Zooplankton of the Antarctica waters

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ABSTRACT

Distribution, abundance and diel variation in zooplankton were studied in Antarctic waters. Zooplankton biomass values ranged from 14 to 624 ml/1000 m^3. High standard stock values (average 284 ml/1000 m^3) were recorded in the Antarctic Convergence where radiolarians and euphasids were the dominant taxa. Copepoda, Amphipoda and Chaetognatha formed the major constituents of zooplankton community in the Polar Divergence and Subtropical Convergence. Salinity fluctuations were not much (33.59 to 35.169k). Temperature variations (-0.33 to 16.66°C) were the important factor influencing the geographical distribution of the species investigated. The species diversity values were low and showed inverse relationship with biomass. No appreciable nocturnal abundance of biomass and zooplankton species was observed.

INTRODUCTION

Zooplankton is one of the major links of the food chain in the ocean. Several large marine zooplankton species are commercially exploited to augment animal protein production for the mankind. The most important zooplankton species with potential protein resource in Antarctic waters is the *krill(Euphausia superba).* The ecological studies of zooplankton in Antarctica were carried out by Farren (1929); Mackintosh (1937); Brodskii (1964) and Voronina, Menshutkin and Tseytlin (1980). The present paper deals with the qualitative and quantitative distribution of groups and species of zooplankton collected during the First Indian Expedition to Antarctica (December, 1981 to February, 1982).

MATERIAL AND METHODS

Zooplankton samples were collected in vertical hauls from 1000 m to the surface using the Indian Ocean Standard Net (Currie, 1963; mesh size 0.3 mm) and from 200 m to the surface using the Heron-Tranter net (mouth area 0.25 m^2; mesh size 0.3 mm). Two sets of collections were made. For the first set, sampling was done at 16 stations (Fig. 1), while for the second set, collections were taken at every 3 hours interval for diel studies at station G2. Zooplankton samples were fixed in 5% formaldehyde. Biomass was determined by displacement volume method. Major zooplankton taxa were sorted out from aliquots (5-20%) and species were identified as far as possible. The number of organisms was calculated for the whole sample and computed per 1000 m^3. For comparison purposes, the area studied has been divided into Polar Divergence (Stations 1 to 9), Antarctic Convergence (Stations 10 to 13) and Subtropical Convergence (Stations 14 to 16). Secondary production was computed by using the formulae given by Cashing (1971 and 1973). Species diversity values were calculated as per the method of Shannon and Weaver (1963).

RESULTS

Hydrography

Polar divergence showed the characteristics of cold (-0.33 to - 1.75°C) and low saline surface Antarctic waters (33.86 to 34.31‰). The Antarctic Convergence is delineated by sudden change of surface temperature (1.49 to 7.2°C) and salinity showing slightly lower values (< x =‰). The further increase in surface temperature (5.47 to 16.16°C) and salinity (33.77 to 35.169‰) were the main hydrographical features of the Subtropical Convergence (Table 1)

Zooplankton biomass

Zooplankton biomass values ranged from 14 to 624 ml/1000 m^3. High zooplankton concentrations were recorded for the Antarctic Convergence (Average 284 ml/1000m^3), followed by the Subtropical Convergence (Average 56 ml/1000 m^3) and the Polar Divergence (Average 45 ml/1000m^3). The highest value of 624 ml/1000m^3 was recorded at Station G-10 where dense aggregations (291000/l000m^3) or radiolarians formed the bulk of zooplantkton biomass. The biomass values obtained for diel cycle investigations at Stations G-2 were rather low (22 to 48 ml/1000m^3) and the zooplankton samples contained mostly the larval stages of crustaceans. No nocturnal abundance of zooplankters was observed. The highest biomass values were obtained at 0930 hrs. (Fig, 2).

