

## Benthic macroinvertebrate community structure and distribution in the Ayeyarwady continental shelf, Andaman Sea

Ansari Z.A.<sup>1\*</sup>, Ramila Furtado<sup>2\*</sup>, Shahin Badesab<sup>3\*</sup>, Pratik Mehta<sup>4\*\*</sup> & Swe Thwin<sup>5\*\*\*</sup>,

<sup>\*</sup>National Institute of Oceanography, Dona Paula, Goa 403 004, India

<sup>\*\*</sup>National Institute of Oceanography, Regional Centre, Andheri, Mumbai, India

<sup>\*\*\*</sup>Department of Marine Science, University of Mawlamyine, Myanmar

<sup>1\*</sup>[E-mail: zakir.ansari2008@gmail.com]

*Received 11 January 2011; revised 13 July 2011*

Quantitative assessment of macrofaunal community of Ayeyarwady continental shelf, Andaman Sea was studied during the coastal resource survey during April-May 2002. About 27 major taxa were identified. Abundance of fauna was in the order of polychaeta (34.2%), crustacean (25.7), mollusca (4.2%) and echinodermata (4.5%), forams 30.3% and other groups 1.1%. Faunal density ranged from 59 to 6027/m<sup>2</sup> and the wet weight biomass from 0.01 to 43.47 g/m<sup>2</sup>. Fauna was dominated by polychaeta with 100% prevalence. Faunal composition differed along the depth gradient of habitat heterogeneity. Macrofaunal abundance during this study was within the range reported for shelf water of Burma and Andaman Sea but were higher than those from the South China Sea. Major shift in the quantitative distribution and spatial heterogeneity was due to several environmental factors.

**[Keywords:** Quantitative distribution, macrobenthos, coastal water, Myanmar]

### Introduction

Abundance of benthic fauna is one of the biological indices that support the food chain hypothesis of overall productivity in marine ecosystem<sup>1</sup>. Changes in benthic community may occur on different spatial scale presumably due to anthropogenic influences or natural seasonal variability. In order to generate effective conservation schemes and guidelines for the sustainable exploitation of natural resources, the dynamic of the distribution and abundance of organisms in relation to environmental, spatial and temporal processes in general and benthic community in particular need to be well understood<sup>2</sup>.

The quantitative assessment of benthic abundance and biomass are necessary components of biological assemblages. Benthic study is needed in the tropics so as to provide some basic data for comparisons to be made for any critical disorder that may arise in the future. Myanmar has a narrow continental shelf and the coastal water is rich in nutrient. It has got characteristic topographical feature which governs the oceanographic conditions to which the fauna and flora of the area are subjected<sup>3</sup>. Eastern extension of Andaman sea including coastal waters of Ayeyarwady continental shelf, are among the least investigated

region in terms of benthos in the Indian Ocean. This is an attempt to study the quantitative distribution of macrobenthos of Ayeyarwady continental shelf, Andaman Sea, in relation to three factors; depth, sediment structure and latitude.

### Material & Methods

Present study is based on the samples collected during April- May 2002 during the visit of ORV Sagar Kanya to Myanmar. A total of 46 stations were sampled in the depth range 20 to 1000 m of the Ayeyarwady continental shelf, Andaman Sea (Figure 1). For the collection of macrofauna a Petersen grab of 0.1 m<sup>2</sup> area was operated. All samples were subjected to sieving through a 0.5 mm sieve and animals retained on the sieve were preserved in 5% formalin Rose Bengal solution on board the ship. Replicate samples were collected as far as possible.

In the laboratory the animals were sorted out, enumerated group wise and wet weight biomass taken. Thus total density and total biomass of the different faunal group was determined and group diversity was measured. Data was subjected to statistical analysis.

