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Copepoda in the southern part of Drake Passage and in Bransfield Strait during early summer 1983—1984 (BIOMASS-SIBEX, December — January)*)

ABSTRACT: Planktonic material was collected at 63 samling stations during the BIOMASS-SIBEX cruise of the r/v "Profesor Siedlecki". Samples were collected with a Bango-505 net in the water column from the sea surface downwards to a depth of about 200 m. Throughout the research area most numerous were the following typically Antarctic species: *Calanoides acutus, Calanus propinquus, Rhincalanus gigas,* and *Metridia gerlachei.* The abundance of the last one was several times higher that of other species. At the time of the investigations the animals were in the final stage of invidual development and in readiness for reproduction.

Key words: Antarctic, Copepoda

1. Introduction

The Antarctic Sector of the Atlantic Ocean belongs to the most often investigated and relatively best known of all the Antarctic waters. The oldest studies on *Copepoda of* these waters are from the end of the 19th century (Brady 1983) and the beginning of the 20th century (Giesbrecht 1902, Wolfenden 1908, 1911). Investigations of plankton in the Scotia Sea, the Weddell Sea, the Bellingshausen Sea and Bransfield Strait were conducted by: Hardy and Gunther (1935), Mackintosh (1934, 1937), Ottestad (1932), Vervoort (1951, 1957), Voronina (1975, 1977), Voronina Vladimirkaja and Żmijewska (1978). Kamirez and Dinofario (1976), Kaczmaruk (1983), Rakusa-Suszczewski (1980, 1983).

This study on *Copepoda* makes a part of the plankton research in the Antarctic and is a continuation of the investigations of Polish planktologists. The aim of this study is the presentation of the species composition, quantitative distribution and age structure of the *Copepoda.*

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2. Material and methods

Macroplankton was sampled with a Bongo net at 63 stations between 10 December 1983 and 8 January 1984. Lokalization of sampling stations is illustrated in paper of Rakusa-Suszczewski and Lipski 1985. The Bongo net consisted of two oculars, each with inlet opening (60 cm in diameter), the filtering screen was made of boltijng cloth (333 μm-mesh in one ocular and 505 μm-mesh in another). Hauling was made in two different ways, obliquely from the sea surface to a depth of about 200 m at the vessel speed of about 3 knots. The net was eqquipped with a depth-recorded and a flow-meter; the filtrering capacity was in the order of 1000 m^3 of water per one ocular. The material presented in this study is taken from the ocular with 505 μm-mesh screen.

Plankton samples were preserved in 4% formaldehyde solution. When the collected material was abundant a part of the samples was kept for analyses. Copepoda were identified using steroscopic microscope in the "Bogorov" chamber. Generally, the whole sample was analysed, less often a part of it. Species composition, age structure, stages of development, and sex in adult forms were determined. The abundance of animals from each haul was calculated in terms of the number of individuals per 1000 m^3 of seawater.

2. Results

In the materials collected in the regions stretching from the South Orkneys to 60°W and to the south of 60°S in the period of time between 10 December 1983 and 8 January 1984 the following species were identified and systematically classified:

Suborder *Calanoida*

Family *Calanidae*

1. *Calanus propinquus* Giesbrecht, 1902
2. *Calanus simillimus* Brady, 1883
3. *Calanoides acutus* Giesbrecht, 1902

Family *Eucalanidae*

4. *Eucalanus longiceps* Matthews, 1925
5. *Rhincalanus gigas* Brady. 1883

Family *Pseudocalanidae*

6. *Clausocalanus laticeps* Farran, 1929
7. *Ctenocalanus vanus* Giesbrecht, 1883

Family *Aeiteidae*

8. *Aeitideopsis minor* Wolfenden, 1911

Table I.

Number of copepods in Bongo — net hauls (ind/1000 m³)

Station No.	3	8	10	12	17	23	29	39	41	52	55	58	60	62	64	67	70	73	75	77	79	81	83
Haul depth (m)	180	180	210	200	185	180	210	193	205	190	223	210	210	170	235	193	193	180	180	145	180	170	163
1. *Calamus propinquus*	68	457	459	41	50	37	65	144	41	65	23	69	149	269	23	92	7	10	13	10	24	23	117
2. *Calanus simillimus*					17						11	1	348	106				1	2	8	3	9	
3. *Calanoides acutus*	343	3239	5193	555	107	61	214	230	1117	260	170	81	304	5917	54	92	20	39	49	20	124	165	1883
4. *Eucalanus longiceps*													7								1		
5. *Rhincalanus gigas*	53	353	820	455	66	18	19	41	248	97	102	108	1398	1793	22	46	35	55	129	49	31	347	1367
6. *Clausocalanus laticeps*			226												5								
7. *Ctenocalanus vanus*							6															23	
8. *Euatideus* sp.																							
9. *Euatideus australis*																2							
10. *Euatideus bradyi*																							
11. *Aetideopsis minor*																							
12. *Euchirella rostromagna*			52										28	49		3							5
13. *Gaidius* sp.																							
14. *Gaetanus* antarcticus																							
15. *Parauchaeta* spp.	739	291	1056	19	20	49	6	53	71			8	88	815	3	52	2		122	7	14	212	436
16. *Scolecithricella* sp.																							
17. *Scolecithricella glacialis*													22			3							
18. *Parauchaeta antarctica*			3																				
19. *Rakovitzanus antarcticus*				7	4	6	13	18				3				8							
20. *Metridia gerlachei*	26	1017	1976	4	253	1321	311	18	35	33	34	195	6	310	98	666		1	22	2			1383
21. *Metridia lucens*												7							1			81	5
22. *Metridia* sp.																					1	22	
23. *Pleuromamma* r.f.*ant.*												4		8								1	
24. *Heterorhabdus farrani*			2																			10	
25. *Heterorhabdus austrinus*												7	6			3				1			
26. *Heterorhabdus* sp.			13				13	4							1								5
27. *Haloptilus ocellatus*			52													2							
28. *Haloptilus oxycephalus*		62	78	4	13	6	13	2	6				11	65	2	9						4	11
29. *Candacia sp.*																						1	
30. *Candacia falicifera*																							
31. *Paralabidocera antarctica*	68	104	110						6														
32. *Harpacticoida* (juv.)																							
33. *Cyclopoida*			6										253							1			
Total	1297	5523	10046	1085	530	1498	660	510	1524	455	340	483	2620	9332	208	978	64	106	338	98	198	898	5212

