

Macrobenthic Standing Stock in the Nodule Areas of Central Indian Ocean Basin

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Abstract

Diversity, distribution and standing stock of macrofauna in the nodule areas of Central Indian Ocean Basin (CIOB) were studied during April 2003. The density ranged between 22 to 132 no.m⁻² (mean: 55± 37 SD, n=25) and biomass ranged (AFDW) between 0.2 to 33 mg. m⁻² (mean: 7 ± 10 SD). Vertically the fauna was observed down to a sediment depth of 40 cm. The highest values were in the top 0-10 cm depth and decreased with increasing sediment depth. Polychaetes were the dominant taxa followed by the crustaceans. Generally, the density and biomass was lower in the CIOB but comparable with the abyssal areas of NE Atlantic and Western Atlantic.

Introduction

It is well recognized that biomass and abundance of deep-sea macrofauna decreases with increasing water depth, whereas diversity tends to increase with increasing depth [1]. Benthic fauna of deep-sea mud is generally considered as food limiting and respond to seasonal input of organic matter from the water column [2]. A number of deep-sea invertebrates show seasonal growth and reproduction, and is linked to the seasonal variations in the availability of food [3]. Many deep-sea animals including sponges, sea anemones, tube worms and barnacles, adopt a 'sit and wait' strategy-- staying for long periods, sometimes permanently, in one place and depending on food particles that either fall on to them or are carried to them by the currents. However, only a fraction (1% or less) of surface productivity reaches the deep ocean floor [4] and therefore, the deep-sea benthos may not necessarily depend on the surface primary productivity as generally argued [5]. Moreover some of the deep-sea invertebrate metazoans such as few polychaetes and cnidarians are known to be carnivorous [6] and benthic foraminifers serve as an important food source to many deep-sea crustaceans, when other types of food are scarce [7].

Considering the fact that Indian Ocean is least studied in terms of deep-sea benthic biology and taxonomy [8], the present study was undertaken in the Central Indian Ocean Basin (CIOB) and was aimed to understand the macrofaunal abundance, distribution, standing stock and preparing an inventory of the benthic species, that can be used as a reference for evaluating the impact of nodule mining in future.

Materials and Methods

Sediment samples for macrobenthos were collected during the deep-sea cruise of R.V. Alaxender Akedemik Sidorenko (No.AAS-61, INDEX-VI). In the CIOB between latitude 9.5°S - 16°S and longitude 73.5°E - 76.5°E (Table I), 25 stations were sampled with a spade box core (50 x 50 x 50 cm size). The sub-sampling was done with the help of plastic core tube (12.5 cm; 50 cm length) and a quadrant of 15x15x10 cm size. The entire core sample was sectioned with a locally developed core cutter at an interval of 5 cm each except for the top 5 cm, which was sub-sectioned as 0-2, and 2-5 cm. All the sub-samples were preserved in 5% formalin Rose Bengal solution and later sieved through 500µm sieves. The fauna was sorted, counted and identified up to the lowest possible level. The blotted wet weight was used to estimate the total biomass as ash free dry weight (AFDW), using conventional conversion factors for each of the faunal groups [9].

Results and Discussion

Composition and Diversity

A total of 12 macrobenthic, invertebrate groups were identified in 78 sub-samples taken from 25 stations. Total density at the abyssal CIOB was 22 to 132 no.m⁻² (mean: 55 ± 37, n=25, Table I).

Dominant among the fauna were Polychaeta (37%) and Crustacea (30%), which together comprised 67% (Figure I). The other groups were nematodes (21%) bivalve (3%), gastropod (3%) and unidentified larval forms (3%). Studies carried out in the abyssal NE Atlantic [10] and Western N. Atlantic (HEBBLE site) [11] shows the similar results as obtained in the present study, wherein polychaetes were the dominant followed by Crustacea (Figure I).

