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Species composition and quantitative variation of zooplankton in the Great Wall Bay and its adjacent waters, Antarctica *

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Abstract A preliminary identification has been made of 35 species of the zooplankton in the Great Wall Bay and its adjacent waters, Antarctica. The dominant species in the investigated area are *Calanus propinquus*, *Calanoides acutus*, *Metrdia gerlachei* and the larvae of antarctic krill.

The results indicated that the zooplankton in the investigated waters were simple in species number, which conforms to the general pattern of the distribution of the zooplankton in antarctic waters.

The total biomass and number of individuals of the zooplankton in the investigated waters showed obvious seasonal variation. In summer there were *Calanioides acutus* and the larvae of antarctic krill; in winter there were *Metrdia gerlacher*, *Calanus propinquus*, *Oithon similis*, *O. frigda* and the larvae of antarctic krill. The quantity of Copepoda occupied a considerable proportion in each month. The water temperature is an important factor in controling the biomass of zooplankton.

Key words Great Wall Bay, zooplankton, species composition, total biomass, seasonal variation.

1 Introduction

Marine zooplankton lies in the key link in the food chain. The number of zooplankton not only reflects the magnitude of secondary productivity but also directly affects the spatial and temporal changes in fishing grounds. Therefore in fishery production as well as in marine ecological research, it is absolutely necessary to develop researches on the distribution and quantity of zooplankton.

In 1982 scientific workers of our country carried out zooplankton investigation (Huang *et al.*, 1986) in the adjacent waters of Davis Station, Antarctica, but the scope of investigation was quite limited. In January ～ February 1985 our first antarctic expedition made a cruise of investigation in the waters of the South Shetland Islands and the Bransfield Strait of Antarctic Ocean (He *et al.*, 1989). Our 1st, 2nd (November 1985 ～ February 1986) and 6th (December 1989 ～ February 1990) Antarctic Expeditions conducted investigations on zooplankton in the waters of Great Wall Station, Antarctica; and the 4th (December 1987～December 1988) and the 5th (December 1988 ～ March 1989) Expeditions conducted investigations for 13 months running on the zooplankton in the waters of the said station. Some valuable data and specimens were

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obtained which have provided basicdata for thorough research in antarctic shallow sea marine ecosystems.

2 Materials and methods

Based on the samples collected for 13 months running during the period from December 1987 to December 1988, this paper makes a general summary of the species composition, biomass and variations in the number of individuals of the zooplankton. Fig. 1 shows the sampling sites in the investigated area, the Great Wall Bay. The zooplankton samples were vertically hauled from sea bottom to the surface with large plankton nets (mouth area 0.5 m^2, length 270 cm; mesh opening 0.505 mm). During July ~ November 1988, samples were hauled vertically after breaking the ice and preserved in 5% formalin in sea water. The biomass of the zooplankton was expressed by driect weighing method (wet weight, later converted to mg/m^3). Before weighing, the jelly fishes and *Thaliacea* containing high water content were picked out from among the samples (Omori and Lkeda, 1984); the counting of the number of zooplankton (individual/100 m^3) was made microscopically.

