Benthic Fauna of the Antarctic Ocean — Quantitative Aspects

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ABSTRACT

Quantitative studies on the macro and meiobenthos of the less explored (between 11 and 41°E longitude) part of the Indian Ocean Sector of Antarctic Ocean, revealed the existence of.rich fauna and high standing crop in the depth range of 200 to 3600 m. Population density contributed by 12 meiofaunal and 3 macrofaunal taxa, was of a high magnitude and it varied from 1110 to 29774 ($\bar{x}$ = 6780 m^{-2}) and from. 118 to 354 ($\bar{x}$ = 221 m^{-2}) for meio and macrofauna respectively. Nematodes {64.20%) and polychaetes (53.33%) were dominant components of meio and macrofauna, respectively. Meiofauna was more abundant in sandy sediments than in clayey bottom deposits and the richness of fauna showed positive correlation with increasing depth. In contrast, the macrofauna showed decreasing abundance with increasing depth. Ratio of macro to meiofauna in the total population was 1to53.

Benthic standing crop was exceptionally high (566.4 gm^{-2}) at shallow depths and exponentially decreased with increasing depths. Macrofauna contributed almost 99% to the total benthic biomass and the contribution of macro and meiofauna was in the ratio of 675 to 1.

High benthic biomass and varied fauna is a consequence of high biological productivity during the Antarctic summer. Results are discussed with environmental relevance to comparable Antarctic marine ecosystems reported by earlier workers.

INTRODUCTION

Earliest information on the Antarctic bottom fauna is from the studies carried out by the British Antarctic Expedition (1839-43) of Sir James Ross (Hooker 1845). However, most of the data, from the earlier investigations pertain to occurrence, distribution, taxonomy and zoogeography (Dell 1972). No report on quantitative aspects of Antarctic benthos was available till the commencement of International Geophysical Year Programme of 1956-58 (Belyaev and Ushakov 1959).

In recent years some information on the quantitative distribution of fauna and benthic production in different sectors or regions of Antarctic Seas is available (Broch 1961, Belyaev 1964, Holmes 1964, Tressler 1964, Vinogradova 1964, Gallardo and Castillo 1970, Lowry 1977, Richardson and Hedgepeth 1977, Oliver 1978 and Everitt, Poore and Pickard 1981). Most of the published reports, relate to regions beyond 40° E longitude and mostly covers the Atlantic and Pacific Ocean Sectors, whereas the benthic investigations during the First Indian Antarctic Expedition of 1981-82, are essentially for the region between 10 and 41°E longitude — rather an unexplored part of the Indian Ocean Sector in Antarctic, (Ushakov 1964) and hence the observations presented here are meant to fill the existing gaps in the available information on the Antarctic benthos.

MATERIAL AND METHODS

Seven stations — G-l to G-6 and G-14 (Fig.l) in the depth range of 227 to 3580 m and within the geographical limits of latitude 45 to 70°S and longitude 11 to 41°E were operated. A 0.18m^2 Petersen Oken type grab (penetration depth 25 cm) was used for collecting the bottom fauna. All the results on population and biomass of macro and meiofauna are mean values of triplicate samples.

A plexiglass core tube, 4.5 cm diameter, was used for subsampling of meiofauna from the undisturbed top 10 cm layer of the bottom deposits, collected by the grab. Samples were seived, on board, through a 44 micron mesh screen and fauna preserved in 1:500 Rose Bengal—Formaldehyde solution. Sorting, identification and enumeration of respective taxon was done under a stereo binocular microscope

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Macrofauna sub-sampling, from the grab samples was done using a 170 cm^2 plexiglass quadrant (10 cm penetration depth) and a 500 micron mesh screen was used for separating the organisms. Biomass measurements were undertaken on a single pan electrical balance having an accuracy 0.0001 g and all the values are on wet weight measurements including the exoskelton. Absolute numbers for populate counts and mean values for biomass, have been raised to square metre units.

Due to non-availability of relevant literature on the taxonomy and systematic position of different benthic organisms, the identification has to be restricted only upto taxon or faunal group level, including a few of the unidentified specimens.