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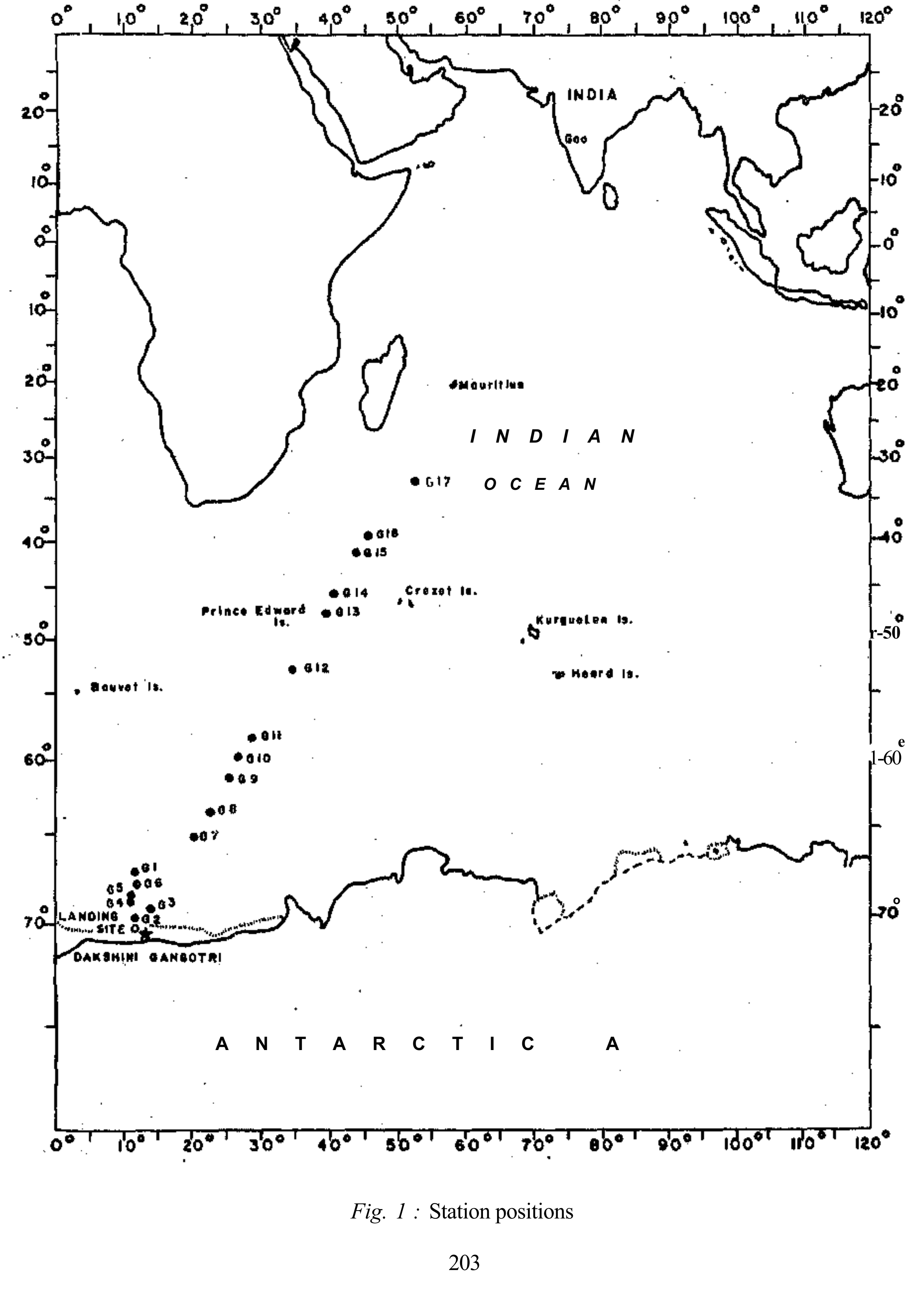


Fig. 1 : Station positions

TABLE 1

Sampling details with surface temperature, salinity and zooplankton biomass values at different stations.

Station No.	Geographical Lat,	Position Long.	Date of collection	Time of collection (hrs).	Depth of Sampling Station (m)	Temperature (°C)	Salinity ‰	Biomass (ml/1000 m^3)
1	2	3	4	5	6	7	8	9
G-1	67° 13-5'S	39°12-3'E	03-01--1982	1915	3600	-1,37	34.31	24
G-2	69°58-14'S	H°54-65'E	14-01--1982	1330	227	-1.36	34 12	34
G-3	69°-00'S	13°41-05'E	19-01--1982	1030	2337	-0.99	33,59	14
G-4	6843-5'S	H°06-7'E	20-01--1982	1700	1661	-0.54	34.10	34
G-5	68°24-65'S	iril-67'E	21-01--1982	1530	2070	-0.33	34.03	25
G-6	67°46-37'S	12°00-04'E	22-01--1982	1330	1990	0.28	33.96	48
G-7	65° 15-27'S	20°03-89'E	25-01--1982	1245	>4000	-0.80	33.86	46
G-8	63°30-20'S	22°26-13'E	26-01--1982	0245	5300	-1.75	33.87	59
G-9	61°28-21'S	25°01-15'E	26-01--1982	1745	5500	-	-	126
G-10	59°58-74'S	26°49-81'E	27-^)1--1982	0630	5600	1.49	33.98	624
G-11	58° 15-53'S	28°42-42'E	27-01--1982	1945	4800	2.43	33.88	283
G-12	52°48-14'S	34°25-44'E	29-01--1982	0745	6799	3,48	33.77	130
G-13	47°23-03'S	39°02-04'E	30-01--1982	2200	>4000	7.20	33.83	102
G-14	45°38-07'S	40°24-62'E	31-01--1982	0845	1680	5.47	33.77	49
G-15	41° 14-36'S	43°45-77'E	01-02--1982	1545	3400	16.16	25.08	29
G-16	39°25-06'S	45°03-08'E	02-02-1982	0545	3600	13.71	35.16	92

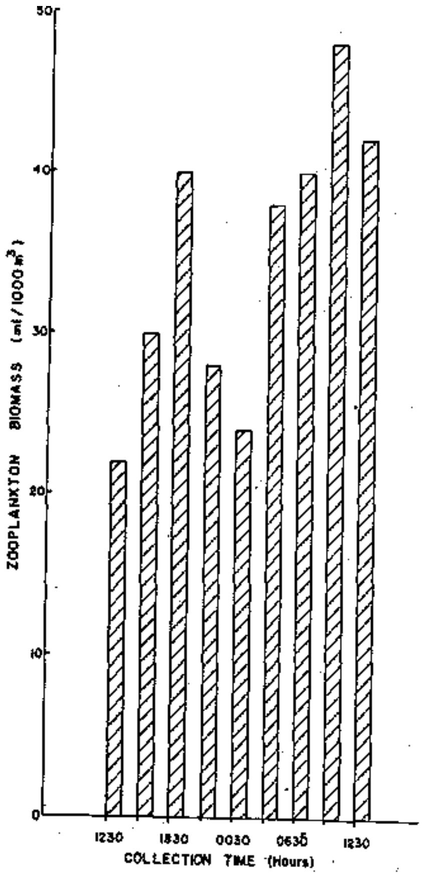


Fig. 2:
Zooplankton biomass
at different hours at station G2.