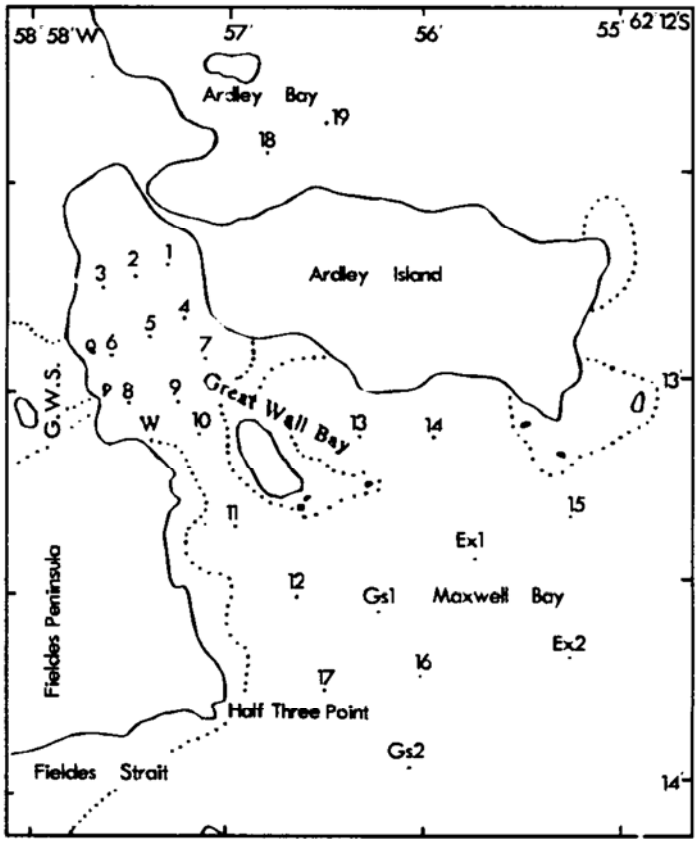

Fig. 1. Sampling sites in the Great Wall Bay.

3 Species composition

A preliminary identification was made of a total of 35 species of zooplankton, of which the jelly fishes accounted for 7 species (Zhang and Liu, 1989), copepods 18,

chaetognaths 1 (O'sullivan, 1982), pteropoda 1, krill 1, ostracod 1, tunicates 2, planktonic polychaetes 2 (Wang and Wu, 1988; Wu *et al.*, 1986), larval fish 2 (Audriashev, 1965), and larval plankton 6 kinds and juveniles 10 kinds. In addition, there are some other species which remain to be reported later.

The species composition of zooplankton in the Great Wall Bay and its adjacent waters, Antarctica was simple. In the investigated area the dominant species were the typical antarctic species of *Calanus propinquus*, *Calanoides acutus*, *Metrdia yerlachei* and *Euphausia superba*. In addition, though the antarctic species of *Othona frigada* and the eurythermal and euryhaline cosmopolitan species *Oithona simili* (Chen *et al.*, 1974) which were the species of this investigation did not form the dominant species, they were the common species in winter. *Pleurobrach* sp. occurred throughout the period from June 1988 to January 1989; in February, a fair amount of tunicates occurred on sea surface, and in most months the number of the pseudoadults of copepods which occupied a considerable proportion was especially worth mentioning; except in March when no larvae were collected, the various kinds of larvae occurred alternately in other months. Among the numbers of the individuals of planktonic larvae, the nauplius of crustacean ranked first, next came the pluteus of echinoderms and the auricularia lava of *Cucumaria attenuata*, then the trochophora of polychaetes and the fewest the veligers of gastropods. The number of planktonic larvae is related to the reproductive period of zooplankton, larval ecology and environment.

4 Seasonal variations

The zooplankton in the Great Wall Bay and its adjacent waters show obvious seasonal variations (Fig. 2).

4.1 Seasonal variations in the biomass of zooplankton

The total biomass of the zooplankton in the Great Wall Bay and its adjacent waters, Antarctica was quite high in summer (December 1987, Jan. ~Mar. 1988), the biomass for each month being more than 11 mg/m^3, and the highest one reaching 13.58 mg/m^3 in Dec. 1987. The larvae of the copepod *Calanoidis accitus* and the antarctic krill *Euphausia superba* were the main species which constituted the biomass in summer. The biomasses in July~September of winter were fairly low, all being not greater than 1.01 mg/m^3, with the lowest value of 0.38 mg/m^3 in July; in the other months of winter (April~June, October~November), the biomasses all fluctuating between 2~6.2 mg/m^3. The biomass in 13 months averaged 5.93 mg/m^3. In winter the biomass were mainly composed of the copepods *Metrdiager lacher*, *Calanus propinquus*, *Oithona similis*, *Oithona frigida* and the larvae of the antarctic krill. According to the seasonal variations in water temperature and biomass (Fig. 3), and by using binary regression to study the relation between temperature and total biomass, a correlation equation $y=6.35+2.26x$ ($R=0.747$, $n=13$, $\alpha=0.01$) was obtained. Judging from this, there is an obvious correlation between the two. In the sea area of this investigation, temperature

