microalgae

2

# ANALYSIS OF THE STOMACH CONTENTS OF ANTARCTIC KRILL, EUPHAUSIA SUPERBA DANA\*

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Abstract Diet components of Euphausia superba of 12 sexual maturity stages from the adjacent waters off the South Shetland Islands, Antarctica were analysed. The major points observed are summaried as follows: 135 taxa of nano- and microorganisms were found in stomach contents of Euphausia superba, of which, the diatoms make up 60% of the total species number. Planktonic nano- diatoms and nano- flagellates smaller than 20µm in diameter accounted for 85% of diet total number. The dominant species in the stomach contents were Nitzschia angulata f. minima, N. curta f. minima, N. curta, Chrysostomum sp., the mean cell number of these species was about 56.99 cells/ind., The stomach fullness increases gradually with the sexual mature of the krill.

Key words the South Shetland Islands, Euphausia superba, stomach contents, nano- and

## Introduction

The Antarctic krill, *Euphausia superba*, is very abundant in the Southern Ocean. The nano- and microalgae are main diet of the krill and play an important role in the Southern Ocean ecosystem and food web.

A great deal of study on stomach contents and faeces of Euphausia superba has been done by foreign scholars (Barkleyi, 1940; Kawamura, 1981; Marr, 1962; Nemoto, 1968, 1972; Pavlov, 1969, 1971; Marchant and Nash, 1986). Chinese researchers have also developed studies on biology and population structrue as well as diet of the krill in recent years (Zhu, 1988, 1989). The species composition and cell numbers of nano- and microalgae in the stomach contents and relationship between the swarming abundance of Euphausia superba and the cell density of nano- and microalgae are dealt with in this paper so as to provide important information for exploiting the Antarctic krill resources and illustrating the Southern Ocean ecosystem.

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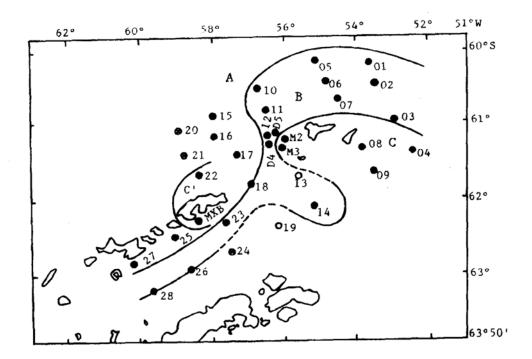


Fig. 1. Sampling stations and corresponding distribution areas of different cluster groups of Euphausia superba. "O" Cluster stations; "O" Not sampling with IKMT standard tows; "O" Euphausia superba was not captured from these stations; "A". "B". "C". Denote the corresponding distribution areas of defferent cluster groups.

## Materials and Methods

The Antarctic krill, was caught using an new midwater trawl (at Sts. T16,T21,D4) and IKMT (at the other stations) in adjacent waters off South Shetland Islands during the austral summer of 1986—1987 (Fig. 1).

According to cluster analysis (12 sexual maturity stages of *Euphausia superba* as variates), the surveyed area can be divided into three subareas, namely, A-subarea, B-suberea and C-subarea.

We select 3 krills of every sexual maturity stage at different stations respectively, and dissect these krills and take out their stomach as well as observe stomach fullness with an stero microscope. The classes of fullness are as follows: a. non-fullness (food is not or is slightly found out in stomach, fullness is below 30%); b. half-fullness (food is moderate in stomach, fullness is between 31% and 60%); c. fullness (stomach is filled by food, fullness is between 61% and 100%). The species and cell number of nano- and microalgae in stomach contents are identified and counted with phase-contrast microscope or scanning electron microscopes, respectively.