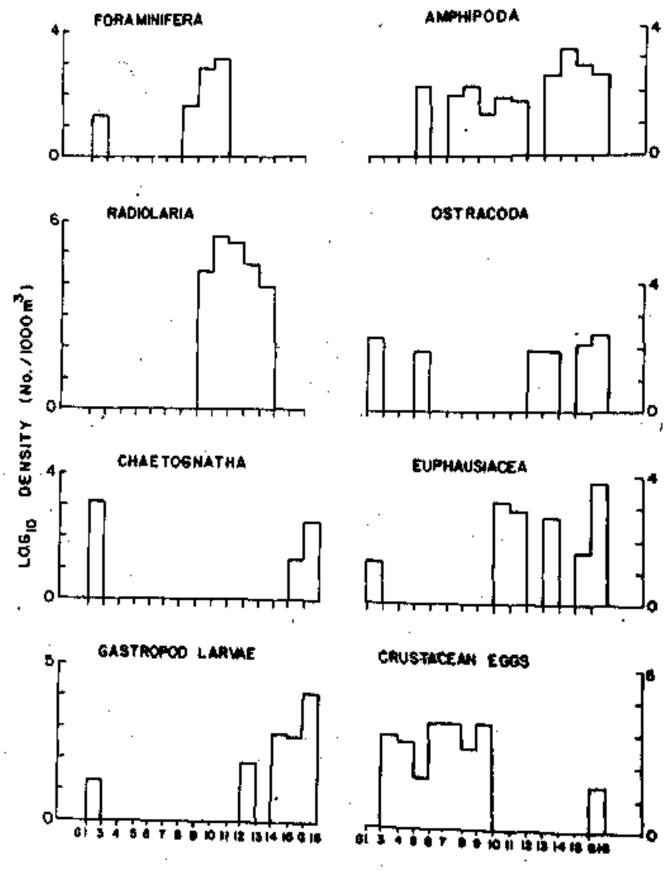


Fig. 3
Occurrence of common zooplankton groups
at different stations.

Faunal composition and species distribution

The highest zooplankton count was obtained at station G 10 (315880/1,000 ra^3) followed by station G11 (226360/l00m^3). The total zooplankton counts obtained for the Polar Divergence were rather poor (2240 to 30531/l000m^3). Sixteen zooplanktonic groups were observed, of which 9 were invariably present at all stations. Based on the total zooplankton counts, the groups in order of abundance were Radiolaria (60.4%), Copepoda (35.1%), Gastropoda (1.4%), Euphausiacea (1%), Crustacean eggs (0.9%), Amphipoda (0.5%), Foraminifera (0.2%), Chaetognatha (0.1%) and Ostracoda (0.1%). Their occurrence at different stations is shown in Fig. 3. Copepods and euphausids were the main groups in zooplankton collections taken at different hours of the day. Their occurrence was independent of the diel cycle. Amphipods and decapod larvae were recorded in the plankton samples taken during 0600 to 1600 hrs and 1800 to 0600 hrs respectively (Fig. 4).

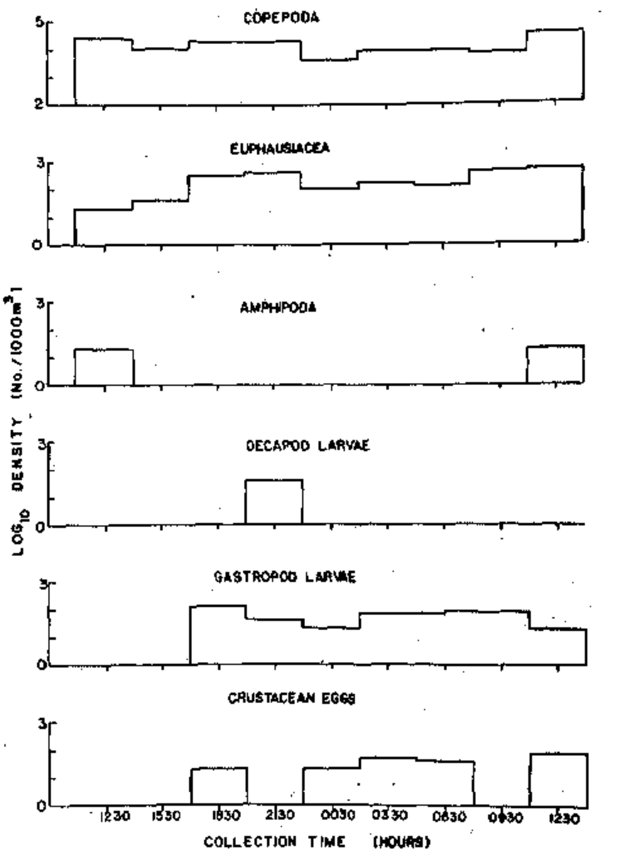
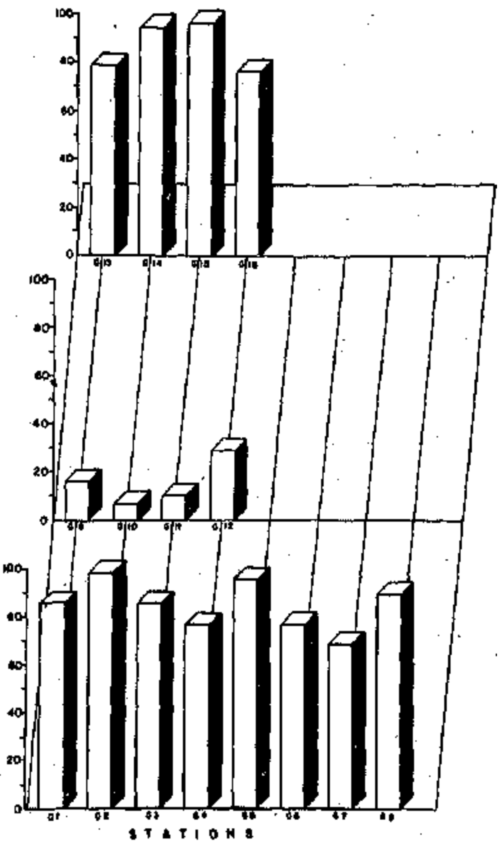


