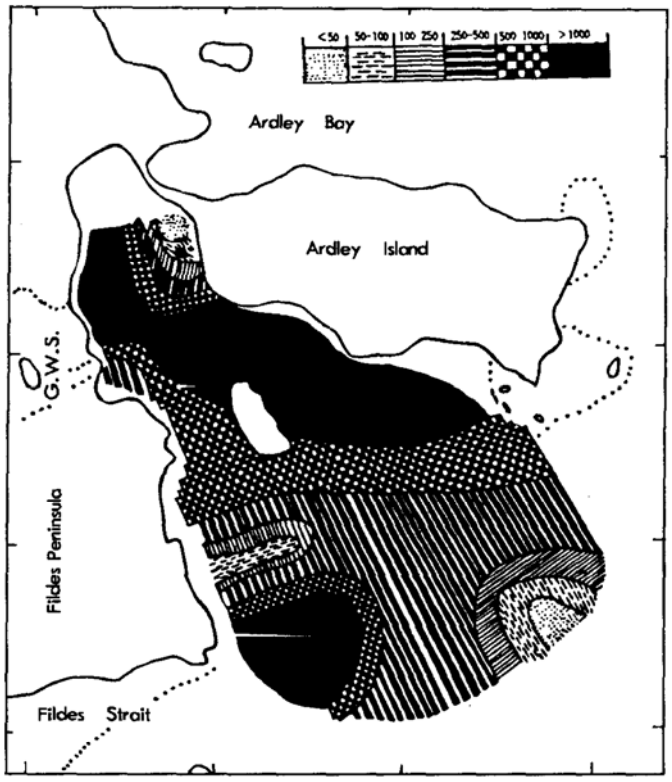

Fig. 4. Distribution of biomass of benthos in Great Wall Bay (Dec., 1987—Feb., 1988).

sp., *Desmarestia menziesii* and *Distaplia cylindrica.*

Low biomass area The ranges of the three areas were all very small. Except the area near the bay top being also low density area, the other two areas are respectively located on both sides of the water ways at the bay mouth, where water is relatively deep and dead tubes and dead shells, mud with H_2S odor were found, showing the unstableness of the sedimentary environment resulting in death of the inhabiting infaunal benthos and the occurrence of low biomass area.

2. Distribution of the Benthos in relation to the sedimentary environment

The Relation to the types of Sediments The sedimentary environment of Great Wall Bay may be roughly divided into 6 types: silty mud and muddy silt; coarse sand, gravel and rocky reef. The distribution of benthos is very closely related to the types of the sediments both in species and in quantity. The benthos taking the mode of a sessile life predominates in rocks and coarse sand and gravel, the colonies of the benthos are mainly macroalgae and compound tunicates taking the mode of a sessile life as well as the polychaetous Spirorbis and Potamilla antarctica. No species that take the mode of a sessile life were found in silty mud and muddy silt except mainly the molluscans, such as Laternula elliptica, Kideria subquadraturn, Yoldia (Aequigoldia/lightes) and the polychaete (Nicomache lumbricalis) which make their living by filtering benthic diatoms or eating organic detritus. But the

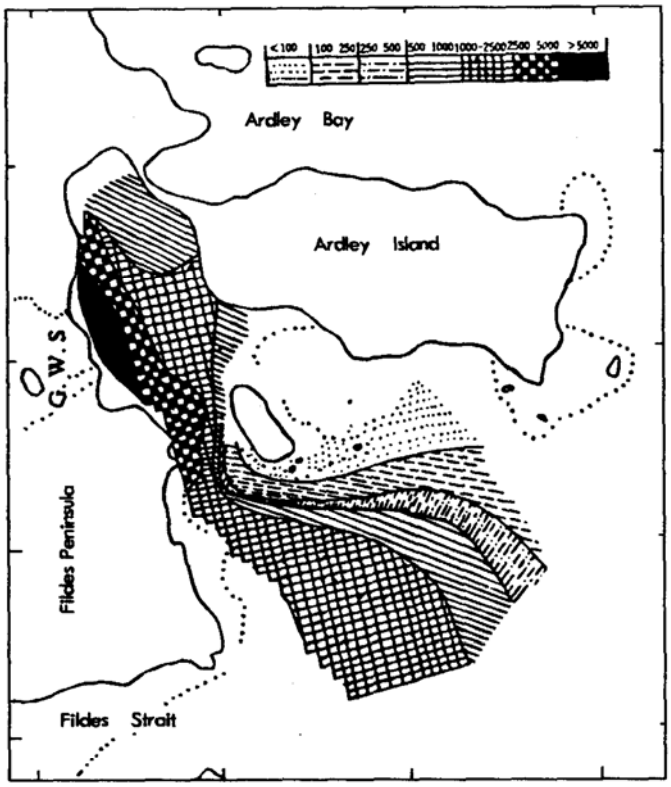

Fig. 5. Distribution of inhabiting density of benthos in Great Wall Bay in Jan., 1988.

benthos, regardless of their species and quantity, were very few in silty or muddy bottom, except mainly a few of the species which live in mud or hide deep in holes such as anemones and nemerteans.

