

Benthos of the Shelf Region along the West Coast of India

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Distribution and abundance of benthos in the depth range of 10-70 m were studied. A definite relationship was observed between benthic biomass, organic carbon, nature of substrata and demersal fish catch. Benthic biomass varied from 0.12 to 190.5 g/m² (mean 11.5 g/m²). Polychaetes formed the dominant group followed by crustaceans, molluscs, sipunculids and echinoderms. The fauna was rich in the nearshore region and decreased towards deeper waters. Quantitative distribution of benthic fauna showed a direct relationship to the exploited demersal fisheries, especially the shrimps.

Estimates of benthic abundance are necessary for the assessment of demersal fishery resources, as benthos forms an important source of food for demersal fishes¹. Earlier works on benthos give information on the qualitative and quantitative distribution of benthos from different regions of the west coast of India²⁻¹⁵. Damodaran¹⁴ has correlated the distribution of benthos with the prawn fishery of the mud bank region of Kerala. This paper presents the abundance, animal-sediment relationship and biomass of benthos along the western Indian shelf together with a possible correlation between benthic biomass and demersal fish stock.

Materials and Methods

The area sampled was between 8°23'N lat. and 69°73'E long. within a depth range of 10-70 m. Samples were collected at 120 stations from the 2nd, 12th and 13th cruises of *R V Gaveshani* during 1976-77 (Fig. 1).

Duplicate samples were collected using a van Veen grab (0.04m² area) or a Lafond Dietz snapper (0.017 m² area). From each sample, sub-samples were taken for the analysis of sediment and organic carbon. Benthic samples were analysed employing the procedure given elsewhere¹⁵. Biomass was expressed as wet weight excluding hard parts. Textural characteristics of the sediment were determined by the method of Inman¹⁶ and organic carbon in the sediment was estimated by the wet oxidation method¹⁷.

Results

Sediment distribution—There were 7 major types of substrata (Fig. 2). In the Gulf of Kutch the sediment was predominantly clayey silt with coralline bottom at a few stations. Silty clay was found in the region off Saurashtra coast. Off the Gulf of Cambay and Ratnagiri, clay was predominant. The inner and outer

shelf areas of Bombay were silty clay and silty sand respectively. Similar pattern of sediment distribution was observed off Goa. Patches of clayey sand and

