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Distribution and structure of zooplankton communities in the austral summer in the Prydz Bay, Antarctica

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Abstract As a structure linking the ecosystem and population, community plays an important role in the marine ecology. Abundance of different species and development-stages were used in our classification to the sampling stations with clustering-analysis and multi-dimension scaling, through which three geographic communities were marked out, respectively as following: the Salp community characterized by presence of *Salp thompni* in the northern area, the Near-shore community by *Euphausia crystallorophias* in the south and the main ocean community located between the above two communities. Indicator species method was then carried out between every two communities to find out which species or stages differ most. It tells that *Rhincalanus gigas*, adult cheatognath, late stages of *Metridia gerlachei* and calyptopis of Euphausiidae are indicators between Salp and neritic communities, between Krill and Salp communities are *Salp thompni*, adult and larvae of Cheatognath and *R. gigas*, and the most notable indicator between the Krill and the neritic communities are *E. crystallorophias*, then nauplii of Euphausiidae and *Onceae conifera* with less evidence.
Key words community, Salp, Krill, copepod, *Euphausia crystallorophias*, indicator species.

1 Introduction

Zooplankton other than krill, mainly copepod, is occupying an increasingly important part in the Southern Ocean research in recent years. At first, copepod was found accounting for much higher proportion of the whole zooplankton biomass than people had imagined before, sometimes exceeding that of krill (Everson 1984; Conover and Huntley 1991), and sometimes consuming more primary production than krill (Conover and Huntley 1991). With its wide distribution taken into account, the role it plays in the trophdynamics of the southern ocean ecosystem has to be re-emphasized. At the same time, it has been found that during the Antarctic exploration of many countries the yield of krill has decreased evidently, sometimes none at all (personal communication), which means that the role of krill as food for fish and other big predators in the ecosystem will be taken over by copepod and other zooplankton, such as *Euphausia crystallorophias*.

More and more efforts are being attributed to interspecific relationship in the recent years, like that competition between krill and salp (Huntley *et al*. 1989; Loeb and Siegel 1997) and top-down control to copepod abundance by krill (Atkinson 1997, 1999). Krill is supposed to be a potentially important predator of small copepods, for maximum clearance rate of juvenile krill was observed on 1 mm to 3 mm calanoides copepods during on-board incubations either with natural or enriched seawater (Atkinson 1997).

Interspecific relationship varies with communities or geographic regions, and is multiform even in the same community. Hence such studies have to be defined in certain community being thoroughly understood. Therefore, it's critical to understand the structure of ecosystem, especially that of different communities in the southern ocean.

Prydz Bay, an open bay with comparatively simple changes on physical environment, is an ideal place for community studies. In the previous study carried out by Hosie and Cochran (1994, 1997), three kinds of communities were marked out; the krill dominated community, the neritic community dominated by *Euphausia crystallorophias* and the main ocean community dominated by copepods and cheatognath. They tried to give some inspiration on trophdynamics of southern ocean ecosystem through explanation of community connecting ecosystem and population.

With a rather small mesh (330 μm), zooplankton net used in our sampling procedure is more efficient on tiny organisms, small copepods and their larvae, than RMT8 and RMT1 in Hosie's. Therefore the consequent analysis may include more information than Hosie, also development of key species and their relationship with the environmental conditions were involved.

2 Materials and methods

26 stations were investigated along three longitudinal sections in Prydz Bay during CHINARE (Chinese National Antarctic Research Expedition) - ㊅㈨ (1998. 11 – 1999. 4) (Fig. 1). Stations iv iv iv-4 and iv iv iv-14 were both repeated twice and the duplications were respectively named as iv iv iv-5 and iv iv iv-16 during data analysis. Zooplankton were reserved in 4% neutral formalin after capture by 200 – 0 m vertical tow with 330 μm mesh-size zooplankton net and identified back to the lab. Dominant species