THE ENVIRONMENT

The present set of benthic collections were obtained in January 1982, which incidently marks the late Antarctic summer season. Accordingly, the water column was characterized by relatively high temperatures varying from - 0.33°C (St. G-5) to 5.47°C (St. G-14) and salinity ranging between 33.59/oo (St. G-3) and 34.31‰ (St. G-1). Area sampled was free of icebergs and anchored ice, however, from the echosounding records, scouring effects of icebergs and anchored ice on the bottom deposits could be ascertained at station G-2, G-4 and G-5 (Fig. 1). This was further authenticated by the presence of gravel, pebbles and boulders, in the bottom deposits, originating from glacial drifting. Otherwise the bottom deposits at most of the sampling sites, were mainly characterized by clay, encrusted With yellow or green or brown oozes. Only at two of the sites (G-2 and G-14) sandy deposits and at one site (G-l) clay silt were encountered (Table 1). While most of the stations, G-l to G-6 were less than 200 nautical miles off the coastline, only the station G-14, though 1500 nautical miles away from the Antarctic coastiline, was less than 30 nautical miles north of Prince Edward Island (Fig. 1)

Fauna-Distribution and Abundance

Distribution of fauna as evident from the occurrence of different taxa (Table 1) was far from continuous. While no macrofauna was observed at 3 of the 7 stations, the meiofauna, in varying number of taxa was prevalent at all the sampling sites.

TABLE 1

Sampling sites in Antarctic Ocean showing the geographical position, depth, sediment type, population density, biomass and number of taxa of benthic fauna.,

Station No.	Geographical Lat. (S°)	Position Long. (E°)	Depth (m)	Type of Bottom	Population Density ($n\ m^{-2}$)		Biomas (gm^{-2})		Number of taxa	
					meiofauna	macrofauna	meio-fauna	macro-fauna	meio-fauna	macro-fauna
G - 1	67 13.5	39 12.3	3580	Clayey silt	1332		0.085		6	—
G - 2	69 58.14	11 54.6	227	Calcareous sand with admixture of clay	3554	354 .	0.032	566.40	3	1
G—3	69 00	13 41.05	2337	Clay wfth brown ooze	2443	177	0.025	1.18	4	2
G - 4	68 43.5	1106.7	1661	Clay with gravel and small stones	29774		0.543	—	9	—
G—5	68 24.65	11 11.67	2070	Clay—yellowish in colour—with pebbles and small stones	4483	Ͳ18	0.079	1.26	5	I
G—6	67 46.37	12 00.04	1990	Clay—greenish in colour	1110	236	0.015	2.42	4	1
G—14	45 38.07	40 24.62	1680	Sandy—white in colour—sticky ooze	4665	—	0.067	—	4	—

The bottom fauna comprised of 12 meiofaunal, including unidentified organisms and 3 macrofaunal taxa-all invertebrates (Table 2). Amongst the meiofauna, turbellaria varied from 4.47 to 20%. The nematodes with percentages ranging between 16.66 and 72.76 had an overall dominance, as they formed more than 64% of the total meiofauna (Table 2). Next in order of importance were polychaetes (6.71 to 20), foraminifera (2.23 to 23.79) and harpacticoid copepods (3.73-20) with an overall contribution of 6.13%, 5.18% and 3.77%, respectively. The percentage prevalence of the three taxa fluctuated between 4N.85% in foraminifera and 57.14% in polychaeta and harpacticoida. Other meiofaunal taxa (Table 2) were rather inconspicuous, both in composition and prevalence.