#### **Results**

1. Species composition of nano- and microalgae in the stomach contents of Euphausia superba

The stomach contents of 340 krills are analysed. The results show that diet of these krills mainly consist of nano- and microalgae which belong to 114 taxa, of which diatoms 81 species (including 4 varieties and 3 forma), dinoflagellates 17 species, Chrysophyceae 7 species, Craspedophyceae 5 species, Chlorophyceae 2 species, Dictyochophyceae 1 species, Cyanophyceae 1 species. In addition to, the diet contains also protozoa (21 species) and a little crustacea (Table 1).

The nano- and microalgae which are smaller than  $20\mu$ m in diameter predominant in the stomach contents. The first dominant species are Nitzschia angulata f. minima, N. curta f. minima and N. curta; the second dominant species are Chrysostomum sp. and N. castracanei (Table 2.)

2. The stomach fullness and number of nano- and microorganisms in the stomach contents of Euphausia superba

The stomach fullness and number of nano- and microorganisms in the stomach contents of *E. superba* obtained from Sts. T<sub>9</sub> and MXB (C-subarea) are biggest and these from Sts. T<sub>12</sub>, D<sub>4</sub>, M<sub>3</sub> (B-subarea) are smallest. Table 3 shows that the stomach fullness and cell number of nano- and microalgae in stomach of female krill are bigger than those of male krill. The average stomach fullness of female and male krill is 37. 58% and 31. 55%, respectively; the average cell number of nano- and microalgae in stomach of female and male krill is 78. 42 and 67. 73 cells/ind. respectively. The stomach fullness and cell number of nano- and microalgae in stomach of juvenile krill are smallest in various development stages krill; those of male krill are largest in 3BM stage and smallest in 2AM stage; the fullness of female krill is largest in 3EF stage and smallest in 2F stage, and its cell number of nano and microalgae is biggest in 3BF and 3EF stages and all small in other stages, it can be seen from this that the stomach fullness increases gradually along with the sexual mature.

3. The mean number and percentage of different diet categories in the stomach contents of E. superba

The number of diatoms in the stomach contents of *E. superba* is largest (average 64.73 cells/ind.) and makes up 89.21% of stomach contents. Secondly, *Chrysophyceae*, dinoflagellates and protozoa account for 5.04%, 3.02%, 2.08%, respectively (Table 4.).

The nano- and microorganisms with the diameter of  $2-20\mu m$  are comprised 85% of the stomach contents, those with the diameter of  $20-30\mu m$  make up 10% of the stomach contents, and microalgae and other plankton which are bigger than  $30\mu m$  in diameter account for 5% of the stomach contents.

Table 1. Species composition of nano— and microalgae in the stomach contents of Euphausia superba Dana.