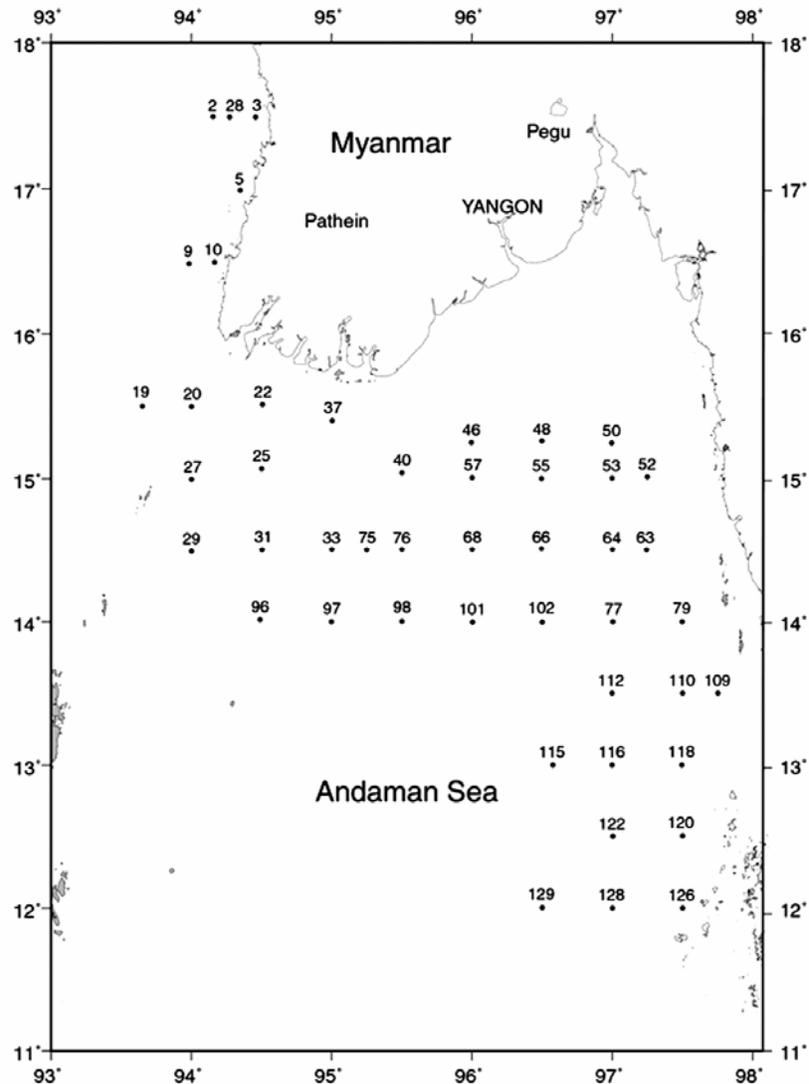


Fig. 1—Map showing location of stations.

## Results

### Sediment

The Ayeyawady -Thanlwin river system discharge huge amount of suspended sediment which gets deposited in the deep Andaman Sea via Martaban canyon by different tidal currents. Coastal areas are covered with silt that remains suspended due to strong currents. High suspended load in the water column does not allow light penetration resulting in low productivity particularly in the shallow coastal areas. Sediment granulometry of the area is reported by Rao *et al.*<sup>4</sup>. Three distinct areas of sediment texture have been delineated, (1) muddy bottom in near shore, (2) sand relict in outer shelf and (3) mixed sediment in the Martaban Canyon. The grain size distribution

varies from sand to mud. The inner shelf of the Gulf of Martaban has low sand and the outer shelf falls in the sand domain. The transition zone sediment occupy sand-silt-clay domain.

### Abundance and Biomass

The macrofaunal community of the Myanmar coast showed large variation in the distribution of faunal density (Figure 2). Total faunal density varied from a minimum of 59 at station 98 located at a depth of 230 m to a maximum of 6027/m<sup>2</sup>, at a depth of 47 m and the average density was 1120/m<sup>2</sup> ± 43 sd. Polychaetes density was ranged from 20-1186/m<sup>2</sup> while the total density of crustaceans was in the range of 20-1404/m<sup>2</sup>. Mollusks and echinoderms were poorly represented in the samples and their density