The relation to the stability of the sedimentary environment The investigation results indicate the sedimentary environment being unstable, the organisms poor in composition and also very low in quantity. In the investigated sea area there occurred three low density areas located at the water ways and the unstableness of the sediments caused the death of organisms and pollution of the sediments with blackening and H_2S odor, which was proved by all the empty tubes and shells left.

Discussions and Concluding Remarks

1. The quantity of the benthos in Great Wall Bay is entremely large, far exceeding that in most waters outside the polar regions, with the average total biomass as high as 955.92 g/m^2, and the average inhabiting density of 1757 ind./m^2. These data are 10—30 times those of the tropic and subtropical shallow waters and also 2.5—13 times as compared with those of Daya Bay, with relatively high biomass area.

2. The proportion of the inhabiting density of the benthonic organisms in Great Wall Bay and that of their biomass were markedly different: in respect of the biomass, the

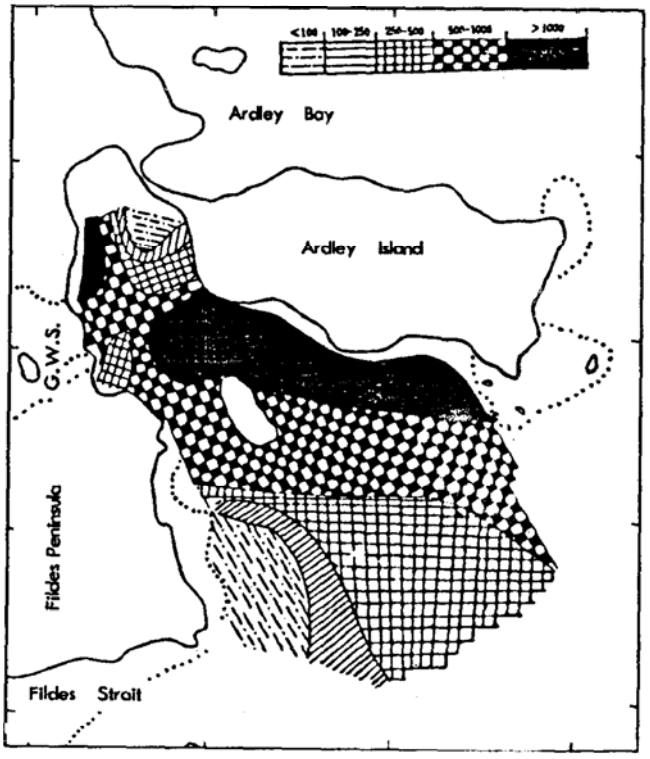

Fig. 6. Distribution of biomass of benthos in Great Wall Bay in Jan., 1988.

molluscans, polychaetes and macroalgae predominated in order of predominance; while in respect of the inhabiting density, the polychaetes, molluscans and crustaceans predominated.

The biomass of molluscans averaged 497.54 g/m^2, the inhabiting density averaged 591 ind./m^2. Monthly variations in warm season were evident; January was the peak. February was the low level. The abundance of the polychaetes was the highest, the inhabiting density averaging 869 ind./m^2 and the biomass 188.15 g/m^2. The monthly variations of the two were evident, the low level was at January. The average biomass of the macroalgae was 125.74 g/m^2, composed mainly of the biomasses of brown algae (amounting to 64%), red algae and green algae. The crustaceans averaged 212 ind./m^2, composed mainly of amphipods.

3. The quantity of the benthos of Great Wall Bay had obvious monthly variations, but the variation of biomass was different from that of inhabiting density: The biomass was at the peak in January but at the low level in February; the inhabiting density was at the low level in January and at the peak in February. This was due to the vigorous reproductive season of the various groups of animals: the reproductive season of the mollusks is during February; the macroalgae begin to reproduce in January, in February the vegetative masses rapidly grow up. Similar conditions exist in other animals. Within the vigorous reproductive period, the biomass dropped due to the death of parents after reproduction, but tended to

rise again soon after the growth and development of the offsprings.

4. Viewed from the total trend, the distribution of the quantity of the benthos of the investigated area had two large-ranged high quantity area and 2 — 3 small-ranged low quantity area. The unstableness of the sediments was the source that causes the low quantity area.

5. The distribution of the benthos of Great Wall Bay is closely related to the types of the sediments. The species that take the mode of a sessile life were found in rocks and coarse sand and gravel sediments. In muddy silt and silty mud sediments there were no species with such a mode of life except mainly the molluscs such as Laternula elliptica, Kideria subquadratun and Yoldia (Aequigaldia) lightis and the polychaete Nicomache lumbricalis predominating; whereas in silty sediments, the benthos was poor in both species and quantity except a few of the species living in muddy tubes and hiding deep in holes.

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