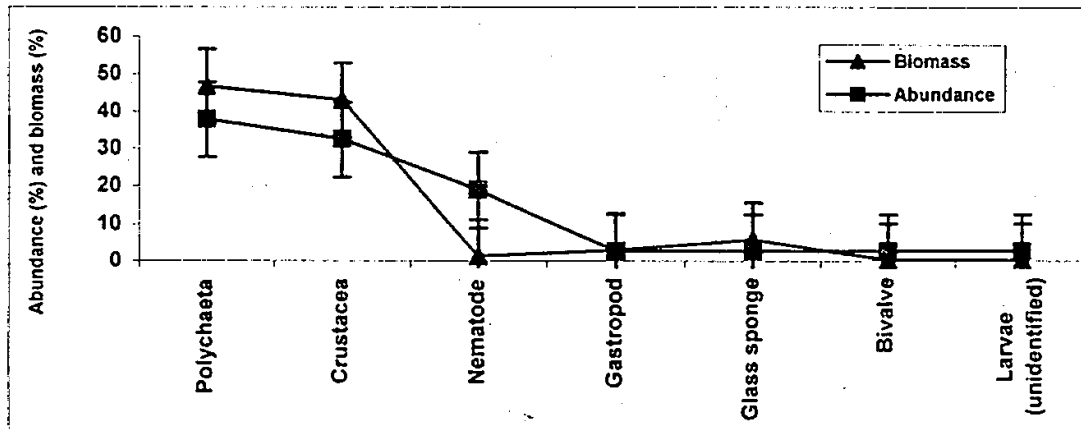


Figure-I: Macrofaunal abundance (%) and Biomass (%)

Table 1: Geographical location and other details of the sampling locations.

Station No.	Longitude (^o E)	Latitude (^o S)	Depth (m)	Density (no./m ²)	Biomass (mg. AFDW/m ²)
1	76.4894	10.2225	5355	44	0.2
2	76.5106	11.00917	5320	0	0
3	76.6553	12.23917	5280	66	0.5
4	76.7375	13.00889	5360	44	3.8
5	76.74639	14.25889	5180	88	0.7
6	76.73194	15.23444	4980	132	1.34
7	76.51194	16.01306	5070	44	1.5
9	74.73528	16.21861	5350	0	0
10	73.76083	16.19861	4900	44	8.95
11	73.75028	15.17611	5480	44	0.34
12	74.50722	15.00306	5390	0	0
13	75.73833	15.00194	5180	110	1.59
14	75.51778	14.06417	5145	88	18.9
15	74.62694	14.005	5160	89	0.34
16	73.51028	14.0875	5120	0	0
17	73.51056	13.08806	4810	88	24.4
18	74.66306	13.25083	5050	44	0.34
19	75.67444	13.19694	5070	44	1.72
20	75.73139	12.01833	5200	66	33.2
21	74.60222	12.25722	5025	44	0.5
22	73.71083	12.00306	4900	44	14
23	73.74361	11.23	5100	88	1.72
24	74.74083	11.24861	5050	22	13
25	75.71722	11.25111	5300	44	5.5
26	75.74972	10.25778	5290	110	22

Among the polychaete families, Flabelligeridae was the most abundant with a share of 27%. Other families were Ampharetidae (18%), Ariciidae (17%), Glyceridae (9%) and Euphrosinidae (9%). In addition, 5 more families were identified from the CIOB area viz; Eunicidae, Syllidae, Spionidae, Sebellidae and Maldanidae, with a relative abundance of 4% each. Crustacea consisted of 6 different orders: Isopoda (11%), Tanaidacea (8%), Halacarida (8%), cyprid larvae (3%), Harpacticoida (3%) and Amphipoda (2%).

Biomass

The biomass (AFDW) values ranged from 0.2 to 33 mg. m⁻² (mean: 7 ± 10 SD, Table I). In all, 44% of the total biomass was comprised of polychaete and 47% by crustaceans. Contrary to abundance, the greatest biomass share of Crustacea was represented by Isopoda (67%). The remaining 33% of biomass consisted of Amphipoda (20%), Tanaidacea (11%), Halacaridae (1%), Harpacticoida (1%) and cyprid larvae (1%). Generally, the values were lower when compared with other areas [12]. Decrease in biomass values are observed in abyssal region with limited food supply.

Vertical Distribution

The depth integrated average density recorded down to the sediment depth of 40 cm ranged from 81 to 405 no. m⁻² (mean: 87 ± 130sd, n=25). Vertically, fauna dominated the 5-10 cm sediment section as >40% fauna was recorded from this layer (Figure II). The top 0-5 cm layer showed an abundance of 26% of the total fauna. It is observed that due to scarcity of food, the infauna stores as much food, as fast as possible, out of the reach of competitors, and therefore most organisms in these highly food-limited abyssal regions are found beneath the sediment surface [13]. However, the high bioturbation rate of the surface sediments, due to increased population of large deposit feeders may also have lead to the downward movement of infaunal organisms seeking to avoid physical disturbances of their habitat [14]. The percent abundance of fauna occurring at sediment section of 10-15 is 19%. Below the 10-15 cm section, the fauna showed consistency in occurrence (Figure II). Tanaidacea, polychaetes and nematodes were present even below 20 cm depth. Though the crustaceans are found in the deeper depth, isotopic signatures reveals that crustacean play a minor role in reworking the introduced material, although their abundance is only slightly lower compared to polychaetes [13]. Thus as observed in our earlier investigations [15], polychaetes were the major biota and were observed down to a sediment depth of 25 cm (Figure II).

