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Faunal composition of meiobenthos from the shelf regions off the west coast of India

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Abstract

Faunal composition of meiobenthos of the shelf sediments of the western continental shelf is discussed. A total of eight taxonomic groups were represented in the meiobenthic samples. Among these, Nematoda, Copepoda and Foraminifera were the most dominant groups occurred in the shelf sediments. During the study, 155 species of nematodes belonging to 29 families were identified. The study indicated a depth wise and latitudinal variation in qualitative distribution of meiobenthos in different transects due to variation in the hydrobiological conditions.

Keywords: Faunal composition, meiobenthos, continental shelf sediments, west coast India

Introduction

Information on the meiobenthos of the Indian shelf sediment is relatively scanty. Even though many workers had made isolated and strenuous efforts from time to time, most of them were localised in and around estuaries or shallow coastal areas of the country (Kurien, 1967; Damodaran, 1972; Ansari, 1978; Parulekar *et al.*, 1976, 1982; Rao, 1986; Reddy and Hariharan, 1986). Harkantra *et al.* (1980) recorded the major fauna of the shelf region off west coast up to a depth of 75m. In general, these studies illustrated only the group level information of meiobenthos. Nematodes are arguably the most diverse and numerically dominant metazoans in marine habitats (Heip *et al*.,1982; De Ley and Blaxter, 2001), usually comprising more than 90% of the fauna and with global species estimates between 10^5 and 10^8 (Lambshead, 1993).Till date there are no species level studies available on the meiobenthos of the entire shelf. In this backdrop a comprehensive study was undertaken as part of the effort by Centre for Marine Living Resources and Ecology (CMLRE), Ministry of Earth Sciences (MoES) to study the Marine Living Resources of the EEZ of the country. The present paper appraises the qualitative nature of meiobenthos of the entire west coast.

Materials and methods

Study area and sampling: The study was conducted in the western continental shelf of India that extended from 08°03'96N and 77°21'96E to 21°56'99N and 67°57'69 E (Fig. 1). Materials were collected onboard Fishery and Oceanographic Research Vessel (FORV) *Sagar Sampada* from the shelf waters off the west coast of India during February-March 1998 and February 2001. Altogether 74 stations in 17 transects were sampled extending from off Cape Comorin to off Dwarka. The transects were Cape Comorin, Thiruvananthapuram, Kollam, Kochi, Vadanappilly, Kozhikode, Kannur, Mangalore, Coondapore, Bhatkal, Goa, Ratnagiri, Dabhol, Mumbai, Porbandar and Dwarka. Samplings were made from 30, 50, 100 and 200m depths from each station to study the depth wise structure of the meiobenthos. Additional samplings from 75m depths were also taken in certain transects due to wider shelf pattern and those transects were, Kollam, Kannur, Bhatkal, Goa, Ratnagiri and Mumbai. Since the shelf was very steep beyond 100m off Thiruvananthapuram, sampling from 200m was not possible. In Mumbai region, because of the restriction for the entry to the Mumbai High region, one transect was created north of this area and was named as 'Off Mumbai' and another, along this area was named 'Along Mumbai'. Since this region has the maximum continental shelf width, sampling was restricted upto 100m depth only.

For convenience of analysis and presentation, the data were pooled into specific depth ranges (*i.e.* 30-50m, 51-100m, 101-150m and >150m). Also the entire west coast was considered as three latitudinal regions, southwest, central and northwest. The southwest transects were Cape Comorin to Kozhikode; central included from Kannur to Ratnagiri and the northwest transects from off Dabhol to Dwarka.

A modified Smith McIntyre grab (0.1 m^2) was used

for collecting sediment samples. Once onboard, the grab was immediately checked; only those with undisturbed sediments were used for analysis. Sub samples were taken for meiobenthos using a glass corer with an internal diameter of 2.6 cm, and a length of 30 cm. Duplicate samples were taken from each station to understand sampling variation. The core samples were immediately fixed in 5 % buffered formalin.