Table 1. Species composition		no a	na mici			stoma	n com	inis of	Femal		peroa	Dana.
Sexual maturation stages	Juvenile JU	2AM	2BM	Male (M) 2CM	3AM	3BM	2F	3AF	3BF	3CF	3DF	3EF
The mean body length (mm)	28	30	40	47	44	45	37	40	43	43	47	44
The mean body wet weight (mg)	187	255	628	957	854	910	435	581	668	849	1320	620
Species composition	10.			TI	ne mean	stomach	content	(cells/in	d)			
DIATOMS												
Achnanthes delicatula		+					_		_			
Actinocyclus actinochilus	-+-		+			+	+ "		+		+	
A. adeliae					_				_		+	
A. curvatulus							_	+				
A. oliverianus						+	-		_			+
Amphiprora sp.			+				_	_=_		1981		
Amphora sp.		+					_			-		
Anaulus elli pticus	<del></del>	+		_		+				+		
Asterolam pra sp.							=	-	+			
Biddul phia striata Biddul phia sp.	-		+	+		_						
Chaetoceros dichaeta	<del></del>			+								
C. tortissimus	<del> </del>		+									
Chaetoceros sp.		+-	+			+			_		+	
Charcotia actinochilus		+		+	+	+	+	,		+		
C. australis			_			+	-	~	_		+	_
C. bifrons	+	+	+	+	+	+	_	_	+-	+		_
C. decrescens	-	_	+		_			T.	-			
C. irregularis	+	+	+	+	+	+	+	+	+	4.	+	
Charcotia sp.	+	+				-	+	+	+	_	+	+
Cocconeis costata	+				~~		_		-			
C. fasciolata	+			-		+		-		·-	_	
Corethron criophilum	+	+	+	+	+	+	+	+	+	+	-	+
Coscinodiscus bouvet	-	+					_	-	+	+		
C. chromoradiatus C. curvatulus		+							+			
C. quadrijarius	<del></del>		+									
C. stellaris	-			_		+						
C. tabularis	<del></del>				+	+				_		
Coscinodiscus sp.	+	+	+	+	+	+	+	+	+	+	+	+
Eucampia balaustium		+	_		_	+			-	_	+	_
Fragilaria striatula		+		+		+	-		+	_	_	
Licmophora gracilis		+	+	+	_		+	_	+	+	+	
L. gracilis v. minor							-		-	+		***
Licmophora sp.		_		_		+	+		_	_		
Melosira charcotii	+											
M. nummuloides	<del>-</del>			+					-			
M. subsetosa M. sulcata	-			+		=	_				+	
Melosira sp.			+	+	+	+			+	+		_
Navicula frequens		+	<u> </u>	-			_	_			_	
N. hahnii		_	-			_			+	-	_	~-
N. trompii			_			-	_		+	_		-
Navicula sp.		+	+	+		+	+		-			
Nitzschia antarctica			_			_	-		+	-		
N. aciculari formis	+											
N. acicularis									+	+		
N. angularis v. tenuistriata N. angulanta	+	+	+	+	+	<del>-</del> -	+	+	+	+	+	+
N. angulata f. minima	++	++	++	+++	++	++	++	++	+++	+++	+	+
N. barkleyi							+					<u> </u>
N. castracanei	+	+	+	+	+	+	+	+	+	++	+	+
N. closterium			-				+		_	_		
N. closterium f. tenuissia	-	+	_			_	_			_		_
N. curta	++	++	++	+	++	++	+	+	++	++	+	+
N. curta f. minima	++	++	++	++	++	++	++	+	++	+++	+	+
N. cylindrus		<u> </u>	<u> </u>	_	<u> </u>			+	+	+		_
N. grunowii		+	+		<u>+</u>	+		+	+	+		
N. heimii N. hybrida	+	+					<del></del>					
N. hypriaa N. kerguelensis	-			+		+	=	+	+	+	+	+
N. obliquecostata	-			_			_		Ŧ			-
N. stellata	+		_	+		_				+		
N. sublinearis	<u> </u>	+		+	+	+			+	+	+	
N. sublinearis v. ambigua		-				_	_		+	+		
Nitzschia sp.	+	+	+	+		+	+		-	+	+	
Rhizosolenia alata	+	+	+	+	+	+	+		+	_		_
R. styliformis	+	+	+				_		_		+	
									+	+	_	_
Rhizosolenia sp.				+		+	+					
Rhizosolenia sp. Schim periella oliverana Synedra barbatula	-					+	+	=	-	=	+	_