Fig. 4:
Occurrence of common zooplankton groups at different hours at station G2.



Fig,5 :
Percentage occurrence of total copepods at different stations

Copepoda

The copepods were the dominant constituent of zooplankton in the Polar Divergence and the Subtropical Convergence *(Fig. 5).* The copepod population at different stations was dominated by calanoids (84.5%) followed by cyclopoids (14.6%) and harpacticoids (0.9%), However, the harpacticoids were recorded in larger numbers in samples obtained for diel studies at stations G2. The corresponding percentage of copepods there were 88.7, 8.4 and 2:9% respectively. A total of 36 copepod species were recorded during the present study (calanoids 27, cyclopoids 7 and harpacticoids 2). Twenty one copepod species viz. *Canthocalanus pauper* (12.8%) *Undinula darwine* (11.3%), *Paracalanus aculeatus* (8.5%).

Calanus simillimus (8.2%), *Clausocalanus arcuicornis* (7.3%), *Calanus propinquus (5%), Eucalanus monachus* (4.6%), *Oncaea conifera* (4%), *Rhincalanus cornutus* (3.9%), *Calanoides acutus* (3.5%), *Eucalanus* sp. (3.4%), *Eucalanus elongatus* (3.2%), *Oncaea venusta* (3%), *Acrocalanus longicomis* (2.8%), *Rhincalanus nasutus* (2.2%), *R. gigas* (2.1%), *Oncaea curvata* (1.9%) *Oithona similis* (1.6%), *Pontellopsis regalis* (1.3%), *Oithona plumifera* (1.1%), *Candacia aethiopica* (1%), formed the bulk of *Copepods.* The remaining 15 species such as *Clausocalanus laticeps, Heterorhabdus spinifrons, Heterorhabdus* sp, *Euchirella brevicornis, Euchirella rostrata, Scolecithrix danae, Scolecithrix* sp, *Candacia* sp, *Euaetideus* sp, *Scaphocalanus* sp, *Haloptilus* sp, *Oithona setigera, Oithona* sp, *Microsetella norvegica* and *Miracia efferata* were recorded in small numbers (1%). The distribution of some of