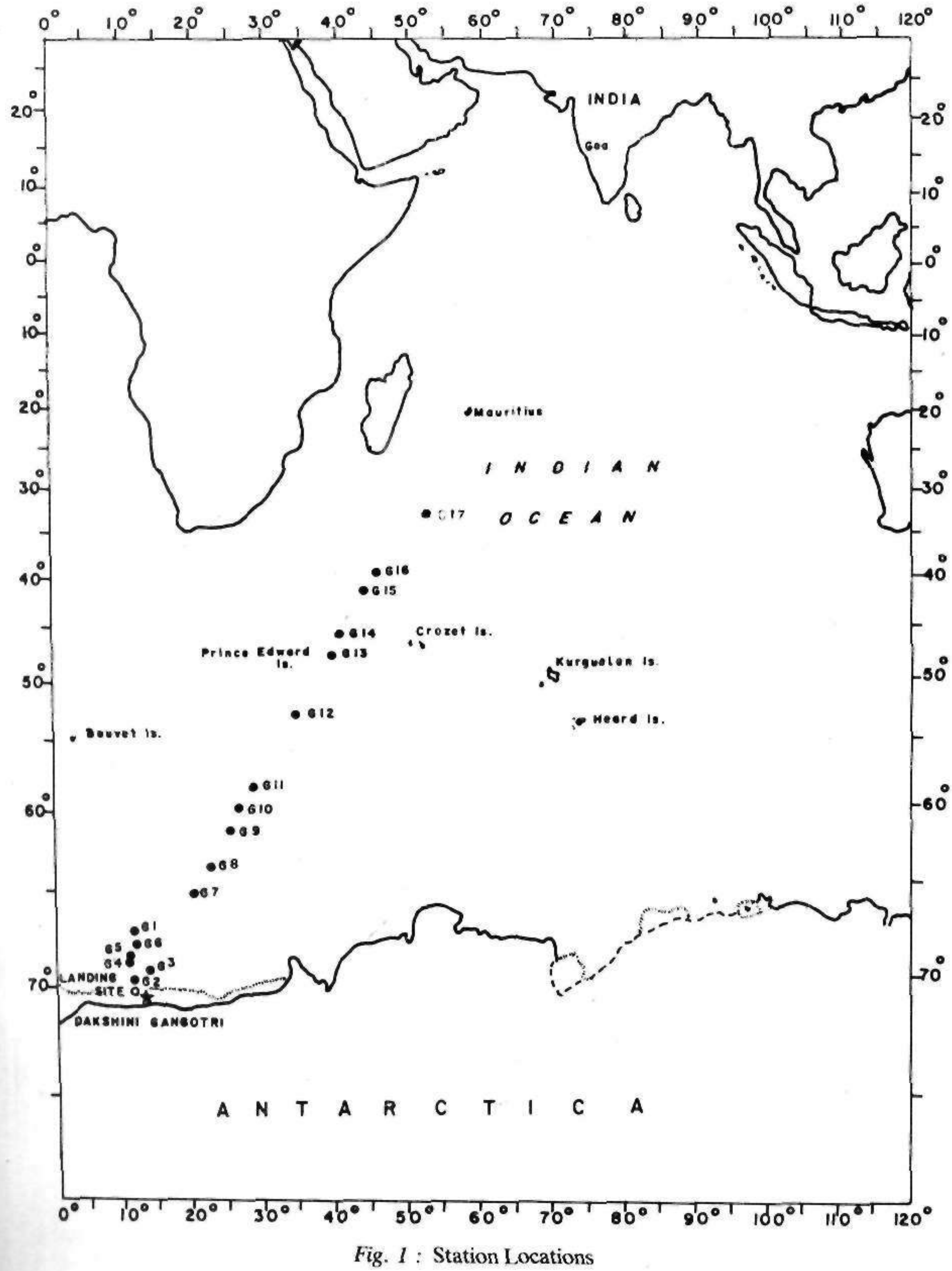

Fig. 1 : Station Locations

TABLE 2

Percent composition and percent prevalence of taxon at different stations and in total benthic fauna

Taxon	G.1	G.2	G.3	G.4	G.5	G.6	G.14	% Composition	% Prevalence
				Oceanographic station					
				MEIOFAUNA					
Foraminifera		18.73		2.23			23.79	5.18	42.85
Hydrozoa				12.68				8.01	14.28
	16.66	12.49	9.08	4.47	9.99	20.00	9.51	7.07	100.00
	16.66	68.78	72.76	64.97	70.04	40.00	61.95	64.20	100.00
Polychaeta			9.08	6.71	9.99	20.00		6.13	57,14
Nemerteans		-		2.98	4.99		-	2.35	28.57
Gastrotricha	16.66							0.47	14.28
Halicardia	16.66			1.49				1.41	28.57
Harpacticoidea	16.66			3.73	4.99	20.00		3.77	57.14
Mysidacea	16.66							0.47	14.28
Pelecypoda		-	9.08					0.47	14.28
Unidentified				0.74			4.75	0.47	14.28
				MACROFAUNA					
Porifera		100	—	—	—	—	—	40.00	25
Polychaeta	—	—	66.66	—	100	100	—	53.33	75
Pelecypoda	—	—	33.33	—	—	—	—	6.66	25

In contrast, the distribution of macrofauna, represented by only 3 invertebrate taxa, was of a restricted nature. Polychaetes were dominant as they formed 66.66 (G-3) to 100% (G-5 and G-6) of the composition, 75% of the prevalence and contributed 53.33% of the total macrofauna. Other two taxa, namely sponges (Porifera) and bivalves (Pelecypoda) had a single occurrence each. While sponges formed the whole bulk of the macrofauna at the shallow station G-2 (deepth 227m), they contributed 40% to the total macrofauna. In contrast, the contribution of bivalve molluscs, 6.66% by composition and 25% by prevalence, was rather insignificant.