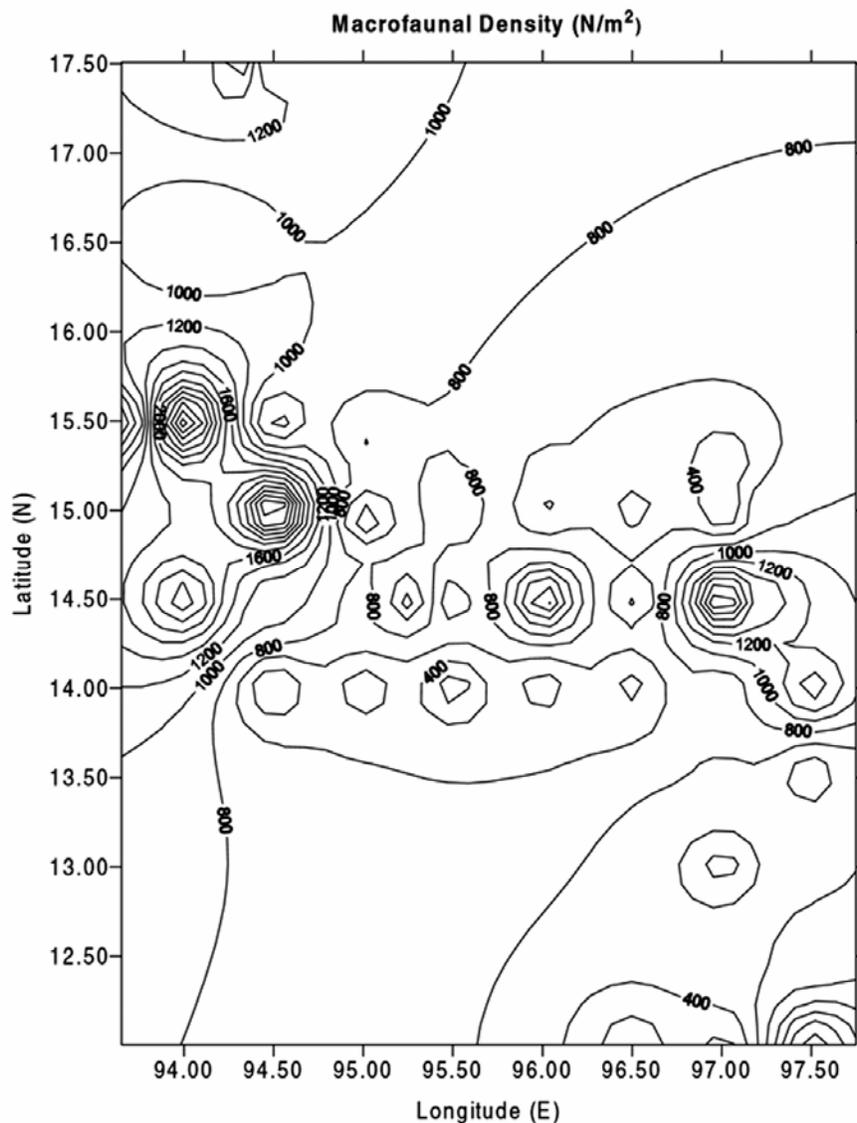


Fig. 2—Latitudinal variation in the distribution of macrofaunal density.

ranged 0-317 and 0-79, respectively. Other groups included fish larvae, flat worms, amphioxus ascidians etc. Total density of these was in the range of 0-13022/m<sup>2</sup>. There were clear geographical variation in the distribution of fauna.

Macrobenthic biomass (wet weight) varied between 0.01 and 43.47 g/m<sup>2</sup>. The average biomass value was 6.54±12.05 g/m<sup>2</sup>. The same is plotted in Figure 3 which also showed latitudinal variation in distribution of biomass. Bulk of the biomass was contributed by crustaceans and polychaetes (>50%). Other important groups for biomass contribution was mollusca. Biomass distribution in relation to depth showed high mean values in shallow water, similar to that of faunal abundance. There was an inverse relation of density

and biomass with depth (Figure 4). Density increased towards north latitude. Relationship between biomass and chlorophyll a is shown in figure 5.