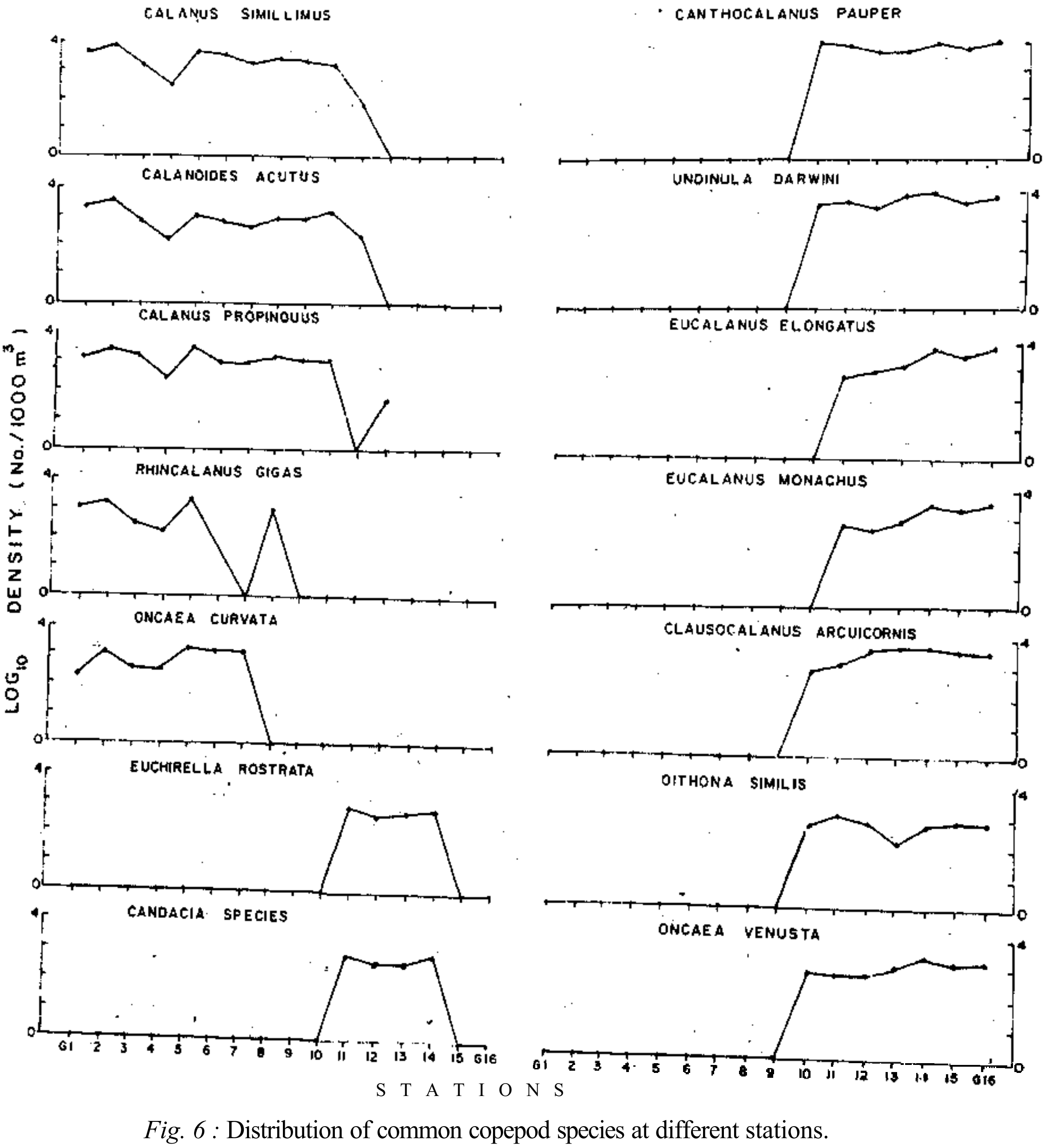


Fig. 6 : Distribution of common copepod species at different stations.

common copepod species is shown in Fig. 6 Spatial variations in the distribution of copepod species were also observed. *Rhincalcmus gigas, Clausocalanus laticeps, Heterorhabdus* sp, *Scolecithrix* sp, *Euaetideus* sp, *Scaphocalanus* sp, *Oithona* sp, and *Oncaea conifera* were recorded only from the Polar Divergence. *Calanus simillimus, C. propinquus, Calanoides acutus and Heterorhabdus spinifrons* were the other abundant species from this region. *Haloptilus* sp, *Acrocalanus longicornis, Scolecithrix danae, Pontellopsis regalis, Candacia aethiopica* from the Antarctic Convergence and *Oithono setigera* and *Miracia efferata* from the Subtropical Convergence. The temperature influenced the geographical distribution of species. The minimum of 6 and maximum of 22 copepod species were obtained from the Polar Divergence and the Antarctic Convergence where the minimum and maximum temperature values were recorded (Table 1). The individuals of a particular species also occurred in greater numbers when temperature was higher (Table 2). The copepod species diversity (D) values ranged from. 1.8 to 2.8 in the Polar Divergence, 3.0 to 3.3 in the Antarctic Convergence and 3.6 to 3.9 in the Subtropical Convergence, The diversity values generally showed inverse relationship with the total copepod biomass in the Polar Divergence indicating that a few copepod species contributed to the total copepod counts (Fig. 6 & 7)