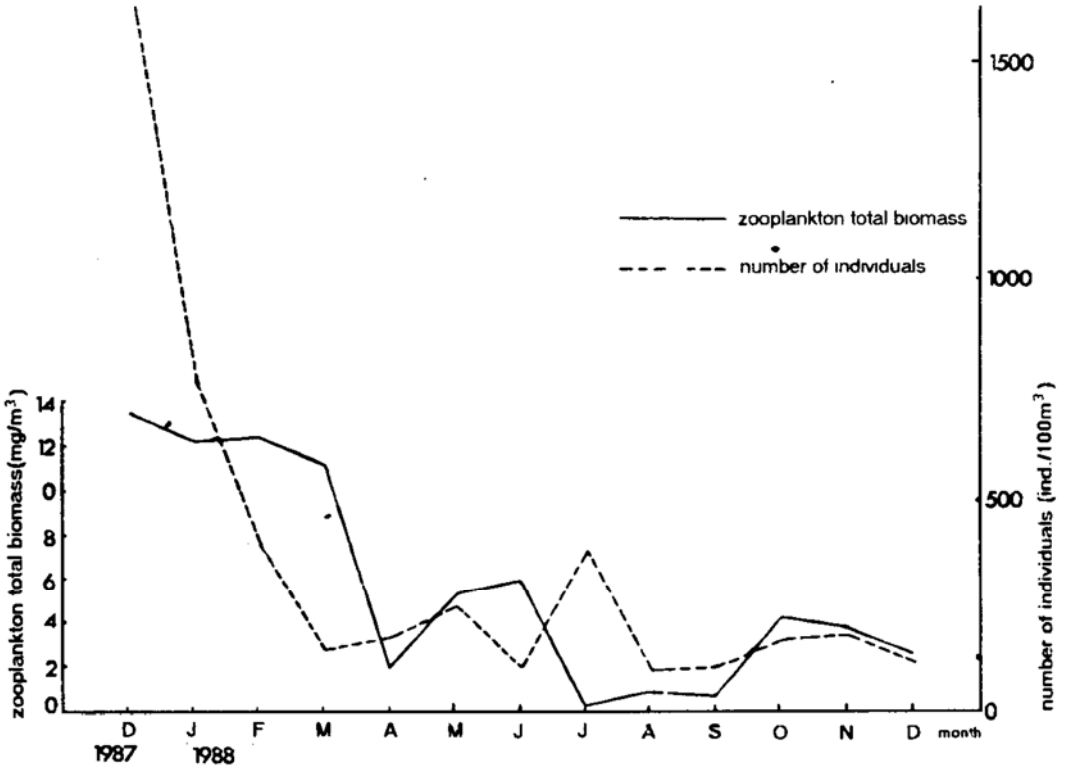

Fig. 2. Seasonal variations of zooplankton total biomass and number of individuals.

was an important factor restricting the biomass of zooplankton.

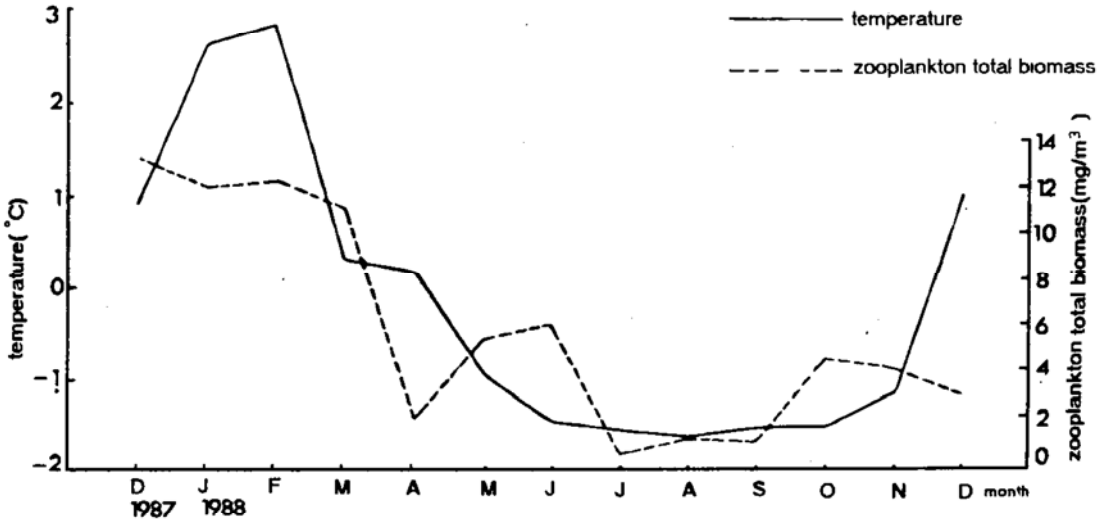

Fig. 3. Seasonal variation of zooplankton total biomass and water temperature.