Station No.	88	91	93	96	99	102	104	107	111	113	116	119	121	123	127	129	131	134	137	140	142	145	150	152	154	156	159	162	165	168	170	173	276	184	200	208	210	213	217
Haul depth (m)	215	215	222	195	197	180	245	150	180	120	205	175	195	117	200	220	210	170	110	167	180	210	75	185	195	192	75	165	180	145	195	160	160	180	200	155	148	197	193
1. *Calamus propinquus*	30	153	217	159	11	82	89	113	69	55	98	102	102	245	221	9	27	54	9	10	21	374	153	48	232	41	39	38	36	19	59	61	137	82	106	105	20	4	33
2. *Calanus simillimus*	19	10																																					
3. *Calanoides acutus*	511	1080	1628	603	285	663	325	592	347	162	416	124	609	489	367	2	82	79	12	27	15	795	1137	371	542	129	79	216	198	168	770	234	455	15	82	17	66	17	60
4. *Eucalanus longiceps*																							2																
5. *Rhincalanus gigas*	1359	411	302	159	86	282	117	385	76	51	61	37	121	302	151	3	8	9	6			568	167	83	208	27	9	20		3	35	16	129	3	8	6	39	12	21
6. *Clausocalanus laticeps*												1				3		19						17				2								1	8	8	2
7. *Ctenocalanus vanus*				7				3																															
8. *Euatideus* sp.																		1								7	2		4										
9. *Euatideus australis*																																							
10. *Euatideus bradyi*			36	28																																			
11. *Aetideopsis minor*									3																														
12. *Euchirella rostromagna*	22		12				3																																
13. *Gaidius* sp.																																							
14. *Gaetanus* antarcticus																						7									3								
15. *Parauchaeta* spp.	252	114	736	194	66	53	38	169	73	8	127	1	167	8	140		30	70	15	3	3	132	2	68	111	259	73	155	71	63	73		129	1	2	18	8		12
16. *Scolecithricella* sp.								10																	5														
17. *Scolecithricella glacialis*								8																															
18. *Parauchaeta antarctica*																																							
19. *Rakovitzanus antarcticus*	26	15	36	21	11	29	13		31	3	8	13	37					4				12			24								3						
20. *Metridia gerlachei*	178	381	15776	15000	11251	2346	1736	2444	1583	23	659	8	4776	137	1388		157	589	58	2		5713		50	5206	1049	146	694	613		129		10722	569	34	328	8	2	
21. *Metridia lucens*	33																																			3			
22. *Metridia* sp.																																							
23. *Pleuromamma* r.f.*ant.*													5																										
24. *Heterorhabdus farrani*	4																						14																
25. *Heterorhabdus austrinus*																																							
26. *Heterorhabdus* sp.	4		12			6	10		7				23															4											
27. *Haloptilus ocellatus*																																							
28. *Haloptilus oxycephalus*		15	97	14				56	14		4		23		32			1				6		4	15				2										
29. *Candacia sp.*																																							
30. *Candacia falicifera*														2									1																
31. *Paralabidocera antarctica*																										7	155	168	232	373	2058		3						64
32. *Harpacticoida* (juv.)																												2											
33. *Cyclopoida*																		86						38					4							4			
Total	2438	2179	18852	16185	11710	3461	2334	3777	2203	302	1373	286	5863	183	2299	17	304	912	100	42	39	7607	1476	679	6343	1519	503	1299	1160	755	2998	311	11578	670	232	460	153	43	192

9. *Euaetideus australis* Vervoort, 1957
10. *Euaetideus bradyi* Scott, 1909
11. *Euaetideus* sp.
12. *Euchirella rostromagna* Wolfenden, 1911
13. *Gaidius* sp.
14. *Gaetanus antarcticus* Wolfeneden, 1911

Family *Euchaetidae*

15. *Parauchaeta antarctica* Giesbrecht. 1902
16. *Parauchaeta* sp.

Family *Scolecithricidae*

17. *Rakovitzanus antarcticus* Giesbrecht, 1902
18. *Scolecithricella glacialis* Gisbrecht, 1902
19. *Scolecithericella* sp.

Family *Metridiidae*

20. *Metridia gerlachei* Giesbrecht, 1902
21. *Metrida lucens* Boeck, 1863
22. *Metridia* sp.
23. *Pleuromamma robusta* f. *antarctica* Steuter, 1931

Family *Heterorhabdidae*

24. *Heterorhabdus austrinus* Giesbrecht, 1902
25. *Heterorhabdus farrani* Brady, 1883
26. *Heterorhabdus* sp.