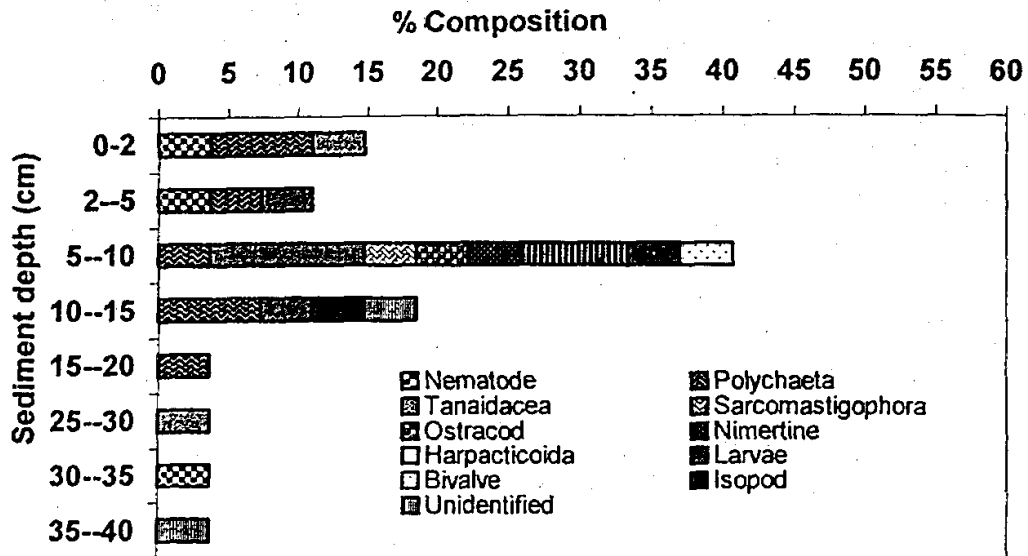


Figure-II: Vertical distribution of macrofaunal

It is observed that the density values in the CIOB are comparable to those obtained in the abyssal NE Atlantic [10] and Western N Atlantic (HEBBLE site) [11]. Similarly, the biomass values in the CIOB were comparable to that of Pacific Ocean and ranged between 1 - 300 mg [16].

The results show that the diversity and biomass of benthic fauna was the highest in the top 15 cm of the sediment, which is the most likely layer to get disturbed by the mining operation. Also, some of the groups have very few organisms, which may be lost due to mining operations. Thus the present study will serve as important baseline data for evaluating the impact of mining on benthic environment.

References

1. Ingole, B.S., Current Science, 85, 328-333, 2003.
2. Witte U., Aberle, N., Sand, M., Wenzhöfer, F., Marine Ecology Progress Series 251, 27-36, 2003.
3. Gage, J.D., and Tyler, P. A., 1991. Deep-sea biology. Cambridge, 504.
4. Juniper, S.K., Workshop on managing risks to biodiversity and the environment on the high sea, including such tools as marine protected areas-scientific requirements and legal aspects, 89-95, 2001.
5. Witte, U., Deep-sea Research II, 47, 2979-2997, 2000.
6. Blake, J.A., Journal of the Marine Biological Association of the United Kingdom, 73, 123-141, 1993.

7. Gudmundsson, G., von Schmalensee, M., and Svavarsson, J., *Deep-Sea Research I*, 47, 2093-2109, 2000.
8. Ingole, B.S., and Koslow, J.A., *Indian journal of Marine Science*, 34, 27-34, 2005.
9. Eleftheriou, A., Basford, D.J., *Journal of the Marine Biological Association of the United Kingdom*, 69(1): 123-143, 1989.
10. Galeron, J., Sibuet, M., Vanreusel, A., Mackenzie, K., Gooday, A.J., Dinet, A., and Wolff, G., *Progress in Oceanography*, 50, 303-324, 2001.
11. Thistle, D., Ertman, S.C., Fauchald, K., *Marine Geology*, 99, 413-422, 1991.
12. Sibuet, M., Monnito, C., Desbruyeres, D., Dinet, A., Khripounoff, A., Rowe, G., and Segonzac, M., *Oceanological Acta*, 7, 345-358, 1984.
13. Aberle, N., and Witte, U., *Marine Ecology Progress Series*, 251, 37-47, 2003.
14. Lamshead, P.J.D., Ferrero, T.J., and Wolff, G.A., *Internationale Revue der gesamten Hydrobiologie*, 80, 327-331, 1995
15. Ingole, B.S., Pavithran, S., and Ansari, Z. A., *Marine Georesources and Geotechnolog*, 2003 (communicated).
16. Murray, J.W., and Kuivila, K.M., *Deep Sea Research*, 37, 59-80, 1990.