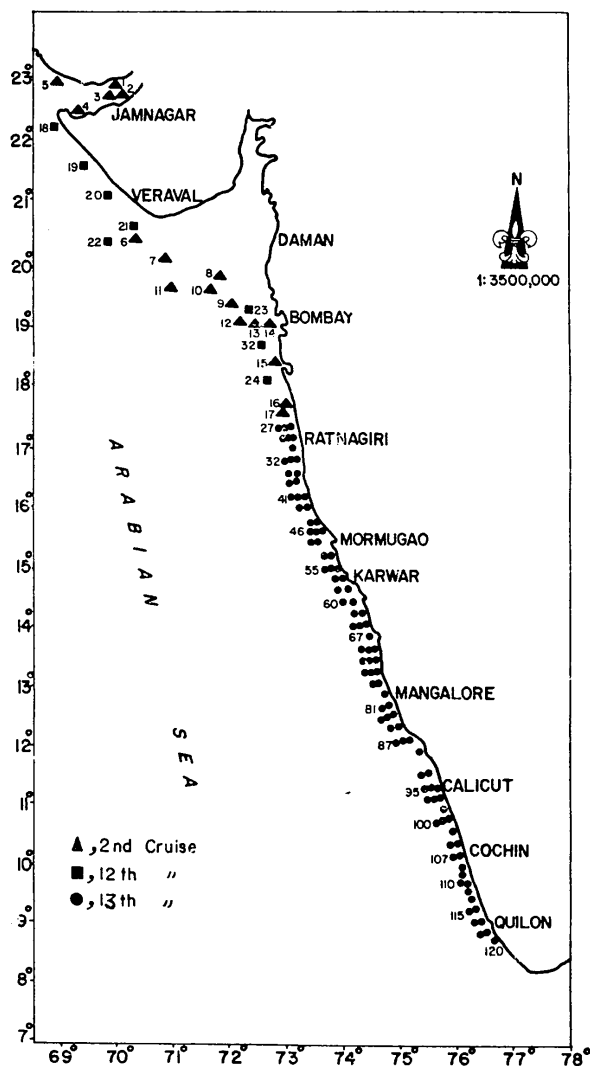


Fig. 1—Station positions

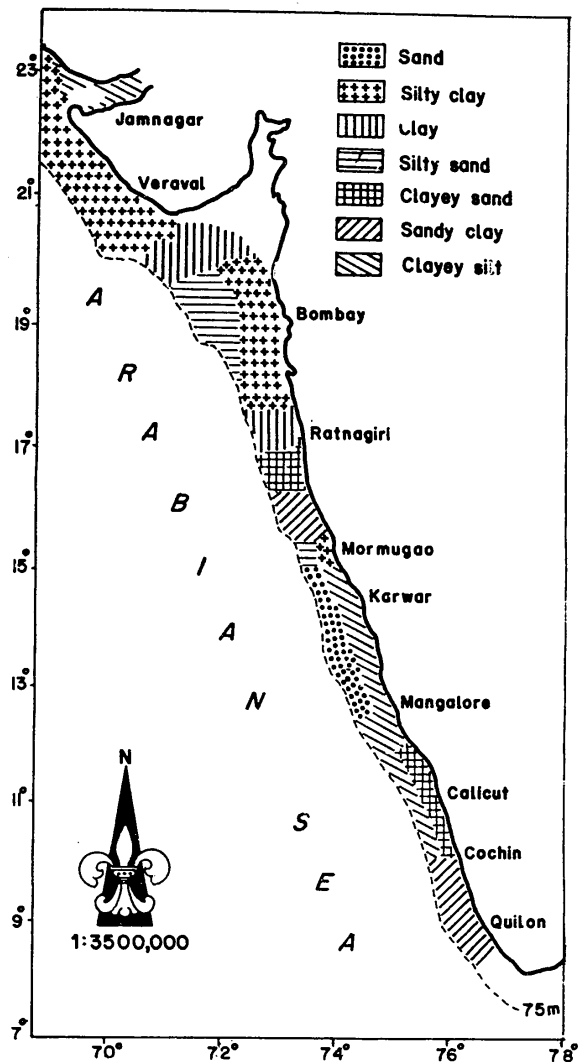


Fig. 2—Sediment distribution

sandy clay were noticed south of Ratnagiri. A strip of sandy belt was observed in the outer shelf of Karnataka coast. A clayey sand band extended from the inner shelf area of the Kerala coast up to Cochin. Clayey silt was observed in the inner and outer shelf of Karnataka and Kerala coast respectively. South of Cochin, up to Quilon, it was sandy clay. The sediment was fine and was dominated by silt and clay in the region north of Goa, whereas it was sandy with little percentage of silt and clay in the region south of Goa.

Organic carbon—Organic carbon varied from 0.47 to 6.18% (av. 3.15%) and was related to the textural characteristics of sediment. Higher values were found in the fine substrata of clay and silt, whereas sandy substrata had a low organic carbon (Table 1).

Faunal composition and distribution—Faunal distribution varied from station to station. However, the qualitative composition of the fauna was almost homogeneous, except along the southwest coast. Fauna was predominantly composed of polychaetes,

Table 1—Variation of Organic Carbon in Relation to Sediment Type

[Mean values are in parentheses]

Sediment type	Organic carbon %
Sand	0.47-3.26 (1.6)
Silty clay	3.05-5.9 (3.6)
Clay	3.15-6.18 (4.15)
Silty sand	2.95-5.55 (2.34)
Clayey sand	3.05-5.15 (2.9)
Sandy clay	3.25-5.45 (3.25)
Clayey silt	3.65-5.85 (3.95)

crustaceans, molluscs, sipunculids and echinoderms. Sixteen faunal groups were identified and their abundance is given in Table 2. Polychaetes formed the most dominant group (62.5%) followed by crustaceans (17.62%), molluscs (12.28%), sipunculids (4.19%) and echinoderms (3.62%). Among the other groups, hydrozoans, nemertean and fish larvae collectively constituted 1.65% of the total fauna. Polychaetes present in the area belonged to the genera, *Amphrodita*, *Eurythoe*, *Hesione*, *Phyllodoce*, *Parasphaerosyllis*, *Nereis*, *Owenia*, *Eunice*, *Marphysa*, *Lumbriconereis*, *Gonida*, *Glycera*, *Diopatra*, *Prinospio*, *Phyllochaetopterus*, *Flabelligers* and *Pectinaria*.