#### Faunal Composition and distribution

The macrofaunal community of the coastal waters of Myanmar is given in Table 1. A total of 27 taxonomic groups were recorded from the study area. Among them the dominant phyla were Foraminiferans, polychaeta, nematoda, crustacea, mollusca, echinodermata and coelentrata. Average percentage composition of major taxa was polychaeta 34.25, crustacean 25.7%, mollusca 4.2%, echinodermata 4.5%, forams 30.3% and the other group consisting of minor phyla was only 1.1%.

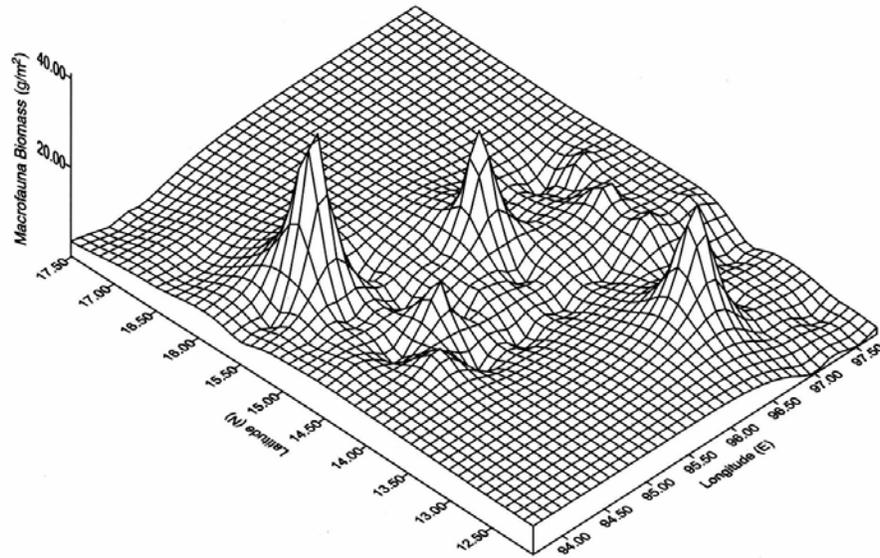


Fig. 3—3D view of biomass distribution.

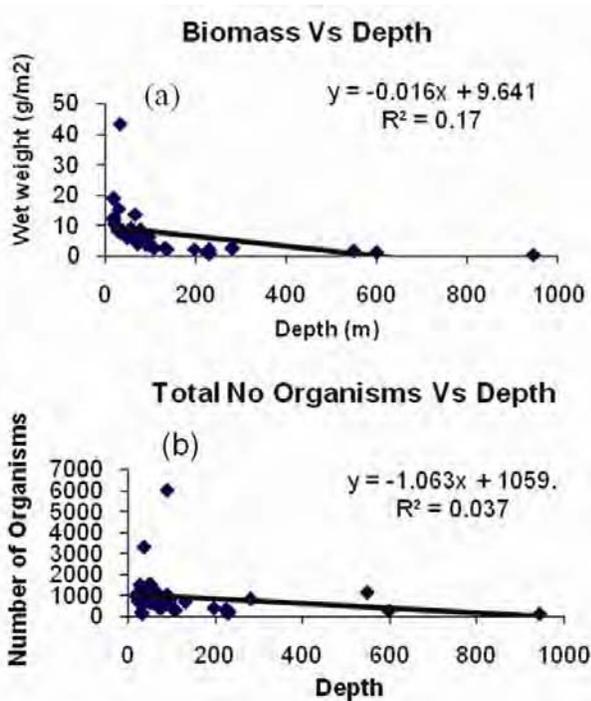
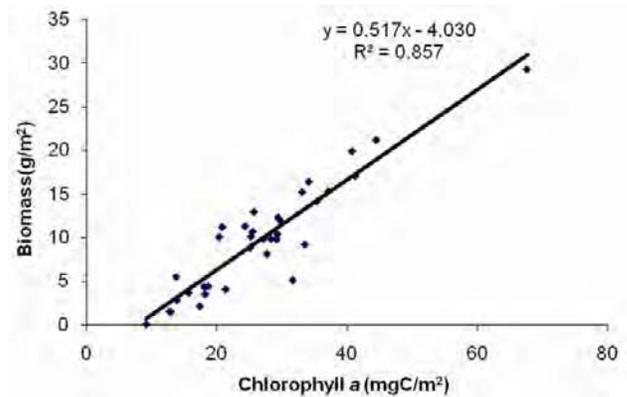


Fig. 4—Distribution of macrobenthos biomass and density in relation to depth.