Family *Augaptilidae*

27. *Haloptilus ocellatus* Wolfenden, 1905
28. *Haloptilus oxycephalus* Giesbrecht, 1888

Family *Candaciidae*

29. *Candacia falcifera* Farran, 1929
30. *Candacia* sp.

Family *Acartiidae*

31. *Paralabidocera antarctica* (I.C. Thompson, 1893)

Suborder *Cyclopoida*

Family *Oithonidae*

32. *Oithona* sp.

Family *Oncaeidae*

33. *Oncaea* sp.

Suborder *Harpacticoida*

34. (copepodit I-V)

For all that variety of the species composition only a few species of *Copepoda* occur in large concentrations (Table I). The highest abundance of *Copepoda* (over 10.000 ind./1000 m^3) was recorded in the southwestern part of the research area, near Anvers Island, in pelagic waters along the line between Joinville Island and the South Orkneys and to the south of Clarence Island.

The presence of the following species: *Calanoides acutus, Calanus propinquus, Rhincalanus gigas, Metridia gerlachei,* and *Parauchaeta* sp., was observed most often and in largest quantities. *Haloptilus oxycephalus* and *Rakovitzanus antarcticus* were recorded fairly often but in rather small numbers. *Paralabidocera antarctica* occurred in great numbers, but only in some particular areas.

Calanoides acutus was present at all the sampling stations. The highest concentrations of this species were observed in the southwestern part of the research region, to the north of Anvers Island, overs the shelf of the South Shetlands to the north of King George Island (peak of abundance — 5193 ind./1000 m^3) and in the eastern part of the investigation area, between Antarctic Peninsula and the South Orkneys. The lowest numbers of *Calanoides acutus* were noted in the southern part of Bransfield Strait and over shelf around the cape of the Antarctic Peninsula (Table I, Fig. 1). The age-structure of *Calanoides acutus* shows insignificant differences throughout the research area. In the western part of the region a distinct predominance of adult forms over the copepodit IV-V stage. In the southeastern part of the research region a small preponderance of the copepodit IV-V stages over the adult stages was observed. The presence of copepodit I-III stages, making up about 30% of the total number of individuals, was noted along the line between Joinville Island and King George Island (Fig. 1).

Calanus propinquus occurs at all the sampling stations throughtout the investigated region. Abundance of this species is several times lower than that of *Calanoides acutus* but their distribution is much alike (Table I, Fig. 2). The age structure of *Calanus propinquus* is in general similar to that of *Calanoides acutus*, with the exception of a marked predominance of adult forms over the copepodit stages IV-V and a mush lower percentage of the youngest copepodits (Fig. 2).

Rhincalanus gigas at all the sampling stations throughout the investigated region and is more numerous than *Calanus propinquus*. Distribution of *Rhincalanus gigas* is similar to that of the two species described above, nonetheless a marked inereasy in number of this species population was noticed in the pelagial waters of the northern and western part of the research area (Table I, Fig. 3).

The age structure of the populations of this species differs from the age structure of the above-described species. The copepodit IV-V stages predominate decidedly, only at some of sampling stations of the research region the percentage of adult forms is even slightly higher than in the others. At some of the sampling stations in Drake Passage (Sta. 60, 70, 79) the presence of *Rhincalanus gigas* naupli and copepodit I—II stages was observed. Practically, the copepodit III stage was present throughout