Crustaceans were largely composed of amphipods, decapods and stomatopods. The other less abundant groups like isopods, ostracods and cumaceans were found at a few stations. *Penaeus* sp., *Metapenaeus* sp., *Mysis* sp. and small brachyuran crabs represented the decapods. The stomatopoda was represented by *Squilla nepa*.

Among the molluscs, the bivalves constituted a major group followed by scaphopods, gastropods and polyplachophors. Bivalves were represented by *Arca fortuosa*, *Gafrarium pectinatum*, *Paphia textile*, *Macra cuneata*, *Pholas orientalis* and few other unidentified genera. Among the gastropods *Umbonium vestiarius*, *Olivia* sp. and *Cerithidea fluviatilis* were conspicuous by their presence. Scaphopoda was represented by *Dentalium elpis* and polyplachophora by *Chiton* sp.

The echinoderms were mainly represented by brittle stars *Ophiothrix* sp., sand dollars *Ophiocnemis* sp. and sea urchins *Echinus* sp. Fish larvae were represented by the Indian cod, *Bregmoceros* sp., gobiid fish *Boleophthalmus* sp. and eel larvae (leptocephali).

In terms of faunal distribution polychaetes showed the highest percentage of occurrence followed by amphipods, bivalves, decapods, sipunculids and stomatopods (Table 2). *Pectinaria* sp. and *Chiton* sp. were observed only off Cochin. Sand dollars and sea urchins were mostly restricted to southwest coast of India. Sipunculids were more abundant along the

Table 2—Population Density and Biomass Distribution in Relation to Depth

	Depth zones, m						% Composition	% Prevalence
	10-20	20-30	30-40	40-50	50-60	60-70		
No. of observations	22	32	25	21	10	10		
Polycheata	596	474	750	413	426	328	62.51	97.32
Amphipoda	30	40	50	43	26	20	4.75	46.04
Decapoda	61	35	25	20	18	10	3.91	43.41
Isopoda	14	20	8	4	5	3	1.25	19.14
Ostracoda	—	—	5	4	—	—	0.13	3.57
Stomatopoda	15	20	30	52	35	25	3.63	33.48
Cumacea	35	30	10	5	5	4	1.95	16.83
Bivalve	97	48	23	15	10	5	4.61	45.32
Gastropoda	20	15	25	30	15	45	3.49	28.74
Scaphopoda	—	10	15	54	60	40	4.05	4.42
Polyplachophora	2	—	—	—	—	—	0.13	3.84
Echinoidea	15	—	—	—	—	—	2.09	11.53
Hydrozoa	10	—	5	—	—	18	0.69	5.97
Sipunculaidea	35	25	15	30	37	40	4.19	35.66
Nemertea	20	5	5	—	—	—	0.69	13.11
Fish larvae	5	2	2	2	—	—	0.27	4.26
Population* No./m ²	985	730	683	657	647	543		
Biomass* g/m ²	24.49	13.69	12.05	7.42	6.12	5.49		

*Values represent mean

northern and southern region. *Bregmeceros* sp. and gobiid fish larvae were observed only off Ratnagiri whereas eel larvae were found off Kerala.

Biomass and population density—Biomass distribution of benthos is shown in Fig. 3. The biomass varied from 0.12 to 190.5 g/m² (av. 11.59 g/m²). The population density ranged between 50 and 3715/m². Maximum benthic biomass and population counts were observed at sts 8 and 101, whereas minimum values were observed at sts 1 and 9 (Fig. 1), respectively. The population count per unit area was directly linked with the biomass values except at those stations where large-sized animals like sipunculids, stomatopods and fish larvae increased the biomass values substantially. Smaller assemblages of polychaetes and amphipods increased the population density considerably.

Distribution in relation to depth—Depthwise distribution, population density and biomass of different animal groups showed a decreasing trend with the increase in depth (Table 2). Almost all the groups except ostracods, scaphopods, polyplachophors, echinoids, hydrozoans, nemertean and fish larvae were observed at all the depth zones. Ostracods were observed at 30-40 m and 40-50 m zones. Scaphopods were conspicuously not observed at 10-20 m zone. Polyplachophors and echinoids were restricted to nearshore-region and were found only in 10-20 m zone. Hydrozoans showed no definite relationship with depths. Nemertean and fish larvae were observed up to 40 and 50 m depths, respectively.