#### Distribution in relation to depth

Faunal composition differed in different depth. Forams were abundant in the shallow region (20-50 m) while the polychaete showed no preference to water depth and were recorded regularly with high prevalence from all stations. Among crustaceans the amphipods, copepods ostracods and macruran crabs

Fig. 5—Relationship between the chlorophyll *a* and biomass of the study area.

were represented at different depths. About 24 taxa were recorded from 20-50 m depth while the intermediate depth of 51-100 m had the maximum taxa (27) and in the deepest zone of 201-1000 m there were only 11 taxa recorded. Depth-wise percentage contribution in the major taxa was polychaetes 15.8 – 54.7%, crustacean 20.0 – 36.2%, mollusca 0 – 6.7, echinoderms 0 – 8.3%. The miscellaneous group such as coelentrata, nemertine, echiurid worms, ascidians etc together accounted for 0 – 19.9.2% (Table 2). Occasionally, rare fish larvae were also recorded. However, among these major taxa only polychaetes, ostracods, copepods, isopods, amphipods, pelecypods and gastropods were recorded from all depth (Table 2). The polychaeta showed a 100% prevalence.

Table 1—Average abundance of macrofauna taxa (No./ m<sup>2</sup>) in different depth zone.

Depth (m)	20-50	51-100	101-200	201-1000
Faunal groups				
Foraminiferans	985	134	32	9
Hydrozoans	0	4	12	0
Anthozoans	18	3	0	0
Nemertines	13	5	16	0
Nematodes	0	3	0	8
Echiuroids	3	3	0	0
Polychaetes	274	424	508	102
Ostracods	25	13	32	0
Harpacticoids	60	66	135	17
Cumaceans	0	7	4	0
Tanaidacean	10	4	12	0
Isopods	13	24	4	6
Amphipods	161	138	146	9
Macrurans	63	23	0	0
Anomurans	1	1	0	0
Brachyurans	11	12	0	9
Stomatopods	4	2	0	0
Gastropods	4	22	8	3
Pelecypods	23	40	8	11
Ophiuroids	21	23	0	14
Echinoids	0	1	0	0
Crinoids	1	2	0	0
Holothuroids	1	2	0	0
Fish larvae	7	4	8	0
Amphioxus	11	0	0	0
Flat worms	1	1	0	0
Miscellaneous	20	17	0	3

Table 2—Percentage contribution of major taxa in different depth zone

Depth (m)	Polychaeta	Crustacea	Mollusca	Echinodermata	Others
0-20	51.2	40.7	0	8.10	0
21-50	34.3	39.1	4.0	2.7	19.9
51-100	46.3	26.0	6.7	3.2	17.8
101-200	49.7	35.4	2.6	4.7	11.3
201-500	62.0	21.7	3.9	8.3	4.1
5001-1000	52.7	27.8	6.9	0	12.6

**Distribution in relation to sediment type:**

Macrobenthic density and biomass was maximum in sandy sediment and minimum in clayey silt (Table 3). Similarly the highest wet weight biomass was recorded in the sandy deposit. Stability of the sediment plays important role in the distribution of macrobenthos. Due to the movement of unstable sediment a transition zone of sand-silt clay domain is developed in the inner area of the Gulf of Martaban while sandy domain in the outer shelf is found. These conditions may help in building different assemblages. This was seen

Table 3—Macrofaunal abundance in different sediment types

Sediment Type	Density (No./m <sup>2</sup> )		Biomass (g/m <sup>2</sup> )	
	Range	Mean	Range	Mean
Sandy	100 - 3320	1109.05	0.1 - 43.47	7.86
Silty, clay	158 - 1975	591.67	0.08 - 10.83	6.88
Clayey silt	60 - 831	372.40	0.03 - 11.30	3.51
*Clayey sand	6027 -	6027	6.65 -	6.65
Sand, silt, clay	59 - 1326	642.63	0.01 - 15.44	4.04

\* Single observation

in the dendrogram (Figure 6) where stations are segregated on the basis of sediment types.