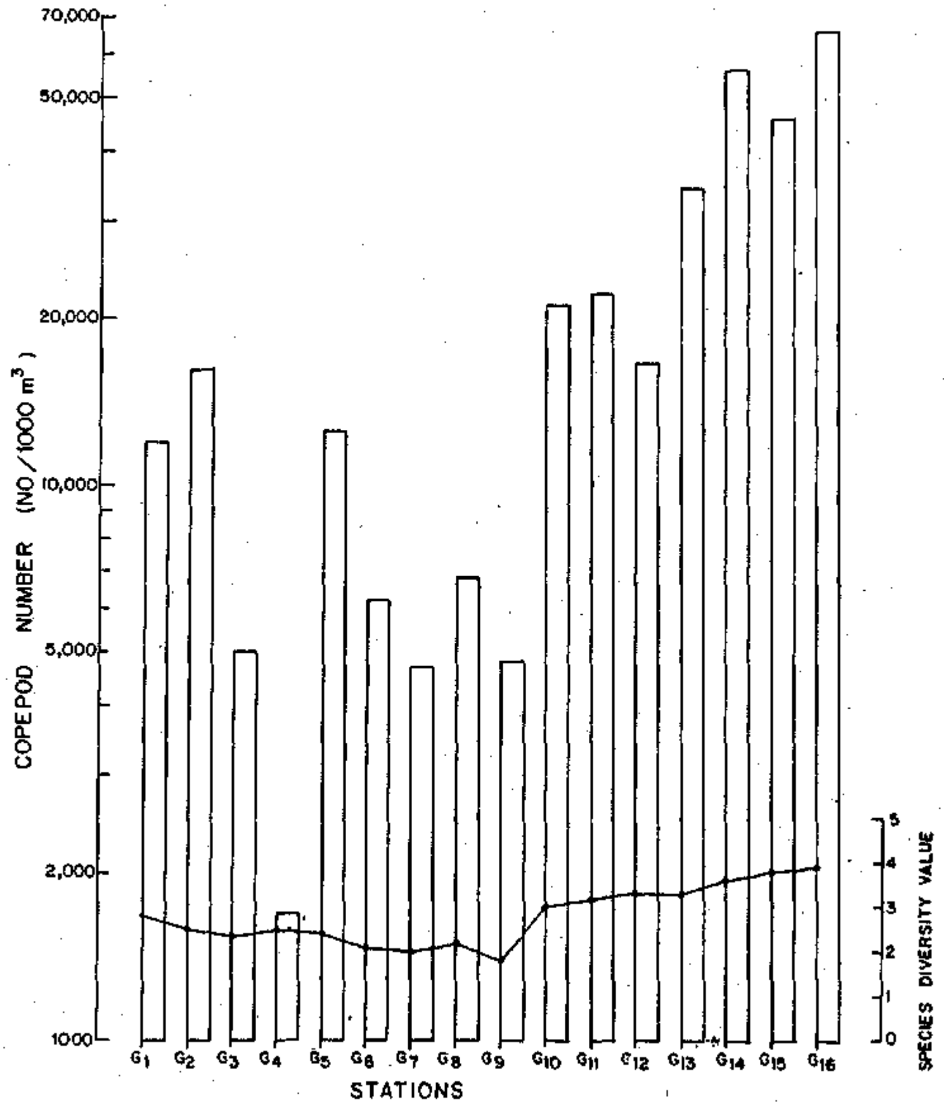


Fig. 7.: The copepod species diversity values and total copepod counts at different stations.

(Fig. 7)

TABLE 2

List of common zooplankton species with maximum population density and observed temperature and salinity tolerance range.

Species	Max. Density (No./1000m^3)	Temperature (°C)	Salinity *(%o)*
Foraminifera			
Neogloboquadrina pochy'derma (Elvenberg)	1200	136 to-1.49	33.86 to 34.31
Radiolaria			
Porospathis spp?	291000	1.49 to 7.20	33.77 to 33.98
Siphonophoro			
Dimophyses arctica (Chun)	200	-1.37	33.88
Anthozoa			
Cerianthula sp	40	-1.75 to 16.16	33.87 to 35.16
Polychaeta			
Typhloscolex mulleri Busch.	40	-0.33 to-1.37	33.59 to 34.31
Tomopteris pl/mktonis Apstein	40	-0.33 to -1.37	35.59 to 34.31
Vanadis sp	40	-0.33 to-1.37	35.59 to 34.31
Copepoda			
Canthocalanus pauper (Giesbrecht)	9169	1.49 to 16.16	33.77 to 35.16
Undinula darwini (Lubbock)	8172	1.49 to 16.16	33.77 to 35.16
Calanus simillimus (Giesbrecht)	6332	-0.33 to 2.43	33.59 to 34.10
C. propinguus Brady	2998	-0.33 to 3.47	33.59 to 34.10
Calamities acutus Giesbrecht	3398	-0.33 to 3.47	33.59 to 34.10
Eucalanus elongatus (Dana)	3519	2.43 to 16.16	33.77 to 35.16
E. monachus Giesbrecht	4960	2.43 to 16.16	33.77 to 35.16
Eucalanus sp	4992	1.49 to 16.16	33.77 to 35.16
Rhincalanus cornutus Dana	5116	2.43 to 16.16	33.77 to 35.16
R. nasutus Giebrecht	3196	5.47 to 16.16	33.77 to 35.08
R. gigas Brady	1962	-0.33 to 00.28	33.59 to 34.31
Paracalanus aculeatus Giebrecht	7110	2.43 to 16.16	33.77 to 35.16
Acrocalanus longicornis Giebrecht	5169	13.71 to 16.16	35.08 to 34.16
Clausocqlanus arcuicomis (Dana)	5116	1.49 to 16.16	33.77 to 35.16
C. laticeps Farren	612	-0.99 to -1.37	33.59 to 34.31
Heterorhabdus spinifrons (Claus)	665	-0.33 to 1.49	33.86 to 34.03
Heterorhabdus sp	.376	-1.36 to 1.49	33.98 to 34.12
Euchirella brevis Sars	716	1.49 to 16.16	33.77 to 35.16
E. rpstrata (Claus)	896	2.43 to '7.20	33.77 to 33.88
Scolecithrix danae (Lubbock)	1096	13.71 to 16.16	35.08 to 35.16
Scolecithrix sp	152	-1.36 to-1.37	34.12 to 34.31
Pontellopsis reqalis (Dana)	3116	13.71 to 16.16	35.08 to 35.16
Canadacia aethiopica (Dana)	2110	5.47 to 16.16	33.77 to 35.16
Candacia sp	892	2.43 to 7.20	33.77 to 33.88
Euatedeus sp	146	-1.36 to-1.37	34.12 to 34.31
Scaphocalanus sp	588	-1.36 to-1.37	34.12 to 34 31
Haloptilus sp	622	2.43 to 7.20	33.77 to 33.88
Oithonaplumifera Baird	812	3.48 to 16.16	33.77 to 35.16
0. similis Claus	1315	1.49.to 16.16	33.77 to 35.16
0. setigera (Dana)	699	5.47 to 16.16	33.77 to 35.16
Oithona sp	526	-1.36 to-1.37	34.12 tp 34.31
Oncaea venusta Phillipi	2664	1.49 to 16.16	33.77 to 35.16
O. Conifera Giesbrecht	4470	1.49 to 16.16	33.77 to 35.16
0. curvata Giebrecht	1452	-0.33 tp 0.28	33.59 to 34.31
Microsetella norvegica (Boeck)	547	1.49 to 16.16	33.77 to 35.16
Miracia efferata Dana	396	13.71 to 16.16	35.08 to 35.16
Amphipoda			
Hyperiella antarctica Bovallius	20	-0.33 to -0.88	33.86 to 33.96
H. dilatata Stebbing	60	*-0.33 to-0.88*	*33.86 to 33.96*
Vibiliastebbingi Behning and Woltereck	80	*-0.33 to-0.80*	*33.86 to 33.96*
Cyllopus magellanicus Dana	60	*-0.80 to 2.43*	*33.86 to 33.88*
Parathetnisto gaudichaudi (Guerin)	200	2.43 to 16.16	33.88-to3316