S. reinboldii		+			T	T =	T -	T===	T	T		-
Synedra sp	+		+	-	_		-		_			
Sticholonche sp.	_							+		+		
Thalassiosira Antarctica		+	+	+	+	+	+		+	+	+	_
T. gracilis	+	+	+	+	+	+	+		+	+	+	
T. lentiginosa		_		_	_	_	-		+	+	-	
T. tumida	_	+	+	+	+	+	+		+	_	+	
Thalassiosira sp. (T. hyalina)	+	+	+	+	+	+	+	+.	+	+	++	+
Trachyneis aspera		+		+					_		_	÷
Tryblionella punchata	+	+	+	+	+	+	+	+	+	L +	+	
DINOFLAGELLATES	<u></u>											
Ceratium fusus							+	75	-	_		
Ceratium sp.		+			_							
Glenodinoum sp.						+	<u> </u>		_		_	
Gonyaulax sp. Gymnodinium agili forme						+	_	-		· -	-	-
G. baccatum	+			<del></del>	_			+				
G. blar	+	+	+	+			+					
G. frigidum				_	+	±		+	+	+	+	+
G. gracile	<del></del>	+		_		+	+	~			<del>  _</del> _	
Gyrodinium sp. (G. glaciale)	+	+	+		+	+		+				+
G. lachryma	+	+	+-	+		+	+		+ +	+	++	+
Oxytoxum sp. (O. criophilum)	+	- <del>-</del>		+		+	T			<del></del>	<del>-</del>	
Protoperidinium archievatum	T		+		+	1	+		+	<del></del>	+-	
P. mediocre			-	+			+			<del>-</del> -	T-	
P. melo				_	_		+					
P. metananum		_		+		+		+			+	+
Protoperidinium sp.	+	+	+	+	+	+	+	+	+	+	+	+
SILICOFLAGELLATES	<del>- '-</del>	_		·			_ '			<u> </u>		-
Diste phanus speculum			-			+	_	~	+	T =	-	+
HYPTOPHYCEAE (PRYMNESIOPHYCEA)												
Chrysastrelia sp.	+		_	_	_	+			+		+	+
Chrysochromulina sp.	+	+	+		_	+	+	~	+	_		-
Chrysostomum sp.	+	+	++	++	+	+	+	+	+	+	+	++
Clericia antarctica	_	_	_			_	-		_	_	_	+
Clericia sp.	+	_	+	+	_		+	+	+	+		-+-
Michaelsarsia sp.		-			_			-	+	_	-	-
Prymnesium sp.		+		_	-	-						
CYANOPHYCEAE												
Merismopedia sp.	+	-						-	-	_	_	-
CHLOROPHYCEAE	1											
Golenkinia sp.				_	-					_	-	+
Golenkinia sp. Nephroselmis sp.	=		=			+						+
Golenkinia sp. Nephroselmis sp. CRASPEDOPHYCEAE		_		-						=		
Golenkinia sp. Nephroselmis sp. CRASPEDOPHYCEAE (CHOANOFLAGELLATES)						+				=		
Golenkinia sp. Nephroselmis sp. CRASPEIX)PHYCEAE ( CHOANOFLAGELLATES ) Bicosta antennigera	+	+	= =	+	+	+	+	-	-+	+	+	
Golenkinia sp. Nephroselmis sp. CRASPEIXOPHYCEAE ( CHOANOFLAGELLATES ) Bicosta antennigera Monosiga ovata	+++	+ +	++	+ +	++	+ + + +	+ +		+	+	+ +	
Golenkinia sp. Nephroselmis sp. CRASPEIXOPHYCEAE (CHOANOFLAGELLATES) Bicosta antennigera Monosiga ovata Parvicorbicula sp. (P. socialis)	+++++	+ + + +	+ + +	+ + +	+ + + +	+ + + + +	+ + +		++++++	+	+ + +	=
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<sup>\* +++,</sup> very abundant (>50 Cells/ind.); ++, abundant (5-50 cells/ind.); +, scarce or rare (<5 cells/ind.); -, absent.

Table 2. The important species in the stomach contents of Euphausia superba.

Main species	Mean cell numbers (cell/ind.)	Percentage (%)
Nitzschia angulata f. minima (=Fragilariopsis rhombica f. minima)	29. 81	41.08
Nitzschia curta f. minima (=Fragilariopsis curta f. minima)	16. 10	22. 19
Nitzschia curta	7.76	10.69
Chrysostomum sp.	3. 32	4. 57
Nitzschia castracanei	2. 60	3. 58
Thalassiosira sp.	1.70	2. 34
Charcotia irregularis	1. 35	1.86
Gyrodinium sp.	1. 23	1.69

Table 4. The mean number and percentage of different categories in the stomach contents of Euphausia superba.