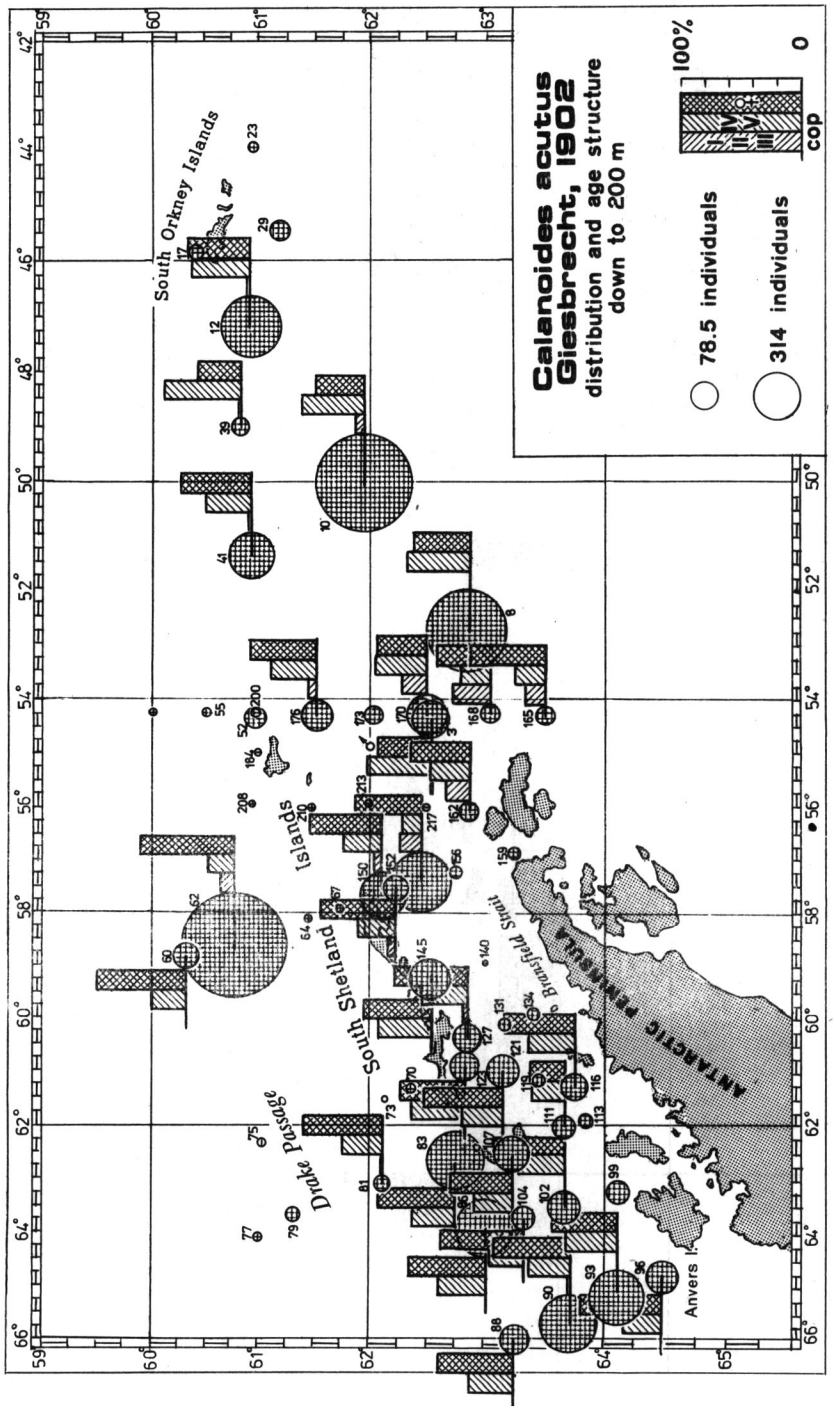

Fig. 1. Distribution and age structure of *Calanoides acutus*, down to 200 m

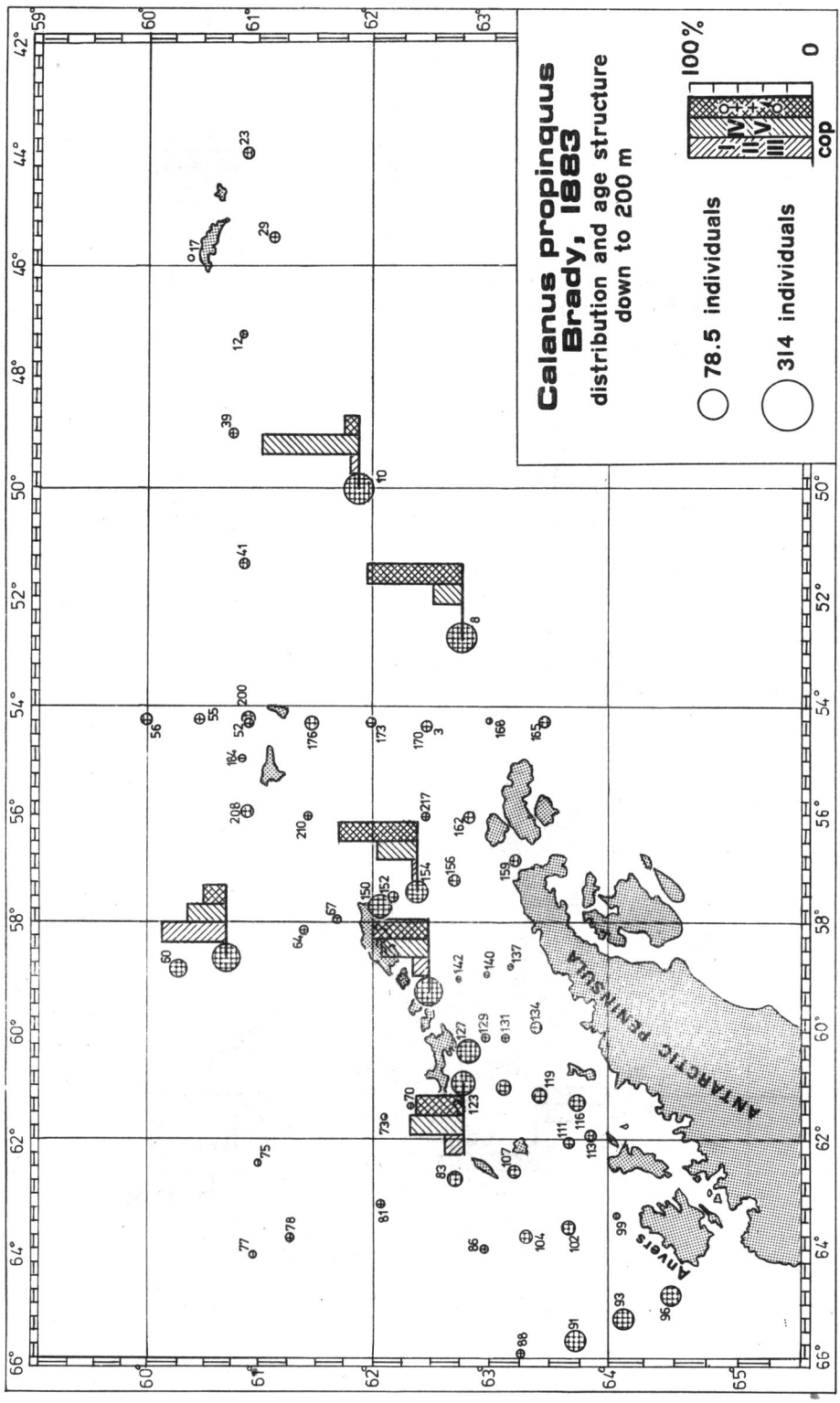

Fig. 2. Distribution and age structure of *Calamus propinquus*, down to 200 m

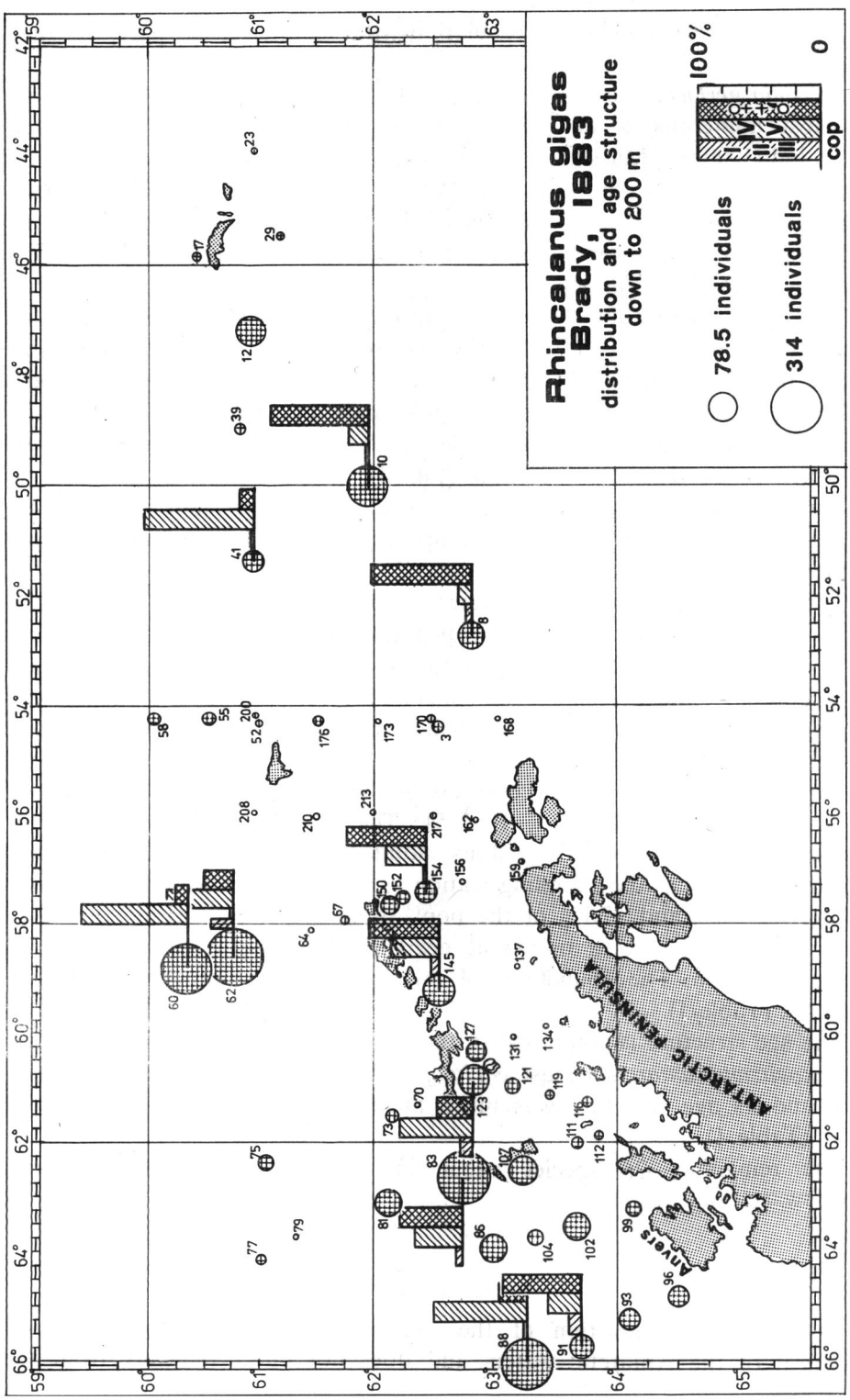

Fig. 3. Distribution and age structure of *Rhincalanus gigas*, down to 200 m

the research area and in particular in the southeastern part of that region (Fig. 3).

Metridia gerlachei occurs throughout the research area. This species was the most numerous of all the *Copepoda* with the maximum abundance 15 776 ind./1000 m^3. Mass-concentrations of *Metridia gerlachei* were observed in the region of the southwestern part of the Antarctic Peninsula shelf, over the shelf of the South Shetlands near Elephant Island and the South Orkney Islands. Northward, a decrease in number of this species population was noted (Table I, Fig. 4).

The age structure of *Metridia gerlachei* shows marked differences in spatial distribution. In the southwestern part of the research area and along the South Shetlands up to King George Island the copepodit IV-V stages predominate. In the eastern part of the region and in the southern part of Bransfield Strait the adult forms are predominant with a marked preponderance of females (Fig. 4).

Parauchaeta sp. occur at almost all the sampling stations, however, they do not concentrate in large groups as other species described above (Table I).

The age structure of this species is little diverified. In almost the whole area of investigations the copepodit I-III stages make up nearly 100% of the population. The region to the east of Joinville Island formed an exception — the percentage of copepodit I—III and IV—V stages was the same. The presence of males and females of *Parauchaeta antarctica* was observed at three stations (Table I).