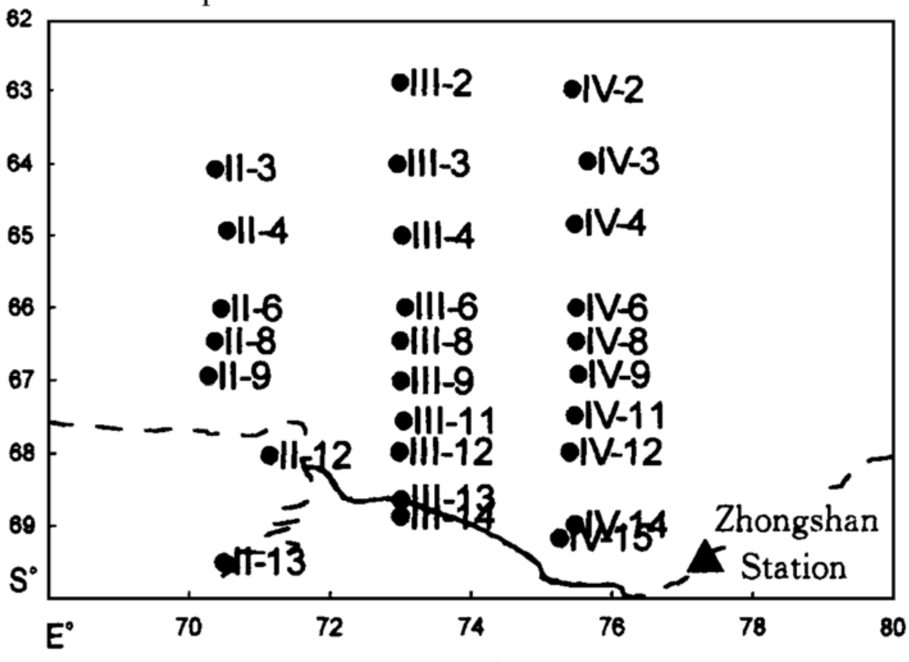

Fig. 1. Sampling station sites.

such as *Calanoides acutus* were divided into different developmental stages, *Calanus propinquus*, *Metrdia gerlachei* and *Rhincalanus gigas* were divided into adult and copepodites, while the others were recognized as different copepod species, salp, cheatognath, polycheata, etc.. IKMT net and high-speed collections were conducted for krill just before the arrival to each station.

Complete details of multispecies distribution pattern analyzing techniques have been described previously by Field *et al*. (1982), which were adopted here with only a little modification. Raw data matrix was formed by different species and developmental stages, expressed as individuals per square meter. Without transformation, cluster analysis was carried out directly according to UPGMA method with matrix by Euclidean distance coefficient and non-metric multi-dimension scaling (NMDS) ordination was then conducted with the distance matrix got above.

After all the stations divided into different groups, information statistic test (Field 1969; Velimirov *et al*. 1979), a means of assessing which species differ most between two sampling groups, was carried out. Comparison was made between every two communities for any one taxon, which means species and developmental stages exceeding 1% of the whole amount, i:

$$2\Delta I_i = 2(I_{ti} - I_{1i} - I_{2i})$$

where $I_{ti} = N_t \log N_t - N_t \log A_{ti} - (N_t - A_{ti}) \log(N_t - A_{ti})$, total information content of the two communities; I_{1i}, I_{2i} means the information content of each community; N_t, stations included in the two communities; A_{ti}, stations that species i appears; $(N_t - A_{ti})$, stations without presentation of species i (Field *et al*. 1982).

3 Results

3.1 Species and abundance

Specimens from 29 stations were divided into 64 characters, including species and developmental stages. Those exceeding 1% of the total amount were listed out in Table 1, during which *Calanoides acutus* and *Oithona similes* were the most widely spread species with large amount while others such as *Paracalanus* spp., *Metridia gerlachei*, juvenile Euphausiids and polycheata were also wide spreading species, however, less in amount.

3.2 Classification of communities

After cluster analysis and ordination, all the stations seem like that they can be divided into three different clusters, as shown in figure 2 and 3, and geographically distributed in various regions along latitude.

3.3 Different types of communities

Stations belonging to the same group were combined together as shown in Fig. 4, in which three geographic communities were marked out.