**Discussion**

There is no realistic estimate on the benthos of Myanmar coastal water until now. Results of the present study show clearly that large scale pattern in macrofauna composition and functional attributes (density, biomass) exist, a part of which can be explained by the prevailing environmental conditions, sediment grain size, and productivity of the overlying water<sup>5</sup>. Oceanographic feature of the Ayeyawady delta and Gulf of Martaban is influenced by the river runoff. It brings major changes in the sediment granulometry which influences the distribution of benthic fauna in the region<sup>4</sup>. A direct link between surface primary production and benthic metabolism in shallow water and the portion of primary produced organic matter reaching the seafloor depth is well established<sup>6</sup>. Chlorophyll a concentration in the water column of the coastal waters of the Myanmar (unpublished data) was high which can support high benthic standing crop. A strong relationship between benthic biomass and chlorophyll a was demonstrated in Fig. 6. It has been reported that the sediment composition and chlorophyll a content has significant influence on distribution of macrobenthos<sup>5</sup>. Among various factors, hydrodynamic environment and sediments are reported to be the primary driving factor in the distribution of infauna macrobenthos<sup>7-8</sup>.

Macroinvertebrate assemblage in the present study was dominated by polychaetes at all depth followed by abundance of crustaceans such as ostracods, copepods, amphipods and decapods. Prevalence of polychaetes and crustaceans in the benthic assemblage has also been reported in the Malaysian coastal water<sup>9</sup>, South China Sea<sup>10</sup> and the Indian coast<sup>1,8</sup>. Prominence and high density of foraminiferans was patchy in the shallower depth while other less important group did not follow any particular depth distribution.

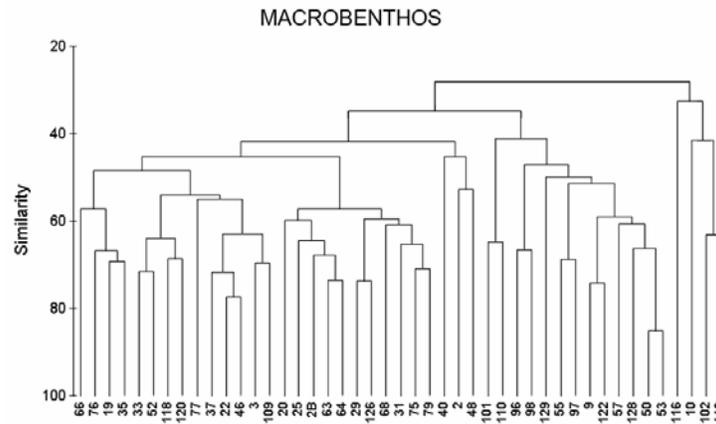


Fig. 6—Dendrogram showing percent similarity between stations of the study area.

Quantitative assessment of major taxa showed high variation both in terms of density and biomass. Neiman<sup>11</sup> reported 0.4 to 10 g/m<sup>2</sup> values of macrobenthos biomass in the shelf region of Burma based on few collections. High variation in quantitative distribution in the present study could be due to different taxonomic assemblages occupying different depth zones and sediment types. Gulf of Martaban is influenced by the load of sediment brought by Ayeyarwady system and enrich the area with high organic content. This produces a unique biogeographic zone<sup>4</sup>. Size of the present study area is significantly large and hence latitudinal variation in the macrobenthic abundance was more pronounced. Pattern of geographical diversity can differ among taxa due to dispersal ability and taxon specific factors which vary with depth and sediment grain size gradient.