As compared with the seasonal variation of the microzooplankton in the coastal waters of Davis Station, Antarctica (Huang *et al.*, 1986), this change was found to occur earlier in the low latitude area in the antarctic waters than in higher latitude areas, while the time of the occurrence of the lowest point of annual variations in the number of the individuals of zooplankton was found to occur later than that in the biomass. The regularities of the seasonal variations in the biomass of the zooplankton at different

latitudes and in different waters of Antarctica remain to be further studied hereafter.

From Fig. 2, it can be obviously seen that the biomass and the number of individuals for the December of 1987 differ greatly, from those for the same month 1988. The meteorological factor and the marine environment of the vicinity of Great Wall Station are important indirect and direct restricting factors. In November and December of 1987 the mean air temperatures of the vicinity of Great Wall Station were −0.5℃ and 0.7℃ respectively. At this time of the year the Great Wall Bay was not covered by sea ice, the sea ice just melted released the ice algae into water, the primary productivity increased and a large amount of the planktonic larvae of the benthic organisms appeared, thus causing the total biomass and the number of individuals of the zooplankton to form the annual peaks. Nevertheless, in the November and December of 1988 the mean air temperatures were −1.8℃ and −0.1℃ respectively (obviously lower than those in the same months of 1987); at this time the surface of the Great Wall Bay was still covered with snow and sea ice about 1 m thick (Qin, 1991), which directly affected the primary productivity of the seawater, and caused the total biomass and the number of individuals of the zooplankton to be markedly lower than those in the same period of 1987.

4.2 The seasonal variations in the number of the individuals of the zooplankton

The trend of the seasonal variations in the number of individuals of the zooplankton was basically similar to that in the total biomass (Fig. 2), the highest peak being in the December of 1987 and the number of individuals of the zooplankton 1612 ind/100 m^3. There were slight differences between the lowest value of the number of the individuals of the zooplankton in August (100 ind/100 m^3), and that of the total biomass in July. In March when the number of individuals was rather low, the biomass was fairly high, the number of individuals for 13 months averaging 361 ind/100 m^3.

Zheng (1964) and Zheng *et al.* (1984) reported that in the whole year there was only one peak (in September) in the seasonal variations of the zooplankton in frigid seas. The results of the present investigation also showed a peak but it was in December. Huang *et al.* (1986) reported that there was also an annual peak in April in the seasonal variations of the microplankton in the coastal waters of Davis Station, Antarctica. The differences in the time of the occurrence of the peaks is probably because of the differences in the longitudes and latitudes of the investigated sea areas.

5 Main species

5.1 Calanus propinquus Brady

According to the reports (Brady, 1918; Farran, 1929; Tanaka, 1960; He *et al.*, 1989), this species was one of the most typical copepods in Antarctica. The female adults were most abundant in the waters between 66°30′～76°S and during the investigation of "Terra Nova" the northernmost station where adults appeared was

located at 54°38′S. The sea area of the present investigation was in the north outer fringe of the most abundant sea areas, this species appeared in all the other months except in August when it was not collected (see Fig. 4). The highest number of individuals was in May, reaching 42 ind/100 m^3, amounting to 12. 2% of the total number of the individuals in that month, with the monthly mean for 13 months being 11 ind/100 m^3, amounting to 4. 5% of the total and becoming one of the main species in the investigated areas.