Table 1. Species or their developmental stages occupying more than 1% of the total amount in the investigation

Species or their developmental stages	Percentage	Species or their developmental stages	Percentage
Oithona similes ④㈣	43/ 20/ 4	*Decapods*	
Calanoides acutus ④㈣	1/ 5/ 1	Furcilia ④㈣	4/ 2/ 1
C iv ④㈣	1/ 4/ 2	Calyptopis ④㈣	1/ 11/ 19
C ㊆ ④㈣	2/ 4/ 6	Nauplii ④㈣	8/ 41
C ㊃ ④㈣	1/ 1/ 1	Nauplii of copepod ④	1/ 1
C ㈨④㈣	2/ 1	*Polycheata*	
☆△ ◇*Salp thompni*	1	Larvae ④㈣	4/ 1
Clausocalanus spp ④	1/ 12	☆*Oncaea conifera* ④	7/ 5
☆△*Euphausia crystallorophias* ㈣	4	*Paracalanus* spp ④㈣	25/ 12/ 6
Metridia gerlachei ④㈣	1/ 11/ 8	*Eurytomora* spp ㈣	1
◇*Rhincalanus gigas*	3	*Haloptilus ocellatus*	1
Nauplii iv iv iv ④	1/ 1		

Notes: The specific name represents the adults of this species when different developmental stages have been identified; ④㈣represent the Salp community, the main oceanic community and the neritic community respectively; ☆△ ◇ mean index species, respectively those between ④㈣, ④and ㈣

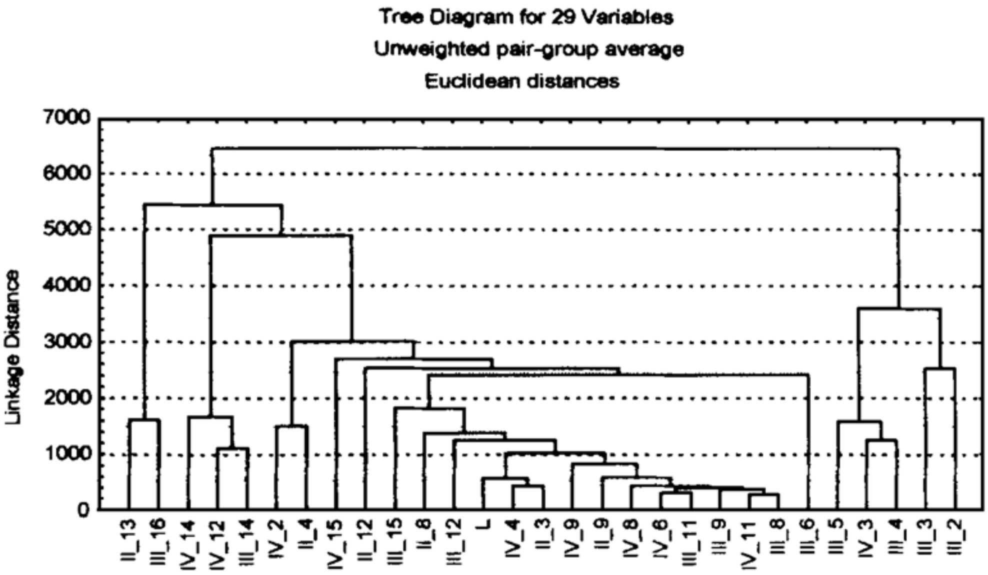

Fig. 2. Diagram of cluster analysis.

3.3.1 Salp community in the north area

Geographically includes stations iv㈦3, iv iv iv-4, iv iv iv-2 and iv iv iv-3 of our investigation, this community hypothetically lies between 62°S and 65°S, its index species is *Salp thompni*. Environmental conditions here are characterized as low in chlorophyll and temperate temperature and salt. As listed in Table 1, species in this community includes small copepods, such as *Oithona similis* and *Paracalanus* spp with densities of (23 - 70) ind/ m^2 and (24 - 40) ind/ m^2 respectively, *Calanoides acutus* ranging (3 - 10) ind/ m^2 predominantly copepodites of CI and CII, and *Oncaea conifera* with a density over 10 ind/ m^2. Though less in amount, *Salp thompni* accounts for a great proportion of the biomass. Cheatognath in this region are dominated by juveniles ranging from 4 ind/ m^2 to 7 ind/ m^2.