In the laboratory, the core samples were washed through 500 µm and 63 µm sieves. The sediment retained in the 63 µm sieve was decanted to extract meiobenthos (Higgins and Thiel, 1988). The organisms retained in the 500 µm sieve were retrieved for any bigger nematodes else considered among macrobenthos. All meiobenthic organisms were sorted and enumerated under a stereomicroscope (Higgins and Thiel, 1988). Identification of the major group was carried out to the species level, whereas the others were identified to group level only.

Sediment granulometry was determined by the pipette method described by Carvar, (1971). Organic carbon was estimated by the wet oxidation method (El-Wakeel, and Riley, 1956) and later converted to organic matter using a conversion factor 1.72 as described by Wiseman and Bennete (1960). Statistical analysis was based on Statistica and Primer software.

Results

Meiobenthos: A total of eight taxonomic groups were represented in the meiobenthic samples. Among these, nematoda (84%), copepoda (8%) and foraminifera (3%) were the most dominant and abundant groups occurred in all stations. The other groups recorded in lower densities (5%) were polychaeta, halacarida (acarids) ostracoda, oligochaeta and kinorhyncha. Apart from the major group's *viz.* nematodes and copepods, all other groups were represented erratically in the shelf sediments. The general composition of meiobenthos and depthwise trend of the most abundant group nematoda are discussed in detail.

Depthwise variation of major group

Nematoda: During the present study, 155 species of nematodes belonging to 97 genera, 29 families were recorded from 69 stations (some of the stations identification was not possible owing to poor preservation). Xyalidae, Desmodoridae, Oncholaimidae Comesomatidae, Linhomoeidae and Selachinematidae were the most abundant families with more than 10 species recorded (Table 1).

Depth wise decline in both species number and abundance was apparent in the case of nematodes (Depth and nematode abundance -0.373, $p<0.01$) with respect to increase in depth. However, maximum number of species was recorded from intermediate depths (51-100m). At 30-50m depth, there were 97 species recorded followed by 106 from 51-100m, 50 from 101-150m and 36 from beyond 150m (Fig. 2). The most dominant nematodes of the shelf were *Dorylaimopsis* sp. recorded from 33 stations, *Tricoma* sp. in 30 and *Theristus* sp. in 29 stations (Table 2).

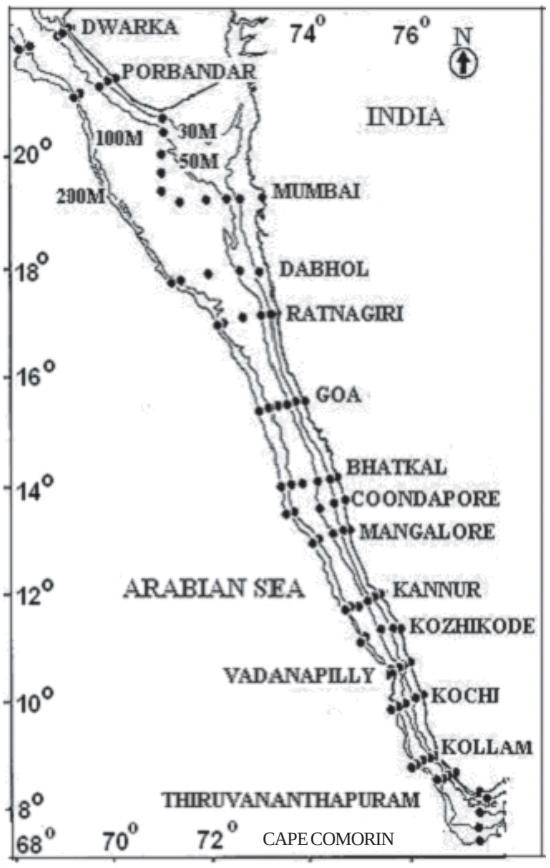

Fig. 1. Chart showing the location of sampling stations

The depth wise variation of major families showed that some of them were represented only in particular depths and absent beyond that (Table 3). Ten families were represented throughout the depth profiles studied. Two families, Trefusiidae and Enoplidae were observed only in 50 and 100m depths. Most of the families were recorded at depths 30-100m. While beyond 100m, some of the families, Enchellididae, Tripyloididae, Leptosomatidae, Phanodermatidae, Trefusiidae, Ethmolaimidae and Axonolaimidae were not recorded.