Paralabidocera antarctica occurs exclusively in the southeastern part of the research region (Table I, Fig. 5). The composition of this species population is unusually homogenous, adult forms made up 100% of the populations; only at the sampling stations 3 and 10 juvenile forms occurred making up 7.4% and 17.1% of the population, respectively (Fig. 5).

Haloptilus oxycephalus occurs at nearly half of the stations in the investigated region. The abundance of this species does not exceed 80 ind./ /1000 m^3 (Table I).

The age structure is composed of the copepodit IV-V stages and females.

Rakovitzanus antarcticus, just as *Haloptilus oxycephalus*, was observed quite often and its age structure was much alike, yet, its abundance was much lower (Table I).

The remaining 26 species occur in very small quantities and at very few stations (Table I).

4. Discussion

The species composition of the *Copepoda* in the investigated region is typical of the Antarctic waters and does not differ radically from the

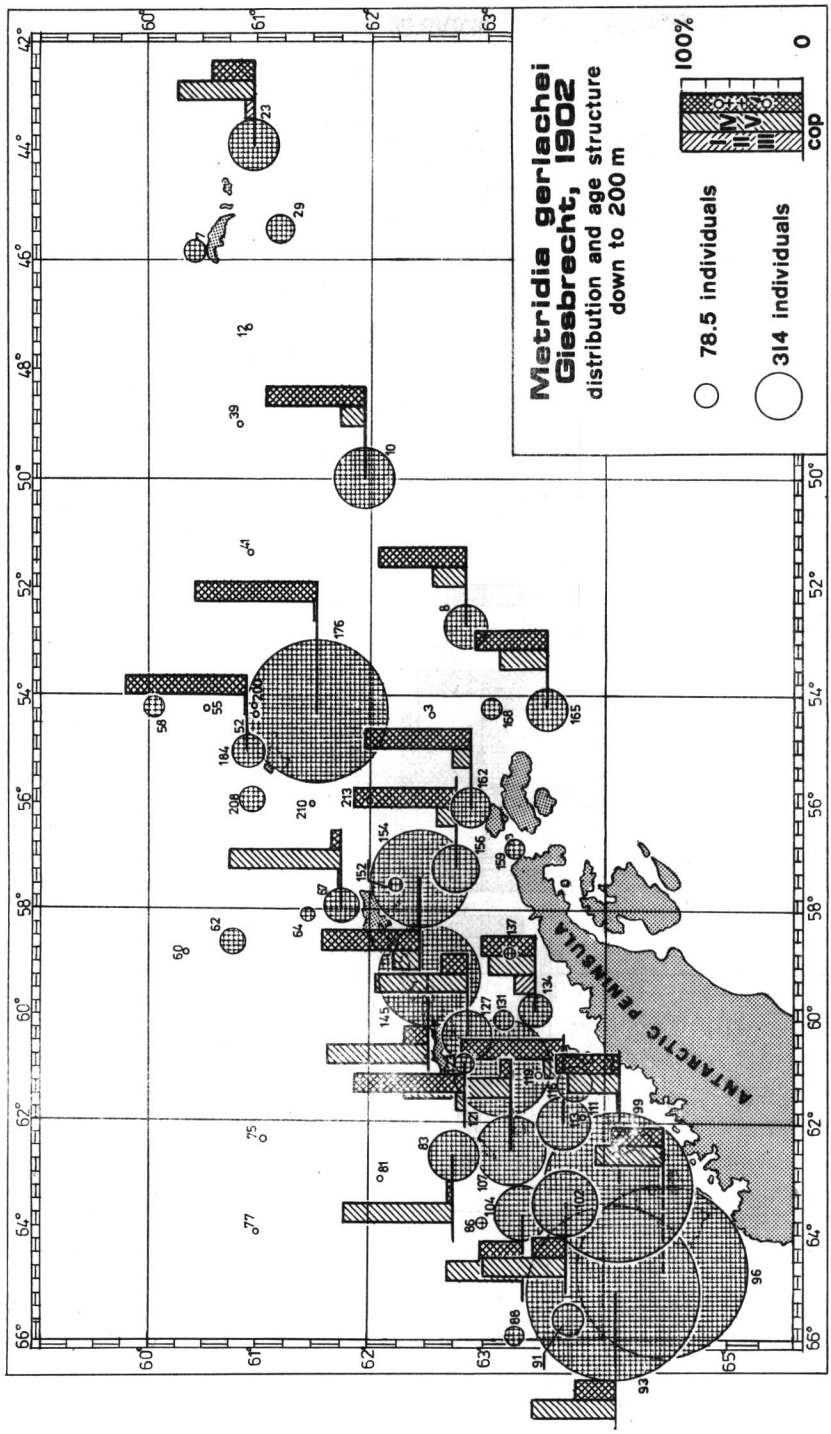

Fig. 4. Distribution and age structure of *Metridia gerlachei*, down to 200 m

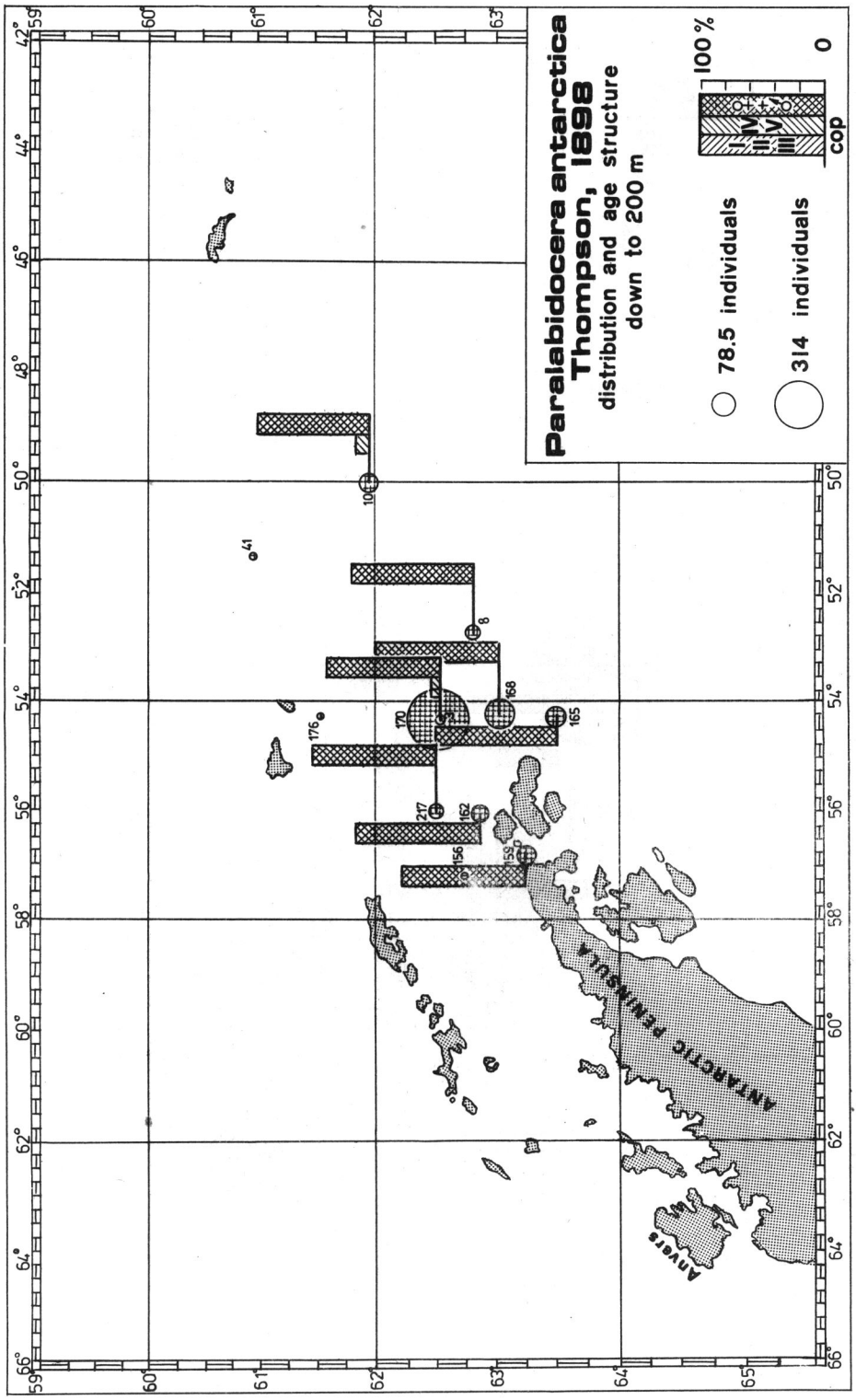

Fig. 5. Distribution and age structure of *Paralabidocera antarctica*, down to 200 m

data of other authors, provided that we take into account the fact that a Bongo-net with a 505 μm-mesh filtering screen catches almost exclusively "large" *Calanoida* (Brady 1883, Giesbrecht 1902, Wolfenden 1911, Mackintosh 1937, Ottestat 1932, Ramirez and Dinofario 1976, Vervoort 1951, 1957, and others). The plankton composition in the research region consists mainly of the typically Antarctic species with predominance of *Calanoides acutus, Calanus propinquus, Rhincalanus gigas, Metridia gerlachei,* and *Parauchaeta* sp.