TABLE 2 (Contd.)

Species	Max. Density (No. /1000m')	Temperature (°C)	Salinity (‰)
P. gracilipes (Norman)	60	*-0.80 to 1.49*	*33.86 to 33.98*
Primno macropa Guerin	20	*-1.75 to 7.20*	*33.83 to 33.88*
Platyscelus serratulus Stebbing	20	2.43 to 16.16	33.77 to 35.16
Scina sp	20	*-0.33 to 0.80*	*33.86to33.96*
Hyperia sp	40	*-0.33 to-0.80*	*33.86 to 33.96*
Ostracoda			
Halocypris brevirostris	40	3.48 to 16.16	33.77 to 35.16
Spinoecia parthenoda	60	3.48 to 16.16	33.77 to 35.16
Paraconchoecia elegens	40	*-0.33 to 2.43*	*33.88 to 34.03*
Decapoda			
Galathea sp	40	*-1.36 to 5.47*	*33.77 to 34.12*
Sergestes sp	40	5.47 to 16.16	33.77 to 35.16
Euphausiacea			
Euphausia superba Dana	1760	*1.36 to 2.43*	*33.88 to 34.31*
E. frigfda Hensen	480	*-1.36 to 3.48*	*33.77 to 34.12*
Thysanoessa sp	6080	13.71 to 16.16	35.08 to 35.16
Chaetognatha			
Sagitta tasmanica Thompson	20	13.71 to 16.16	35.08 to 35.16
S. gazellae Rittor-Zahony	20	13.71 to 16.16	35.08 to 35.16
S. zetesios Fowler	40	13.71 to 16.16	35.08 to 35.16
S. iyra Krohn	20	*-1.37*	*34.31*
S. decipiens Fowler	120	*-1.37*	*34.31*
Eukrohnia hamata (Mohius)	20	13.71 to 16.16	35.08 to 35.16
Fish larvae			
Protomyctophum sp	20	*-1.37*	*34.31*

Ten copepod species were common in the zooplankton samples for the diel cycle studies. *Calanus simillimus* was the most dominant species. The distribution of the various species in the samples taken during different time of the day is given in Table 3. The occurrence of most of the copepod species such as *C. simillmus. C.propinquus, C. acutus, Rhincalanus gigas, Oithona* sp, and *Oncae* sp *was* independent of diel cycle. *Heterorhabdus* sp, and *Scolecithrix* sp, were more in the day collections. *Microsetella norvegica* and *Euaetideus* sp were abundant in the night collections.

TABLE 3

Diel variation in occurrence of copepod species (No/1000m^3 at station G-2

Species	Collection Time (Hours)									%
	"1230	1530	1830	2130	0030	0330	0630	.0930	1230	Occurrence
Calamis simillimus	11198	5130	13110	8950	1020	3116	2698	1812	9962	39.4
C. propinquus.	4200	2523	1624	2116	617	1291	2162	2210	6110	15.8
Calanoides acinus	' 6135	2111	4529	4962	1050.	' 1350	1290	960	8196	21.1
Rhincalanus gigas	916	1010	816	2100	714	982	1030	750	4968	9.2
Euaetideus sp	—	50	600	874	245	300	—	—	—	1.4
Heterorhabdus sp	218	107	46	—	—	89	120	136	600	0.9
Scolecithrix sp	341	250	100	—	—	117	260	—	306	0.9
Oithona sp	889 ,	245	416	580	216	418	298	164	2640	4.0
Oncaea sp	1013	544	729	812	413	675	316	110	1698	4.3
Microsetella norvegica -	130	190	910	1126	205	382	306	98	800	2.8