5. 2 *Metridia gerlachei* Giesbrecht

This species is also one of the typical antarctic copepod, occurring in the middle and deep waters around the Antarctica (Tanaka, 1960; Vervoort, 1951; He *et al.*, 1989). During the present investigation, this species was not collected in January～February, the larger quantity of the number of individuals occurred in April～July of winter, during which the maximum of 227 ind. /100m^3 occurred in April, amounting to 81. 9% of the total number of individuals in that month; the mean of 55 ind. /100 m^3 for 13 months amounting to 21. 7%. This species was the main component of the number of the individuals of the zooplankton in winter in the investigated area and become one of the main dominant species in the investigation.

5. 3 *Calanoides acutus* Giesbrecht

This species is a typical antarctic surface copepod distributed around the whole Antarctica. The Antarctic Convergence is a clear demarcation line of the northward distribution of this species. Its quantity markedly decreased in the Antarctic Convergence area. The results of the "Saya" investigation also showed this pattern of distribution (Taisoo, 1978; Tanaka, 1960; He *et al.*, 1989). During the present investigation for 13 months running, this species appeared in all the other months except in August when it was not collected. Its quantity in summer was larger, for in January the number of individuals reached a maximum of 492 ind/100 m^3, amounting to 70. 8% of the total number of individuals in that month, the mean of 13 months being 94 ind. /100 m^3, amounting to 19. 2%, and becoming one of the main species in the investigated areas.

5. 4 *Euphausia superba* Dana

The Antarctic krill is one of the major living resources in Antarctica, and distributed in the waters south of the Antarctic Convergence (Kirkwood, 1982; Tattersall, 1924; Wang and Chen, 1989). During the investigation for 13 months running (from December 1987 to December 1988), this species occurred (most of the specimens were larvae, but a few were pseudo-adults) in all the other months except in August～September when it was not collected. The quantity of individuals during December 1987～March and October 1988 it was fairly high, and in December 1988 it was the highest (656 ind. /100 m^3), amounting to 30. 3% of the total number in that month; the mean

of the 13 months was 94 ind. /100 m^3, amounting to 16.1% of the total. The trend of the seasonal variation in the quantity of individuals of this species was comparatively similar to that of *Calanaides acutus*, and in quantity it was slightly higher. Hence, the larva of the krill was also one of the dominant species in the investigated waters.

In addition, although the antarctic species *Oithona frigida* and the eurythermal, euryhalinc cosmopolitan species *Oithona similis* Claus did not become the dominant species, yet they were quite common in winter in the investigated waters. The former appeared in June ~ September, but its quantity was not high; the latter occurred in May ~ September as well as in November, the highest quantity of the individuals in July was 18 ind. /100 m^3.

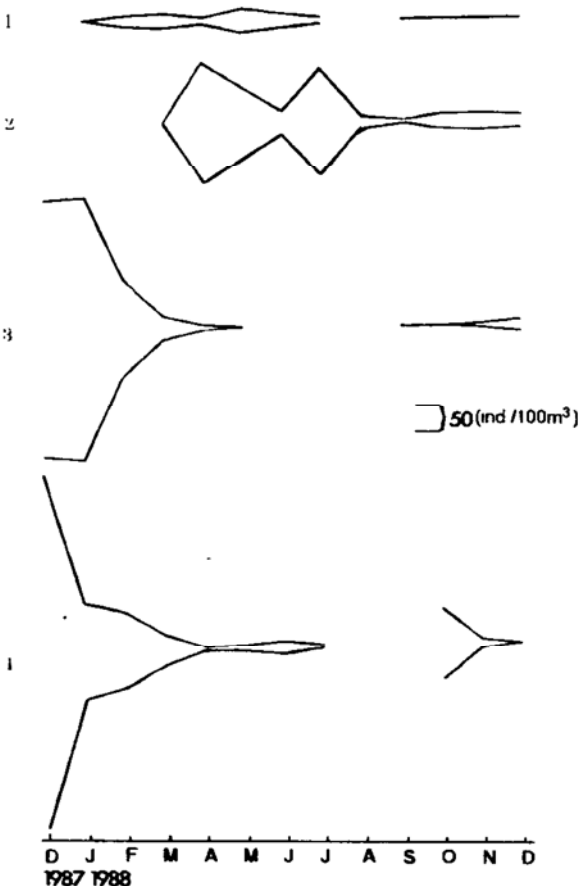

Fig. 4. Seasonal variations of the zooplankton species. ① *Calanus propinguus* Brandy; ② *Metrdia gerlacchi* Giesbrecht; ③ *Calanoides acutus* Giesbrecht; ④ *Euphausia superbe* Dana.