The occurrence of the animals of sub-Antarctic origin, such as: *Calanus simillimus, Eucalanus longiceps, Metridia lucens, Pleuromamma robusta* f. *antarctica,* was limited to the stations in the utmost northern part of Drake Passage calanus simillimus, just as the bove-mentioned species, was quite often observed to the south of the Antarctic Convergence (Naumov 1973, Brodsky 1967, Żmijewska 1980). Kaczmaruk (1983) noticed the occurrence of *Calanus simillimus* within the middle part of the Weddell Sea, which is an interesting phenomenon, since in the studies published in the last few years the presence of this species in the coastal waters of Antarctica was not mentioned (Bradford 1971, Zvereva 1972, Żmijewska 1983).

The distribution of *Paralabidocera antarctica* is a matter of some interest. This species occurs exclusively in the southeastern part of the research region, which is under the influence of the Weddell Sea waters. Bradford (1971), Vervoort (1957), Tanaka (1964) associate high frequency of *Paralabidocera antarctica* with the masses of waters flowing from the Antarctic continent.

High frequency and predominance of about forms of the species occurring in large quantities such as: *Calanoides acutus, Calanus propinquus,* or *Rhincalanus gigas,* evidence the fact that the animals have completed their spring migration and are in full procreation season. These species belong to the group "interzonal" animals, staying in summer in the superficial layers and in winter in deep waters (Ommanney 1936, Mackintosh 1937, Andrews 1966, Voronina 1970, 1975).