In general the macrobenthic abundance in the study area was higher in inshore coastal waters than offshore areas. Fauna in the shallow habitat was most distinctive and nearly 60% of the common taxa were abundant only in the shallow habitat. Montra<sup>12</sup> reported that quantitative abundance, biomass and species diversity of macrobenthos was more in the inshore waters than in the offshore areas of Malaysia and Gulf of Thailand. As indicated earlier, a significant amount of the variation in faunal abundances, not unexpectedly, is a function of depth as well as the type of sediment. The macrobenthic assemblages were separated both qualitative and quantitative by depth zones. Each zone has its characteristic fauna. It has been suggested that changes in hydrodynamic condition, depth, geochemical factors, food availability, and predation

Table 4—Comparison of quantitative macrofaunal data

Reference area	Range in density No./m <sup>2</sup>	Average No./m <sup>2</sup>	Reference
Mallaca Strait	118 - 525	258	Parulekar & Ansari
Bay of Bengal	58 - 1644	517	Ansari et al
Andaman Sea	80 - 998	406	Parulekar & Ansari
Malaysia coast	100 -2060	584	Ahmed et al
Present study	59-6027	1120	

are responsible factors in controlling the population density and diversity of macrobenthos<sup>13</sup>.

The macrobenthos showed clear demarcation by depth, sediment grain size and latitude in qualitative and quantitative distribution. These findings are consistent with other studies<sup>8,14</sup>. Supply of food is a critical factor for the distribution of subtidal benthos and can act as limiting factor for deep-sea benthos. Persistence of assemblage is more pronounced in shallow (<200 m) than in deeper water which could be related to the regular supply of food in shallower areas<sup>15</sup>. Spatial scale changes with weak relationship between macrobenthos community structure and environmental variables has also been reported<sup>13</sup>. Large variations in the distribution of macrobenthic standing crop were the feature of coastal waters including the mouth of estuary<sup>1</sup>.

A comparison of the quantitative data (Table 4) with other areas suggest that the faunal abundance was highest in the present study. It was comparable to the one reported from coastal waters of Malaysia<sup>9</sup>, but higher than those of South China Sea<sup>10</sup>, Andaman sea<sup>16</sup> and Bay of Bengal<sup>17</sup>. This could be related to differences in sampling methods. The trends in the abundance of fauna reported here support the hypothesis that the quantity and species diversity of macrobenthos are higher in near shore rather than in

the offshore area with exception of specialized ecosystems<sup>18</sup>. Comparative average density of macrobenthos were higher than other areas. In the depth distribution the abundance of fauna in the intermediate depth (100-200 m) was also reported from Bay of Bengal<sup>17</sup>. High input of organic rich terrigenous sediment may be responsible to high benthic standing crop in the northern Andaman Sea and Gulf of Martaban. The variability in the supply of organic matter to the sea floor influence the structure and abundance of benthic communities<sup>7,8</sup>. This may explain the geographical variation in the standing crop of benthos. Present study revealed the habitat heterogeneity in distribution of macrofauna. Hydrographic environment and the amount of food appeared primary driving forces, with depth and sediment grain size as secondary correlates in the quantitative distribution of benthos.

### Acknowledgements

Present study is a part of the collaborative project "India-Myanmar joint Oceanographic studies in the Andaman sea". Authors thank the officers and crew members of ORV Sagar Kanya for assistance in sampling and Director, National Institute of Oceanography (NIO), Goa for his encouragement. This is contribution No. 5079 from NIO.