Table 1 *Free-living marine nematods of west coast of India*

Sl.no.	Species	Sl.no.	Species	Sl.no.	Species
	Order Enoplida	30	*Trefusia longicaudata*	70	*C. inaurita*
	Family Oncholaimidae		Order Cromadorida	71	*Metachromadora pulvinata*
1	*Oncholaimus dujardini*	31	*Laimella* sp.	72	*Metachromadora* sp
2	*Oncholaimus* sp.	32	*L. longicaudata*	73	*Acanthopharyngoides chitwoodi*
3	*Viscosia* sp.1	33	*L.filipjeavi*	74	*Perspira* spp.
4	*Viscosia* sp.2	34	*Dorylaimopsis* sp.	75	*Acanthopharynx* spp.
5	*V. viscosa*	35	*Comesoma* spp.		Family Microlaimidae
6	*V.elagans*	36	*Paracomesoma longispiculum*	76	*Bolbolaimus teutonicus*
7	*V.carynleyensis*	37	*Sabatieria* sp.	77	*Calomicrolaimus spirifer*
8	*V.macramphida*	38	*S.paracupida*		Family Chromadoridae
9	*Oncholaimium vesicarium*			78	*Actinonema pachydermatum*
10	*Oncholaimellus carlsbergi*	39	*Setosabateiria hilarula*	79	*Spilophorella cauxina*
11	*Metoncholaimus* sp.	40	*Hopperia* spp.	80	*S. tollenifera*
12	*Filoncholaimus filicaudatus*	41	*Actarjania* spp.	81	*S. candida*
	Family Enoplidae	42	*Cervonema macramphis*	82	*Spilophorella* sp.
13	*Enoplus* sp.		Family Selachinematidae	83	*Dichromodora geophila*
	Family Oxystominidae	43	*Richtersia* sp.	84	*Neochromadora* sp.
14	*Halalaimus isaitshikovi*	44	*R.inaequalis*	85	*Trochamus* spp.
15	*H. meyersi*	45	*Choaniolaimus papillatus*	86	*Paraeuchromadora longicaudata*
16	*H.longicaudatum*	46	*Halichoanolaimus conimilis*		Family Cyatholaimidae
17	*H. gracilis*	47	*H. dolichurus*	87	*Longicyatholaimus* sp.
18	*Halalaimus* sp.	48	*Gamanema* spp.	88	*L.quadriseta*
19	*Oxystomina elongata*	49	*Synonchiella riemani*	89	*Pomponema segregata*
20	*O. clavicoudata*	50	*Latronema* sp.	90	*Paralongicyatholaimus minutus*
21	*Weiseria* spp.	51	*L.piratica*	91	*Metacyatholaimus* sp.
	Family Enchellidiidae	52	*L. orcina*	92	*M. spatiosus*
22	*Eurystomina* sp.	53	*Cherionchus* spp.		Family Ceramonematidae
23	*Ledovitia phanertrata*		Family Desmoscolecidae	93	*Pselionema* sp.
	Family Trypyloididae	54	*Tricoma* sp.	94	*P. longiseta*
24	*Trypyloides marinus*	55	*T. filipjevi*	95	*Ceramonema carinatum*
25	*Bathylaimus* spp.	56	*T. brevirostris*	96	*Dasynemella* spp.
	Family Anoplostomatidae	57	*Greeffiella* spp.	97	*Dasynemoides albaensis*
26	*Anoplostoma* spp.	58	*Quadricoma* sp.		Family Ethmolaimidae
	Family Leptosomatidae	59	*Q. scanica*	98	*Flintonchus filiformis*
27	*Pseudocella* spp.	60	*Catenema macintyrei*		Family Aegialoalaimidae
			Family Desmodoridae		
	Family Rhabdodemaniidae	61	*Leptonemella aphanothecae*	100	*Cyartonema* sp.
28	*Rhabdonemania* sp.	62	*Spirinia similis*	100	*C. germanicum*
29	*Crenopharynx marioni*	63	*S.parasitifera*	101	*Southernia zosterae*
	Family Trefusiidae	64	*Spirinia* sp.		Family Monoposthiidae
30	*Trefusia longicaudata*	66	*Desmodora* sp.	102	*Rhinema* spp.
	Order Cromadorida	67	*D.brachypharynx*	103	*Nudora* sp.
29	*Crenopharynx marioni*	68	*D.scaldansis*	104	*Nudora crepidata*
	Family Trefusiidae	69	*Chromaspirini* sp.		