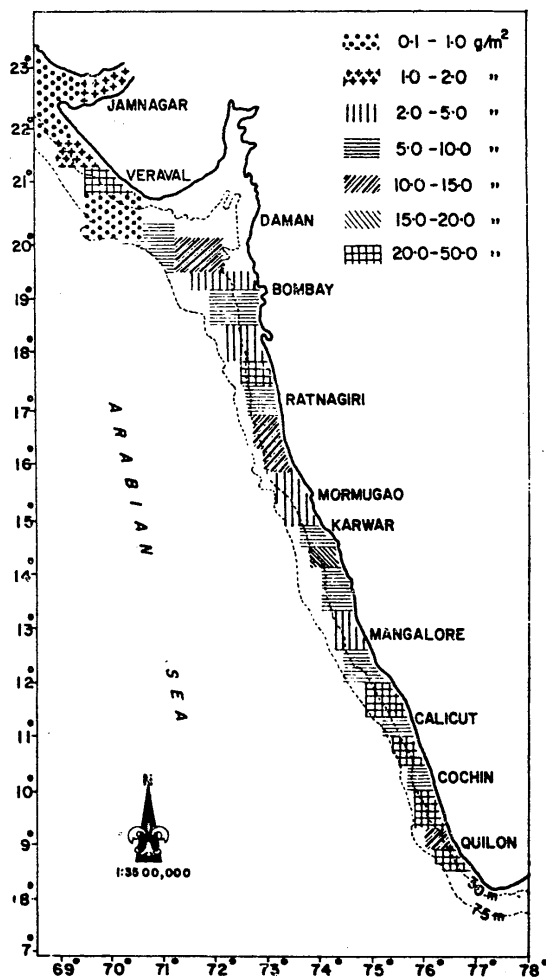


Fig. 3—Biomass distribution

Discussion

Variation of biomass and population density from station to station may probably be attributed to the impact of localised biotic and abiotic factors^{4,12}. The average biomass in the inner shelf region of the west coast of India is 11.5 g/m². Neiman⁸ has reported an average value of 20 g/m² in the western Indian shelf. The reason for this difference seems to be the size of the screen used for washing the samples and the number of stations sampled. However, the difference in biomass and population density reported earlier^{3,4,9,10} is attributed to seasonal variation, migration, food availability, reproduction, recruitment, etc.

The finding that benthic fauna in the nearshore region is dense and rich and progressively decreases towards deeper stations (Table 2) agrees with the earlier reports^{2-4,8,10-13}. Enrichment of coastal waters due to riverine flow and land run off also seems to be one of the factors contributing to richness of the fauna in the nearshore regions¹⁰. Analysis of biomass distribution shows higher values in the southern region with more diverse fauna than in the northern region (Fig. 3). This may probably be due to the influence of equatorial waters and upwelling^{2,18-22}.

Relationship between the benthic abundance and percentage organic carbon has been studied by many workers²³⁻²⁶. But it is still unknown as to how much of the labile organic carbon is utilized by benthic animals. Bader²³, while studying the abundance of bivalves in relation to percentage of organic carbon, has observed the decrease in population above 3% of organic carbon. He points out that beyond this concentration, products of bacterial decomposition and decline in the available oxygen become limiting factors. Ganapati and Raman²⁶ also show that in the Indian waters higher organic carbon up to 6% is anoxic to the marine life. In the present study decrease in benthic animals is observed when organic carbon is high (>4%; Fig. 4). Hence, organic carbon seems to be one of the limiting factors controlling the distribution and abundance of benthic population²³.