Abundance of meio and macrofauna varied from 1110 to 29774/m^2 and from 118 to 345/m^2, respectively (Table 1). While the richness of meiofauna was rather independent of depth variations, the macrofauna was found to be most abundant at lower or shallow depths and decreased rapidly with increasing depth. Bottom deposits, having the varying admixture of clay and sand harboured higher meiofaunal population than in clayey silt or sandy substratum. On the other hand, the macrofauna was more abundant in sandy deposits than in the clayey sediments. However, no statistically significant relationship between the abundance of fauna and the depth variations or the type of bottom deposits could be established. The overall proportion of macro to meiofauna in the total benthic population was in the ratio of 1:53

Standing Crop

The macrofaunal biomass varied from 1.18 to 566.40 g m^{-2} (Table 1). Highest standing crop was observed at the shallowest station and the lowest biomass at the deepest station and thus a positive correlation between the depth and the standing crop could be observed. Similarly, the nearshore regions were observed to be far more productive than the offshore areas. A positive trend was observed between the nature of bottom deposits and the magnitude of macrofaunal biomass. Accordingly, the sandy sediments with little or no clay harboured high macrofaunal standing crop than the substratum with clay as dominant sediment type.

Meiofauna contributed insignificantly to the total standing crop and the biomass values varied from 0.015 to 0.543 with a mean value of 0.120 g m^{-2}(Table 1). Though the meiofaunal biomass showed a decreasing trend with increasing depth, no statistically significant correlation could be found. Similar to the observed dependence of macrofaunal biomass with the distance from the shore,' a relationship between the meiofaunal standing crop and the distance was observed. While the macrofaunal biomass decreased away from the shore,. the meiofaunal biomass rather increased with the increase in distance. In an overall analysis, the contribution of macro and meiofauna biomass in the total standing crop was in the ratio of 675 to 1.

DISCUSSION

Benthic collections in the western and north-western Antarctic Ocean have been less intensive than on the opposite side of the continent. Area investigated, in the present study, is primarily the Indian Ocean sector of the Antarctic. The earlier investigations by the Soviet Antarctic Expedition of 1956-58 on *Ob,* covered the area between 20°E and 110°W longitude (Ushakov 1964) and thus the present account, for the first time, deals with the benthos from the unexplored coastal and open ocean areas, between 10 to 20°E longitude besides providing additional information for the area between 20 to 41°E longitude.

The unique contribution of Antarctic waters can better be understood by the objective estimation that the waters south of Antarctic convergence (i.e. 48°S Latitude) support a total production equivalent to about 20% of that produced by all the oceans of the world (El-Sayed 1968). Abundant and varied benthic fauna, reflect the excellent supply of food material and relatively stable environmental conditions in the study area. A summer-long phytoplankton bloom provides a vast supply of food to which the life-cycles of many benthic animals are directly or indirectly linked. The continental shelf around Antarctica is narrow and mostly covered by ice. The continental slope descends without any very complicated bottom features to depths of about 3000 m. Outside the continental slope, the sea floor extends as broad ridges or deep basins (Brodie 1965). The bottom sediments are influenced primarily by the fact that practically all the effective transport of terrigenous material is by ice. Sediments are deposited when melting icebergs release sediments from continental margins near the coast. These sediments range in size from mud to boulders and have a northern extent of approximately 65°S. North of glacial sediments and extending south upto polar front, is an extensive (1000 to 2000 km wide) zone of diatom ooze (Bakus, Garling and Buchanan 1978).

The predominant bottom fauna of the Antarctic coast is a heterogenous mixture containing representatives of benthos associated with different bottom deposits. The coastal waters, below 500 m depth, show a rather dense standing crop (average 500 g m^{-2}). This is many times higher than for comparable depths in any other ocean area (Belyaev 1964). It is due to proliferation of benthic taxa that are not food types (sponges). At depths more than 1000 m and upto 3000 m, the average biomass is less than 0.08 g m^{-2} and is totally contributed by meiofauna. Abundance of standing crop also depends upon the distance from the coast. This dependence is more pronounced, very close to the shoreline and at relatively shallow depths, but diminishes in the abyss of the open ocean.

The Antarctic deep water area is a separate zoogeograpbic area (Vinogradava 1964). This region covers the depth of the Atlantic, the Indian and the Pacific Ocean, south of 40°S. The benthic fauna of this region is more and more specialized with increase in depth. The fauna of the Indian and the Pacific sector are quite similar (Ushakov 1964) and this makes it possible to divide the Antarctic deep water region into two subregions: the Antarctic-Atlantic and Antarctic-Indian-Pacific (Vinogradova 1964). However, for zoogeographic characterization of bethic fauna, it is imperative to have further detailed investigations.

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