Other groups

Neogloboquadrina pachyderma and *Porospathic spp?* were the common representatives of foraminiferans and radiolarians. They were abundant in zooplankton collections from the Antarctic Convergence. *Dimophyses arctica* and *Cerianthula* sp were the only forms recorded for siphonophores and anthozoans. Both the species were obtained at station G 1. The polychaete larvae recorded from the Polar Divergence were represented by 3 species viz. *Typhloscolex mulleri, Tomopteris planktonis* and *Vanadis* sp. The amphipods were quite common in the zooplankton samples. Ten species belonging to 8 genera were identified (Table 2). *Hyperiella antarctica, H. dilatata, Vibilia stebbingi, Scina* sp and *Hyperia* sp were abundant in collections from the Polar Divergence, *Cyllopus magellanicus, Parathemisto gaudichaudi, P. gracilipes, Primno macropa* and *Platyscelus serratulus* showed wide distribution in the studied area. The ostracods (*Halocypris brevirostris Paraconchoecia elegens* and *Spinoecia parthenoda)* and decapod larvae *(Galathea* sp and *Sergestes* sp) also showed wide distribution. *Galathea* sp was abundant in the night collections. The euphausids particularly, *Euphausia superba* were collected more in the Antarctic Convergence. Numerous juvenile of this species (1760/1000 m^3) were obtained at station 10. Six species belonging to 2 genera were the common chaetognaths. No chaetognath specimen was obtained from the Antarctic Convergence. *Sagitta iyra* and *S. decipiens* were recorded at station G 1.*S. tasmanica, S. gazellae, S. zetesios* and *Eukrohnia hamata* were taken from Subtropical Convergence (stations 15 & 16) *protomyctophum* sp was the only fish larva obtained at station G 1.

DISCUSSION

Antarctica is valuable to mankind for its natural resources. Krill *(E. superba)* is strictly antarctic and dense krill shoals (upto 15 kg m^{-3}) occur in summer (January-April) in areas with strong surface water downwelling associated with neighbouring upheavals (Kinne, 1982). The annual production of this animal is estimated to be in order of 500 x 10^6t (Gullard, 1970), which greatly exceeds the estimated total fish production 100 x 10^6t in the world oceans (Ryther, 1969). During the present study, numerous specimens of krill were obtained in the Antarctic Convergence, where zooplankton biomass values varied from 102 to 624 ml/1000 m^3) .Voronina and Zadorina (1974) gave the standing crop values for subsurface waters (0 to 100 m) to be 120 to 170 ml/1000 m^3 in the Antarctic zone; 760 to 1100 ml/1000 m^3 in areas with maximum phytoplankton abundance and 560 to 2000 ml/1000 m^3 in the Subantarctic zone. The secondary production values computed from the zooplankton biomass values worked out to be 249.8, 205.7 and 8.4 mgC/m^2/day for the Antarctic Convergence, the Subtropical Convergence and the Polar Divergence zones respectively. Voronina, Menshutkin and Tseytlin (1981 b) reported secondary production value of 70 g/m^2 (wet weight basis) or gC/m^2/year for the Antarctic pelagic region. The secondary production values (grrr^2 year -^{1}) for 4 dominant copepod species were 18.1 for *Calanoides acutus,* 8.3 for *C. propinquus,* 28.4 for *Rhincalanus gigas* and 1.0 for *Centropages kroyeri* (Voronina, Menshutkin and Tseytlin, 1981 a). The latitudinal variations in the distribution and abundance of zooplankton groups and species were observed. Copepods were reported to be dominant group in Antarctica (Farren, 1929, Mackintosh, 1937 and Brodskii, 1964) but in the present zooplankton collections from the Antarctic Convergence, the radiolarians outnumbered the copepods. The zooplankter species such as *Rhincalanus nasutus, Acrocalanus longicornis, Scolecithrix danae, Candacia aetheopica, Oithona setigera, Miracia efferata, Sagitta tasmanica, S. gazellae, S, zetesios* and *Eukrohnia hamata* showed restricted distribution between 40°S to 50°. *Euchirella rostrata, Haloptilus* sp, *Candacia* sp, *Euphausia superba* and *Platyscelus serratulus* were common forms between 50°S to 60°S. The cold water species viz. *Calanus simillimus, C. propinquus, C. acutus,* were typical Antarctic species as also reported earlier.(Wolfenden, 1908.) Vinogradov (1962) reported *H. dilatata* to be a cold water species living chiefly south of 60°S. The zooplankton samples taken from 200 to 0 m were homogeneous and consisted mostly of phytophagous forms. The omnivorous and carnivorous species *(Euchaeta* sp) dominated the zooplankton counts in samples from 1000 to 0 m. The phytophagous copepod species such as C. *simillimus, C. propinquus, C. acutus* and *R. gigas* were reported to be dominant constituent of winter zooplankton population inhabiting 500 to 1000 m, layers (Vladimirskaya, 1978). Again, on the basis of bathymetric distribution, the chaetognath species viz. *Sagitta decipiens, S. iyra* and *S. zetesios,* were grouped as mesoplanktonic (Nair

1977). However, during the present study, all these species were common in collection from 200-0 m. Their occurrence may be due to vertical migration to surface layers for feeding during summer. The species diversity in antarctic waters was poor compared to oceanic realm in tropics. The waters around Antarctica, which support few species but large populations, are one of the richest biological provinces on the earth (Qasim, 1982). The low temperature, availability of food and prolonged seasons may be the factors responsible for low species diversity. The seasonal studies of zooplankton would be important for proper utilization of biological resources of the Antarctica, particularly the krills.

ACKNOWLEDGEMENTS

The author is grateful to Dr. S. Z. Qasim, Secretary, Department of Ocean Development, Government of India, for allowing to work on zooplankton samples and for critically reviewing the manuscript. Sincere thanks are due to Dr. A. H. Parulekar and Shri S. G. P. Matondkar for collection of samples and to other colleagues at regional centres of NIO for help in identification of species. Thanks are also due to Dr. V. V. R. Varadachari, Director, and to Dr. T. S. S. Rao, Head, Biology Division, NIO for facilities.

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