3.3.2 Krill dominant community in the middle

Including far more stations than the other two communities, this community located between 65°S - 68°S, a region known to be variable in chlorophyll and high in tempera-

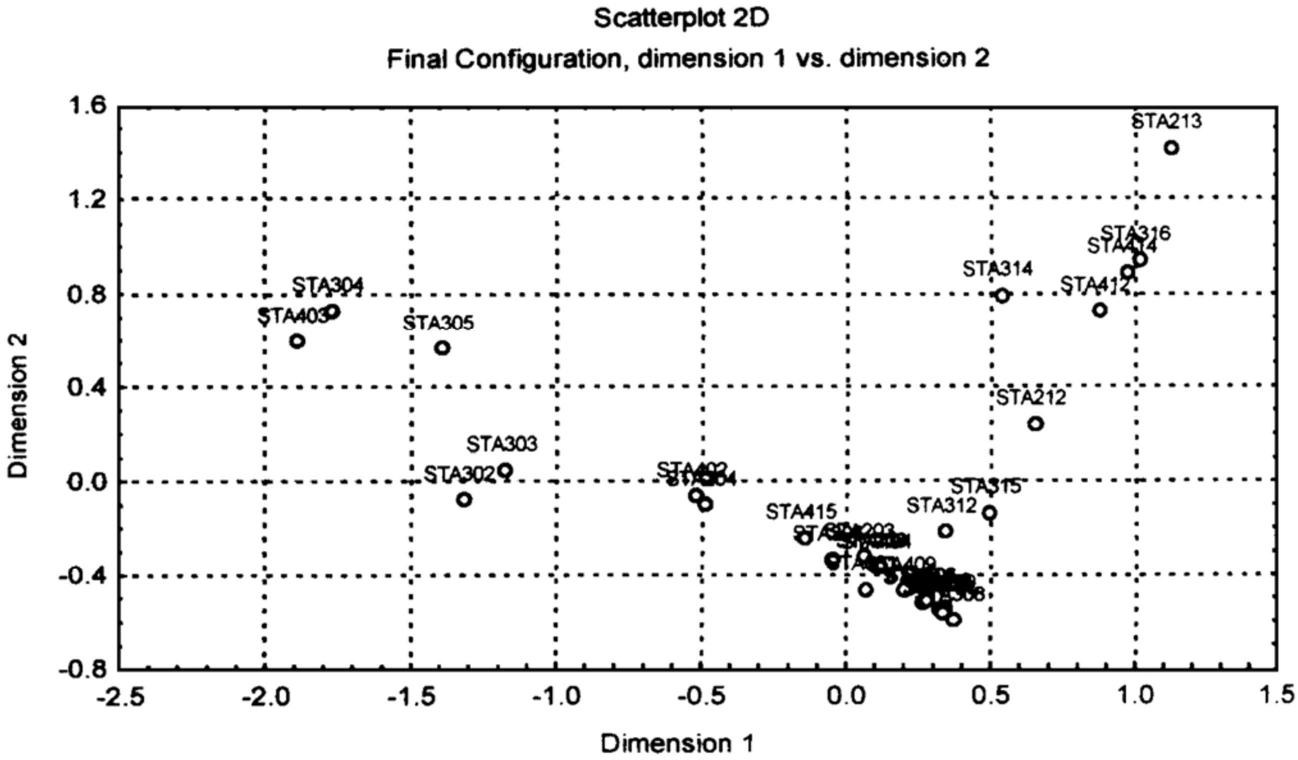

Fig. 3. NMDS ordination plot.