6 Summary

(1) In analysis of the zooplankton samples collected from December 1987 ~ December 1988 in the Great Wall Bay and its adjacent waters, a preliminary identification was made of 35 species, of which 7 were jelly fishes, 18 copepods, 1 chaetognath, 1 pteropod, 1 euphausiid, 1 ostrocod, 2 tunicates, 2 planktonic polychaetes, 2 larval fishes, 6 kinds of planktonic larvae and 10 kinds of juveniles. The typical antarctic copepods *Calanus propiquus*, *Calanoides acutus* and *Metrdia geriacei* and the larvae of the antarctic krill *Euphausia superba* Dana were the dominant species in the investigated waters. The antarctic species *Oithona frigida* and the eurythermal, euryhaline cosmopolitan species *Oithona similis*, were common in winter; the *Pleurobrach* sp. was common in the investigated area in June ~ December 1988. The zooplankton in the investigated waters was simple in species number, which conformed to the general pattern of the distribution of the zooplankton in antarctic waters.

(2) The total biomass of the zooplankton in the investigated waters showed obvious seasonal variations. The annual highest peak occurred in December 1987, reaching 13.58 mg/m^3, with the mininum 0.38 mg/m^3 in July and the average of 5.71 mg/m^3.

(3) The quantity of individuals of zooplankton also showed obvious variations and the trend of its variations was basically similar to that of the total biomass. The highest peak of 1612 ind. /100 m^3 occurred in December 1987 and the minimum of 100 ind. /100

m^3 in August, with the mean of 361 ind. /100 m^3.

(4) Among the zooplankton species in the Great Wall Bay and its adjacent waters, the main ones in summer were *Calanoides acutus* and the larvae of the antarctic krill *Euphausia superbas* Dana, in winter there were mainly *Metrdia gerlacher*, *Calanus propinquus*, *Oithona similis*, *O. frigida* and the larvae of *Ephausia superba* Dana, The quantity of the pseudo-adults of copepods occupied a considerable proportion in each month.

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Appendix: List of Zooplankton Species in the Great Wall Bay

Russellia mirabilis Kramp, 1957
Arctapodema antarctica (Vnhoffen, 1912)
Diphyes antarctica Moser, 1925
Dimophyes arctica (Chun, 1897)
Euchlora sp.
Pleurobrachia sp.
Mnemiopsis leidyi A. Agassiz
Calanus propinquus Brady, 1883
Calanoides acutus (Giesbrecht, 1902)
Metridia gerlachei Giesbrecht, 1902
Scolecithricella glacialis (Giesbrecht, 1902)
Microsetella norvigica (Boeck, 1846)
Tisbidae sp.
Cymbasoma sp.
Eukrohnia hamata Mobius, 1975
Limacina sp.
Euphausia superba Dana, 1850
Conchoecia sp.
Scaphocalanus subbrevicornis Farran, 1929
Stephus longipes Giesbrecht, 1902
Haloptilus ocellatus Wolfenden, 1908
Rhincalanus grgas Brady, 1883
Euchirella sp.
Neocalanus sp.
Pareuchaeta sp.
Angaptilus sp.
Oithona similis Claus, 1866
Oithona frigida Giesbrecht, 1902
Oncaea curvata Giesbrecht, 1902
Oikopleura sp.
Doliolum sp.
Pelagobia longicirrta Greeff, 1879
Tomopteris carpenteri Quatrefages, 1865
Notothenia larseni Lonnb
Notothenia gibberifrons Lonnb

Larva
Calanoid nauplius
Euphausiacea nauplius
Pluteus
Larva of Euphausiacea
Larva of Copepodids
Larva of Spio
Larva of Phyllodoce
Larva of Aphrodita
Polychaeta trochophora
Gastropoda veliger
Cucumaria auricularia
Larva of Orbinia
Larva of Syllis
Larva of Maldane
Larva of Shell
Larva of Gastropod