Table 1 *contind....*

Sl.no.	Species	Sl.no.	Species	Sl.no.	Species
	Family Draconematidae	121	*Paramonhystera* sp.	141	*Eumorpholaimus sabulicolus*
105	*Dracognomus simplex*	122	*P. butchschlii*	142	*Terschellingia longicaudata*
106	*Notochaetosoma killeri*	123	*Linhystera* spp.	143	*T. communis*
	Family Leptolaimidae	124	*Elzalia* spp.	144	*Disconema alaima*
107	*Antimicron elegans*	125	*Rhynchonema cinctum*	145	*Elutherolaimus stenosoma*
	Order. Monhysterida	126	*Promonhystera faber*	146	*Paralinhomoeus tenuicaudata*
	Family Sphaerolaimidae	127	*Amphimonhystera anechma*	147	*Paralinhomoeus* sp.
108	*Sphairolaimus* sp.	128	*Cobbia* spp.	148	*P. lepturus*
109	*S. pacifica*	129	*Linhomoeus* spp.	149	*Metalinhomoeus* sp.
110	*S.islandicus*	130	*Metadesmolaimus* sp.	150	*Metalinhomoeus longisetosus*
111	*S.hirsutus*	131	*M. aduncus*		Family Diplopeltidae
112	*S. macrocirculus*	132	*Xenolaimus striatus*	151	*Didelta scutata*
113	*S. pencillus*	133	*Daptonema oxycerca*	152	*Diplopeltula asetosa*
	Family Xyalidae	134	*Daptonema* sp.		Family Siphonolaimidae
			Family Axonolaimidae	153	*Siphonolaimus* sp.
114	*Theristus* sp.1	135	*Axonolaimus* sp.	154	*S. pachyderma*
115	*Theristus* sp.2	136	*A. spinosus*	155	*S. auratus*
116	*T. fistulatus*	137	*Ascolaimus elongatus*		
117	*T. alternus*	138	*Parodontophora brevamphida*		
118	*T. acer*	139	*P. brevisita*		
119	*T. exutus*		Family Linhomoeidae		
120	*Monhystris* sp.	140	*Paralinhomeous pachyamphis*		Spp. = more than one species

Table 2. *Dominant free-living nematodes of the selected depth ranges, west coast of India*

Selected depths (m)	Dominant species
30-50	*Dorylaimopsis* sp., *Desmodora* sp., *Tricoma* sp. and *Terschellingia longicaudatus*.
51-100	*Tricom*a sp., *Sabatieria* sp., *Theristus* sp; *Spirinia* sp; *Dorylaimopsis* sp and *Halalaimus* sp.
101-150	*Tricoma* sp., *Spilophorella tollenifera*, *Sabatieria* sp. and *Paramonhystera* sp.
>150	*Desmodora* sp. *Theristus* sp., *Dorylaimopsis* sp. and *Promonhystera* sp.

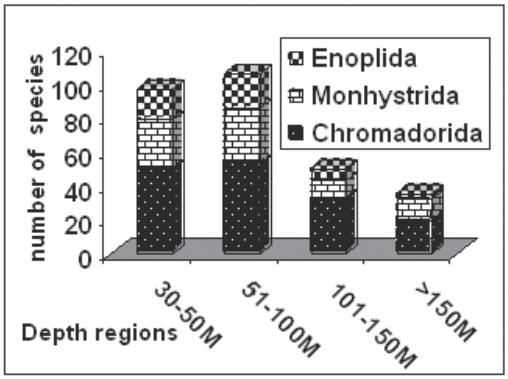

Fig. 2. Depth-wise distribution of free-living nematodes of the shelf sediments.

In the edge of the shelf (beyond 150m) there were only 13 families out of the total 29 recorded. The families Diplopeltidae, Siphonolaimidae, Ceramonematidae, Monoposthidae, Microlaimidae, Rhabdonematidae and Anoplostomatidae were present in all the depth ranges except beyond 150m depths.