In the investigations period *Calanoides acutus* was superior to *Calanus propinquus* in respect of the stage of development, which was manifested by a much higher percentage of the adult forms of the former species. The development of both these species is asynchronous (Voronina 1975, Voronina, Vladimirskaja and Żmijewska 1978). Andrews (1966) in his studies on the biology of *Calanoides acutus* indicates December-January period as the time of the egg-production season; the time and place of reproduction is not mentioned.

The fact of the presence of four male specimens of *Calanoides acutus* in the analysed planktonic material is a noteworthy event. They were caught in Bransfield Strait. For the first time a male individual of this

species was described, on the basis of a single specimen, by Vervoort (1951). That author is of opinion that *Calanoides acutus* males are found very rerely, since fertilization occurs in deep waters and they live a very short line. The process of migration of this species, much the same as that of other "interzonal" *Copepoda*, is a process of long duration. The animals need about four months to reach the euphotic water layer (Voronina, Vladimirskaja and Żmijewska 1978). In the material described by author the *Calanoides acutus* males had been collected from 0—200 m depths, and according to Vervoort (1951) the lifetime of males is very short, thus fertilization may occur in the upper part of the Antarctic waters.

Rhincalanus gigas, just the same as *Calanoides acutus*, occurs in large quantities all over the research area (Fig. 2) and is represented by old generation with predominance of females and a low percentage of males, also, some individuals in the copeopodit III stage were observed. These animals belong to the winter population. The appearance of nauplii and copepodit I-II stages in Drake Passage evidences the beginning of reproduction. *Rhincalanus gigas* has two reproduction cycles: one occurs in winter another in summer (Ommanney 1936, Voronina, Vladimirskaja and Żmijewska 1978); both generations were present in the material under discussion, yet "winter" generation was predominant.

Metridia gerlachei is the most numerous of all the species occurring in the research area, its abundance is much higher than that of other *Calanoida*. The frequency of this species decreases from the south towards the north, where it is replaced by an allied species — *Metridia lucens* (Table I, Fig. 4). According to Vervoort (1965) the horizontal and vertical distribution of *Metridia gerlachei* is determined by isotherm — 1°C and the animals stay day and night in the layer between 100 and 250 m depth, which confirm ist abundant occurrence in the research area.

The age-structure of *Metridia gerlachei* population was strongly differentiated, it consisted of copepodit IV-V stages and adult individuals with the presence of males and predominance of females, both belonging to the same generation. It seems that the animals living in the eastern part of the investigated region and southern part of Bransfield Strait (over 70% of the population consisted of adult forms) were ready reproduction, which would not corroborate the statement of Vervoort (1965) that *Metridia gerlachei* procreates at the end of the austral summer.

The mass-occurrence of *Copepoda* plays an important role in the ecosystem of the Antarctic. These animals are phytophages, except the omnivorous *Metridia gerlachei* (Nakamura and Kadota 1982), and therefore they are rivals of krill in the competition for food (cf. Rakusa-Suszczewski 1983).

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5. Резюме

Представлены результаты исследований копепод в течение БИОМАСС-СИБЭКС в конце декабря 1983 и начале января 1984. Пробы планктона были собраны на 63 станциях расположенных в районе Южных Оркнейских островов до 66°W и на юг от 60°S. Исследовательский материал был собран сетью Бонго — 505 со слоя 0—200 м. Были обнаружены 34 вида копепод, причём наиболее частным были виды типичные для Антарктики: *Calanoides acutus*, *Calanus propinquus*, *Rhincalanus gigas* и *Metridia gerlachei*. Численность последнего вида была несколько раз выше чем остальных (таблица I, рис. 4). Влияние субантарктических видов ограничивалось к северо-западной части пролива Дрейка. Распределение *Paralabidocera antarctica* позволяет судить, что этот вид является характерным для вод моря Уэдделла.

Возрастная структура массово обнаруженных видов копепод и доминация взрослых особъей свидетельствуют о совершении созревания старой генерации и проготовлении к разроду. В проливе Брансфилда были обнаружены самцы *Calanoides acutus*, что связано с возможностью оплодотворения этого вида в более высоких слоях антарктических вод. Исследования подтвердили асинхронность развития доминирующих копепод.

6. Streszczenie

Przedstawiono wyniki badań *Copepoda* ze zbiorów BIOMASS-SIBEX, z przełomu grudnia 1983 i stycznia 1984. Próby planktonowe pochodziły z 63 stacji usytuowanych na obszarze od Południowych Orkadów po 66°W i na południe od 60°S. Materiał badawczy pobierano siecią Bongo — 505 z warstwy 0—200 m. Stwierdzono 34 gatunki *Copepoda*, z czego najliczniej na całym obszarze badań występowały gatunki typowo antarktyczne: *Calanoides acutus*, *Calanus propinquus*, *Rhincalanus gigas* i *Metridia gerlachei*. Liczebność tego ostatniego była kilkakrotnie wyższa niż pozostałych gatunków (tabela I, rys. 4). Wpływ gatunków subantarktycznych ograniczał się do północno-zachodniej części Cieśniny Drake'a. Rozmieszczenie *Paralabiocera antarctica* sugeruje, że jest gatunek ten wskaźnikiem wód Morza Weddella.

Struktura wiekowa masowo występujących gatunków *Copepoda* dominacja form dorosłych, świadczy o schyłku rozwoju osobniczego starej generacji i gotowości do rozrodu. W Cieśninie Bransfielda stwierdzono obecność samców *Calanoides acutus*, co wiąże się z możliwością rozrodu tego gatunku w wyższych warstwach wód antarktycznych. Badania potwierdziły asynchroniczność rozwoju domimujących *Copepoda*.

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