Category	Geneus	species	Percentage of species number(%)	Mean number (cell/ind.)	Percentage of number (%)
Diatoms	26	81	60.0	64.73	89. 21
Dinoflagellates	8	17	12. 6	2. 19	3. 02
Chrysophyceae	6	7	5. 2	3. 66	5.04
Protozoa	17	21	15.5	1.51	2. 08
Craspedophyceae	5	5	3. 7	0.30	0.42
Cyanophyceae(1) Dictyochophyceae(1) Chlorophyceae(2)	4	4	3. 0	0.06	0.08
Unidentified microplankton				0. 11	0. 15

## Discussion and Conclusion

The diet of *E. superba* consists of nano- and microorganisms which belong to 135 taxa, of which, the diatoms are main diet of *E. superba* and make up 60% of the total species number. In addition to diet of *E. superba* contains also protozoa (15.5%), dinoflagellates (12.6%), Chrysophyceae (5.2%), Craspedophyceae (3.7%), and other organisms (3.0%).

The dominant species in the stomach contents are Nitzschia angulata f. minima, N. curta f. minima. N. castracanei and N. angulata. The cell number of these species reachs 56.96 cells/ind and makes up 78.50% of total number of nano- and microalgae, and they are all found in the stomach contents of the different sexual maturity stages.

Marchant and Nash (1986) reported that N. curta, the diameter of which is between  $10-20\mu m$  is also very abundant in gut contents and faeces of E. superba, it is attributed to E. superba has a filter basket of special function which is advantageous to feeding or filtering

Table 3. The stomach fullness and number of nano— and microorganisms in the stomach contents and faeces of Euphausia superba.