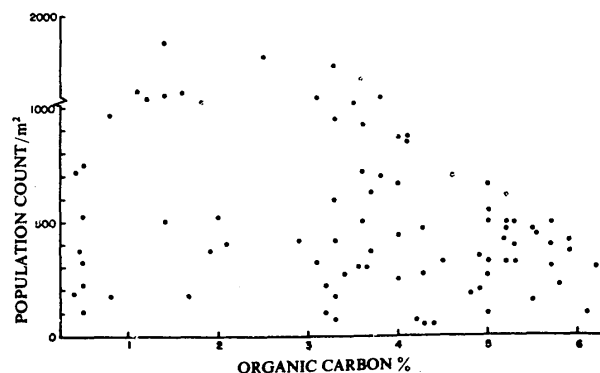


Fig. 4—Population density in relation to organic matter in the sediment

A definite relationship between the nature of the deposit and the distribution of benthic fauna has been reported^{12,27-29}. The abundance of benthos is clearly observed in sandy clay sediments followed by silty-sand sediments. Clay supported a very poor benthic population indicating that the median particle size harbours more population than the fine particle size (Fig. 5). Similarly, higher biomass is associated with sandy substrata. Kurian⁴, while studying the benthos of the southwest coast of India, has reported similar observations except in the mud banks region where the soft ooze like mud mostly formed of clay harboured very rich fauna especially after the formation of mud banks. The nature of the fauna varies according to the types of deposits. The suspension feeders (polychaetes) predominate the sandy bottom composed of medium particle size. Filter feeders (bivalve) dominate the sand and the deposit feeders (crustaceans) show a preference towards fine particles (silty-clay). The abundance of detritus feeders which include most of the crustaceans seems to be related to the availability of detritus rather than the type of substratum. The browsers (crustaceans), feeding mainly on detritus dominate the shallow region and the mouths of the estuaries. The seston feeding species of bivalves and echinoderms are limited to sandy bottom sediment.

According to Spark³⁰ the average number and weight of benthic organisms has a correlation with production, climatic factors and also with demersal fish production. Relationship between the benthic production and exploited demersal fishery resources has been reported^{1,31,32}. Damodaran¹⁴ while working on the mud bank regions of Kerala coast has reported a

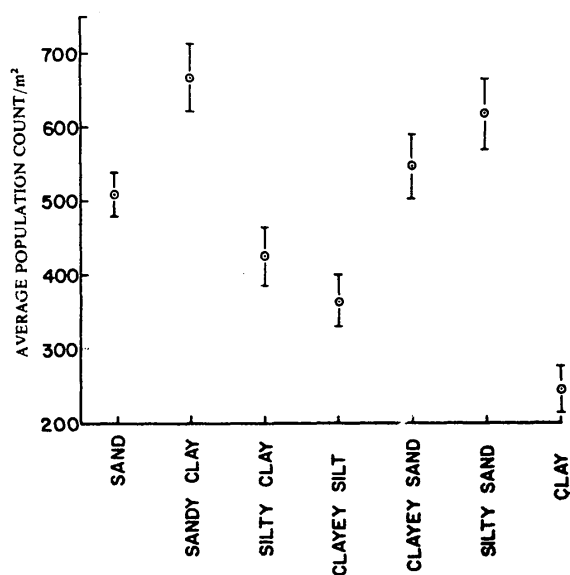


Fig. 5—Average population with 95% confidence limits in relation to type of substrata

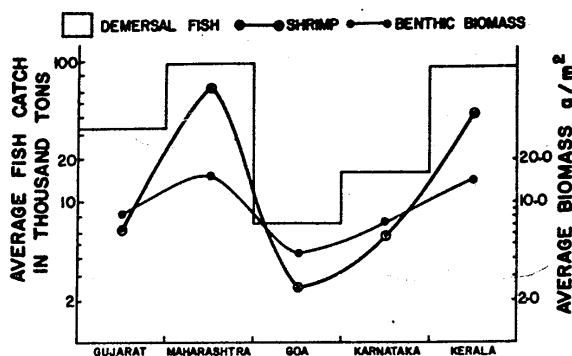


Fig. 6—Demersal fish catch in relation to benthic biomass along the west coast of India (state-wise)

relationship between benthos and prawn catch. Rao and Dorairaj³³ have found an increase in prawn catch towards the southwest coast of India associated with an increase in benthic biomass (Fig. 2). The correlation between benthic biomass with demersal fish catch as given by Rao³⁴ along the west coast of India shows more or less a positive correlation (Fig. 3). An analysis of state-wise benthic production shows a good relationship with the demersal fish catch (Fig. 6). Moreover, there is a good agreement between the shrimp catch and the benthic biomass. Dependence of shrimps on benthos has been demonstrated by Damodaran¹⁴. Ansari *et al.*¹³ have reported that major part of the demersal fish landing off Goa is from the high benthic production zones. Such a correlation indicates the important role of benthic biomass in the dietary of demersal fish. Hence, for the assessment of demersal fishery resources, the quantitative data on benthos can be used as an efficient tool.

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