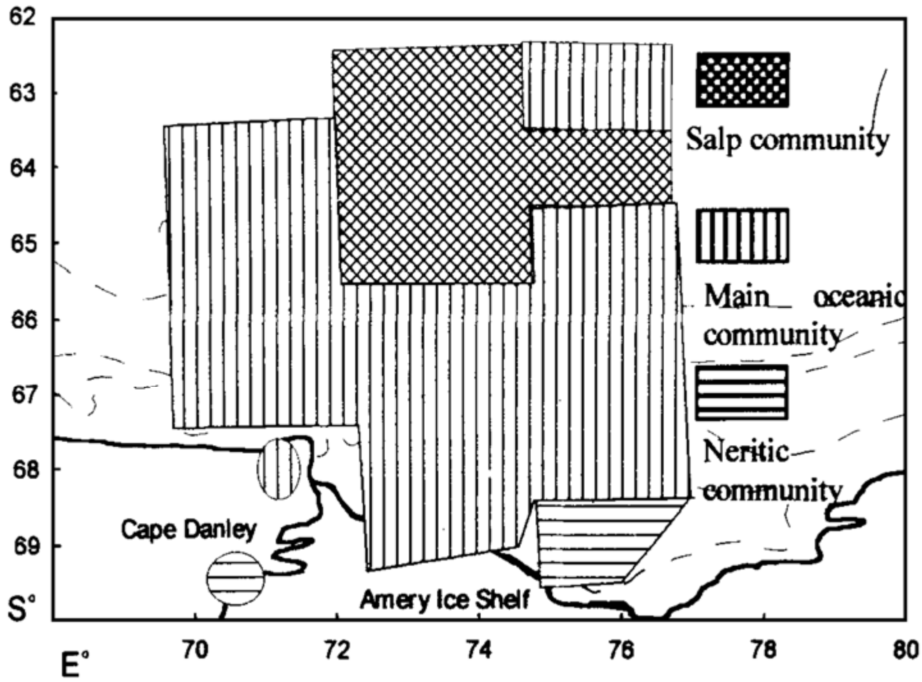

Fig. 4. Geographic distribution pattern of community.

ture and salinity. The name was carried on as that from Hosie and Cohran (1994), though no krill has been captured in this region during our voyage. Species, in this community, present with a similar probability and are close in amounts. However, it has been found that *Metridia gerlachei* presented in a comparatively large amount and polycheata and cheatognath distributed widely. Population of *Calanoides acutus* is also mainly constituted by copepodites of CI and CII, while adults are in comparatively low density.

3.3.3 Neritic community

Mainly the continental shelf area on the south of 68°S, this community is characterized in *Euphausia crystallorophias* (mianly nauplii), including stations ⅳ(九)12, 14 and ⅳ ⅳ-13. Nauplii of Euphausiid were found in large amount in the sampling, more than 30 ind/m^2 in station ⅳ(九)12, 14 ind/m^2 and 8 ind/m^2 in ⅳ ⅳ-13. Calyptopis, however, attains 32 ind/m^2. Again, *Calanoides acutus* here includes mainly copepodite of CII and few of adults.

3.4 Indicator species

When communities of the north and the middle areas were compared, indicator species were *Salp thompni*, juveniles of cheatognath, *Rhincalanus gigas* and adult cheatognath. *Rhincalanus gigas*, adult cheatognath, *Metridia gerlachei* and calyptopis of Euphausiid were indicator species between north and neritic communities. Most evident indicator specie between middle and neritic communities was *Euphausia crystallorophias*, then nauplii of Euphausiid and *Onaea conifera* with less evidence.

4 Discussion

Different with those of Hosie and Cohran (1997), in our results: (1) salp community lies more southwards, (2) no difference was found in species and amount in the main oceanic community, which was divided into two parts by Hosie according to the appearance of krill. With interaction between krill and copepod (Atkinson 1997, 1999) taken into account, alternation may exist between the taxon geographically or yearly. As Hosie and Cohran (1997) have pointed out in their article, for better understanding to the community structure, synchronous survey on zooplankton was necessary when krill was investigated. At the same time, information on krill had to be included in zooplankton investigation. Though IKMT net and high-speed collections were carried out during our sampling procedures, but almost no krill was found, the same as our Australian and German colleagues (personal communications). However, average densities of other species were found much higher than those from Antarctic Peninsula (Yang 1987). Therefore, it seems impossible that it's just caused technologically. After all, community distribution in our research has keep good consistence with that in Hosie and Cohran (1997), suggesting a steady distribution pattern of zooplankton in the Prydz Bay.

Salp thompni and *Euphausia crystallorophias* were found in demirance in different areas, so got two main kinds of community. Small copepods were found in large amount in north area, trophic structure was then made complex. *Salp thompni* was found less than 70 ind/m^2 in western Antarctica; however, it doubled in Prydz Bay. Indicator species of the three communities were respectively *Salp thompni*, krill (in theory) and *Euphausia crystallorophias*, and all interact with copepods.

Since juvenile (including nauplii, calyptopis and furcilia) were found in dominance in neritic area, there may be ideal for study on recruitment or Euphausiids. In various communities, *Calanoides acutus* was found in different population structure, which may represent different developmental stages of its life history. Though it's not comparable because the investigation was completed in different time, it's almost certain that developmental difference exists in different area.

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