													-													
Stages of	jo -	Juvenile	nile					Male (M)	Q				_					Fer	Female (F)	_					Ave	Average
sextual maturity	ity	J.	1	2AM	×	ABM	>	2CM	Ţ	3AM	<u></u>	3BM		2F		3AF		3BF		3CF		3DF	m	3EF		ıχ
Item		S. F. S.	Ü	S. F.	S. C.	S. F.	s. c. s	S. F. S.	s. c. s.	. F. S.	. C. S.	. F. S.	. C. S.	F. S.	C. S.	F. S. C	C. S. I	F. S. (	C. S. F	F. S. C.	. S. F.	S. C.	R.	S. C.	S.F.	S.C.
Subarea	Sts.																									
	T15	1	ı	1	ı	f	1	1	-	1	- 5	50.0	48.0	-	_		-	_	20.	0 22.0	0 20.0	56.0	40.0	27.0	40.0	38.3
	T16	5.0	7.3	5.0	8.3	15.0	11.3	10.01	0.92	1	_ 1	15.0 2	23.3	_	<u>'</u>	-	10.	0 17.	3 30.	0 10.0	15.0	15.0	1	1	13.1	14.8
V	T17	10.0	4.5	30.0	24.0	30.0	61.3	30.0	62.3		ī	Т	1	'	- 90.	0 33.	30.	0 16.	3 60.	0 6.7	90.0	23.7	70.0	17.5	48.9	27.7
	T21	10.0	17.3	10.0	20.3	80.0	50.7	65.0 2	29.7	10.01	12.3 7	75.0	24.3	10.0 22.	2.0 15.	0 27.	7 90.	0 32.	0 75.	0 22.7	30.0	14.3	75.0	69.5	45.4	28.6
	T27	ı	Į	1	1	í	1	1	1	ı	6	90.0	65.0		-	-		-	10.	0 3.0	0	0	15.0	13.5	28.8	20.4
	T2	10.0	11.0	10.0	12.3	10.0	13.7	10.0	10.0	1	-	80.0	30.3	10.0 22.	2.0 80.	0 19.	3 60.	0 45.	3	1	1	1	1.	1	33.8	20.5
	Т3	10.0	8.3	Ι	1	1	ı	1	1	ı	-	15.0	10.3	_	_	!	10.	0 12.	0 15.	0.9 0	50.0	34.7	1		20.0	14.3
	T6	5.0	9.0	3.0	3.3	40.0	13.7	10.0	4.7	60.0	11.7	60.0	17.3 5	5.0 21.	1.3 10.	0 5.	7 30.	0 18.	0 40.	0 6.7	1	-	1	1	26.3	11.1
М	T10	1	ı	ı	ı	1	ı	i	ı	ı	ı	ı	ı		-	-	1	-	+	1	50.0	72.7	1		50.0	72.7
	T12	ı	1	-	1	1	1	-	-		-	15.0	4.7	_	_		15.	0 4.	0 15.	0 3.7	1	-	1	1	15.0	4.1
	D4	10.0	1.3	3.0	1.0	20,0	6.0	20.0	5.3	15.0	3.0	2.0	3.3 1	5.0 7.	.7 15.	0 4.	3 5.	0 0.	7 5.0	0 3.0	1	-	1	1	11.3	3.6
	M3	5.0	1.0	3.0	3.0	2.0	1.0	15.0	14.3	20.0	7.0 3	30.0	5.7 5	5.0 3.	.3 30.	0 2.	7 5.0	0 2.	3	1	-	_	1	-	12.8	4.5
	T4	30.0	95.7	30.0	136.3	45.0	675.3	75.0 5	587.0	40.0	139.0 4	40.0	122.3	20.0 79.	3.3 20.	.0 127.	7 70.	0 758.	0 20.	0 36.0		-	1	_	39.0	275.7
	T9	50.0	47.0	50.0	50.7	35.0	48.7	35.0	56.7	90.0	182.0 9	90.0	591.7	35.0 64.	1.0	<u> </u>	90.	0 942.	0 80.	0 935.0	- 0	1	1	1	61.7	324.2
)	T22	60.09	18.3	ı	ļ	1	!	Ι,	1	1	ı	1		_	1	1	1	-	1	1	-	-	1	1	0.09	18.3
	MXB	55.0	55.0 124.3	45.0	49.3	65.0	150.0	1	1	1	6	90.06	653.3 6	60.0 66.	2		65.	0 205.	3 95.	0 1009.	- 4	ı	1	1	67.9	322.7
В-С	T18	30.0	15.7	20.0	13.0	20.0	8.3	20.02	10.3	1	1	2.0	3.3 1	10.0 11.	7			_	1	I	1	1	ı		17.0	10.4
Average (x)		22.1	27.8	19.0	29.5	33. 2	94.5	29.0	80.6	39.2	59.2 4	46.9 1	114.5	18.9 33.		37.7 31.5	5 40.0	0 171.1	.1 38.8	172.	9 40.7	30.9	50.0	31.9	34.6	72.0

 $\star$  S. F. = Stomach fullness(%) S. F. = Cell number of nano— and microorganisms in the stomach contents (cells/ind. )

18 Zhu Genhai

nanoplankton of  $2-20\mu m$  in diameter. Recent studies on the feeding apparatus of krill indicate that they are capable of ingesting organisms smaller than  $3\mu m$  in diameter but retain organisms of  $10-20\mu m$  with greatest efficiency (McMclatchie and Boyd, 1983). the other reason may be that these species (nanodiatoms and nanoflagellates) have hard siliceous frustule and are no digested rapidly as well as are retained in the stomach contents (Zhu, 1988).

The stomach fullness increaes gradually with the sexual mature of the krill. It is more obvious in female krill than in male krill. This is because the stomach size and feeding quantity increase gradually with the sexual mature of the krill. Because the female 3BF—3CF stages are after the mating stage, their feeding quantity increace steeply and the cell number of nano- and microorganisms in their stomaches becomes highest.