### References

- 1 Parulekar A H, Harkantra S N & Z.A. Ansari Benthic production and the assessment of demersal fishery resources of the Indian seas. *Ind. J. Mar. Sci.*, 11 (1982): 107-115.
- 2 Gray J S., The measurement of marine species diversity with an application to the benthic fauna of the Norwegian continental shelf. *J. Exp. Mar. Biol and Ecol.*, 250 (2000), 23-49.
- 3 Ramaswamy V, Rao P S, Rao K H , Thwin S, Rao N S & V. Raiker -2004 - Tidal influence on suspended sediment distribution and dispersal in the northern Andaman Sea and Gulf of Martaban; *Mar. Geol.*, 208 (2004), 33-42.
- 4 Rao P S, Ramaswamy V & Swe Thwin - Sediment texture, distribution and transport of the Ayeyarwady continental shelf, Andaman Sea. *Mar. Geol.*, 216 ,(2005), 239-247.
- 5 Heip C, Basford D, Craeymeersch J A, Dewarumez J M, Dorjes J, Wilde P, de Duineveld G, Eleftheriou, A., Herman, P M J, Nierman U P, Kingston P, Kunitzer, A, Rachor E, Rumohr H, Soetaert K , T. Soltwedel , Trends in biomass, density and diversity of North Sea macrofauna. *ICES J. Mar. Sci.*, 49 (1992), :13-22.
- 6 Rowe, G.T., Benthic biomass and surface productivity. In: edited by J.D. Costlow, Fertility of sea. 9New York, Gordon and Breach0, Volume 2 ,1971, 441-454.
- 7 Snelgrove P V R, & C.A. Butman Animal-sediment relationship revisited: cause versus effect. *Oceanography and Marine Biology: Ann. Review.* 32 (1994), 111-177.
- 8 Jairaj K A, Sheeba P, Jacob J, Ravichandran C, Arun P K, Praseeda K S, Nisha, P A, & K.A. Rasheed, Response of infaunal macrobenthos to the sediment granulometry in a tropical continental margin – south west coast of India. *Estuarine, Coastal and Shelf Science* 77 (2008), 743-754.
- 9 Ahmad A, Sollahuddin, A R, Jamaludin I, & M.I. Mahyam , Distribution of macrobenthos in the coastal waters of the east coast of Peninsular Malaysia. In: *Mansor (ed) Thirteenth Trawl survey of the coastal waters off the east coast of Peninsular Malaysia*, 2002, p138.
- 10 Abdul Hamid Y, & A.R. Sollahuddin, Distribution of macrobenthos in the South China Sea, Area I: Gulf of Thailand and East coast of peninsular Malaysia, In: *Proceeding of the first Technical seminar on marine fishery resources in the South China Sea area I; Gulf of Thailand and East coast of peninsular Malaysia*. (TDSEAFDEC, Thailand), 1999, 285-293.
- 11 Neiman A A , Soviet Fisheries investigation in the Indian Ocean. In: Bogdanav A.S., editor, 1973, pp127.
- 12 Montira P. -1999 - Temporal changes in the abundance of macrobenthos in the South China Sea, AreaI. Gulf of Thailand and East coast of Peninsular Malaysia. In: *Proceeding of the second Technical seminar on marine fishery resources survey in the south China Sea area I; Gulf of Thailand and East Coast of Peninsular Malaysia*. (TD SEAFDEC, Thailand), 1999, 156-171.
- 13 Shin P K S, & K.E. Ellingsen ,Spatial pattern of soft sediment benthic diversity in subtropical Hong kong water. *Mar. Ecol. Prog. Ser.*,(2004), 276::25-35.
- 14 Oug E, - 1998 - Relating species pattern and environmental variables by canonical ordination: An analysis of soft bottom macrofauna in the region of Tromso, Northern Norway. *Mar. Ecol. Prog. Ser.*, 45 (2004),: 29-45.
- 15 Kunitzer A, Basford D, Craeymeetsch J A, Dewarumez J M, Dorjes J, Duineveld, G C A, Eleftheriou A, Heip C, Herman P, Kingston P, Niermann U, Rachor E, Rumohr H & P.A.J. de Wilde,The benthic infauna of the North Sea. *ICES J. Mar. Sci.*, 49 (1992): 127-144.
- 16 Parulekar A H, Z.A. Ansari, Benthic macrofauna of the Andaman Sea. *Indian. J. Mar. Sci.*, 10 (1981), : 280-284.
- 17 Ansari Z A, Harkantra, S N, Nair, S A & A.H. Parulekar – 1977- Benthos of the Bay of Bengal – A preliminary account. *Mahasager-Bull. Nat. Inst. Oceanogr.*, 10:55-60.
- 18 Gee J K., R.M. Warwick, A study of global biodiversity pattern in the marine motile fauna of hard substrata. *Journal of Marine Biological Association of the United Kingdom* 76 (1996): 177-184.