The number of nano- and microorganisms in stomach contents of E. superba form Sts. T<sub>9</sub> and MXB (C-subarea is the largest, this is because nano- and microalgae are abundant in this subarea and can satisfy the krill's feeding needs; that in stomach contents of E. superba from Sts. T12, D4 and M3 (B-subarea) is the smallest, we make a krill trial capture in this subarea, echo-sounder image and trawl catch show that maximal abundance of the krill is in this subarea, consequently, nano- and microalgae can't satisfy the krill's feeding needs and the stomach fullness and the number of nano- and microorganisms in stomach contents become lowest. Although the abundance of phytoplankton is higher and that of the krill is lower (71inds./1000m3) at the St. T18, stomach fullness and the number of nano- and microalgae in stomach are lower. This is because nano- and microphytoplankton at the station mainly consist of Chaetoceros spp. which is tender and fragile as well as is digested easily by the krill. The other reason may be physiological factor, it is worth while to further culture investigation in future, all of the works are important to the theory of swarming distribution of E. superba (Antezana and Ray, 1983). In addition to ,Corethron criophilam which dominates phytoplankton from net sample in adjacent waters off the South Shetland Islands is not abundant in stomach contents of the krill (Table 5.) and its cells are mostly incomplete, it may be because Chaetoceros and Corethron criphilum are decomposed rapidly in stomach of the krill when they are feeded by E. superba.

Table 3 show that the stomach fullness is not direct proportion to the number of nanoand microorganisms in the stomach contents of *E. superba*. This is because the stomach fullness is affected not only by the number of nano- and microorganisms in the stomach contents but also by the stomach size of the different sexual maturity stages and diet size as well as diet digestibility.

The above results show that diet of E. superba mainly consists of nano- and microphytoplankton between  $2-30\mu\mathrm{m}$  in diameter. This is because plankton in the continental shelf off the South Shetland Islands mostly consists of nano- and microalgae (Brandini and Kutner, 1987; Kopczynska, 1992). Yamaguchi and Shibata (1982) have shown that cells<10 $\mu$ m in size constitute about 50% of the total phytoplankton biomass in antarctic waters, and the abundance of this size group was relatively constant, whereas the size fraction >10 $\mu$ m showed large variations. Hews et al. (1985) reported the importance

Table 5. Relationship between the number of nano- and microorganisms in the stomach contents, cell density

of phytoplankton in the sea water and krill density.

Subarea	Station	Krill density (0-200m) (ind. /1000m³)	(net sample)	No. of Phytoplankton (water sample) (X10³cells/m³)	Stomach fullness (%)	Stomach contents (cells/ind.)
	T15	17	1692	25920	40.0	38. 3
	T16	26	820	18000	13. 1	14.8
Α	T17	86	366	23280	48. 9	27. 7
	T21	44	746	18480	45. 4	28. 6
	T27	12	12040	145680	28. 8	20.0
	T2	628	17. 7	9840	33. 8	20. 5
	T3	293	175. 7	8880	20. 0	14. 3
	T6	6536	268. 1	11280	26. 3	11.1
В	T10	11	830.8	21120	50. 0	72. 7
	T12	1322	95. 4	12000	15. 0	4.1
	D4	4249	_	_	11. 3	3. 6
	M3	980	_		12. 8	4.5
	T4	902	123. 5	35520	39. 0	275. 7
С	Т9	695	90.8	26400	61. 7	324. 2
C	T22	18	812	42000	60.0	18. 3
	MXB	930	294767	_	67. 9	322. 7
В-С	T18	71	77880	467520	17. 0	10. 4

<sup>\* &</sup>quot;-": Not sampling

of ciliates of protozooplankton in Antarctic Ocean ecosystem. In addition to, the results show also that *E. superba* also feeds larger organisms, such as, *Corethron criophilum*, *Rhizosolenia* spp., *Chaetoceros* spp. protozooplankton and copepodites when nano- and microorganisms are not adequate. Boyd *et al.* (1984) demonstrated that *E. superba* are omnivorous.

The above results are similar to the previous conclusion (Marchant and Nash, 1986; Marr, 1962). It is clear that the diet of *E. superba* depends on the dominant species of nanoand microorganisms in sea water. This is consistent with the previous results (Zhu, 1988, 1989).

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20 Zhu Genhai

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