Latitudinal variation

Latitudinal variation in species abundance was prominent in the entire shelf. Southwest region showed higher number of species (114) followed by central-west (101) and northwest with 69 (Fig.3). Among the stations, the number of nematode species noted were Thiruvananthapuram (30), Kochi (30 & 50), Vadanappilly (30), Kollam (30) Kannur (30, 50), Goa (30), Ratnagiri (50) and off Mumbai (50) .

Latitudinal trend (similarity) of the nematodes of the entire shelf in southwest, central-west and northwest

Table 3. *Free-living marine nematode families recorded from* selected depths, west coast of India

Family	depths			
	30m	51-100m	>101m	>150m
Oncholaimidae	v	v	v	v
Oxystominidae	v	v	v	v
Enchellididae	v	v	a	a
Trypyloididae	v	v	a	a
Anoplostomatidae	v	v	v	a
Leptosomatidae	v	a	a	a
Rhabdonematidae	v	v	v	a
Phanodermatidae	v	v	a	a
Trefusiidae	a	v	a	a
Enoplidae	a	a	v	a
Comesomatidae	v	v	v	v
Selachinematidae	v	v	v	v
Desmodoridae	v	v	v	v
Desmoscolecidae	v	v	v	v
Microlaimidae	v	v	v	a
Monoposthidae	v	v	v	a
Aegialaimidae	v	a	v	a
Chromadoridae	v	v	v	v
Cyatholaimidae	v	v	v	v
Ceramonematidae	v	v	v	a
Ethmolaimidae	a	v	a	a
Leptolaimidae	a	v	a	v
Draconematidae	v	v	v	v
Sphaerolaimidae	v	v	a	v
Xyalidae	v	v	v	v
Axonolaimidae	v	v	a	a
Linhomoeidae	v	v	v	v
Diplopeltidae	v	v	v	a
Siphonolaimidae	v	v	v	a

v= present; a= absent

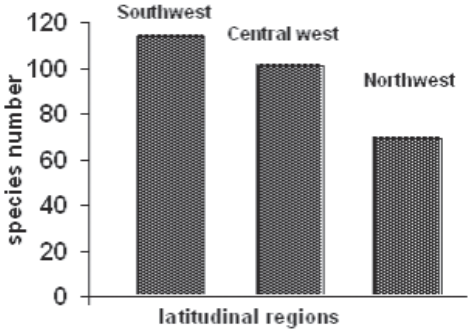

Fig. 3. Latitudinal distribution (species number) of the nematodes of the shelf region.

regions did not show any clear separation as species were clubbed together in three regions (Fig.4). The most common species among the three regions of the shelf also showed not much difference except for their proportion in abundance. In the southwest region, the dominant species were *Tricoma* spp., *Desmodora tenuispiculum*, *Desmodora* spp., *Dorylaimopsis* spp. and *Sprinia* spp. In the case of central-west coast the dominant were *Theristus* spp., *Dorylaimopsis* spp., *Tricoma* spp., *Sabatieria* spp., and *Terschellingia longicaudata*. In the northwest region, the major nematodes were *Dorylaimopsis* spp., *Tricoma* spp., *Sprinia* spp., *Halalaimus* spp. *and Desmodora* spp. The dominant species showed more abundance in the central- west region than southwest or northwest. Significantly, the *Desmodora* spp. were more abundant in northern stations of the shelf.

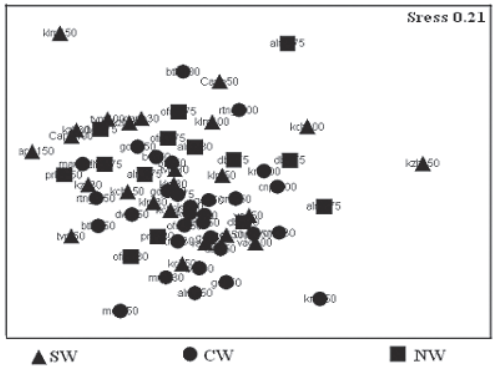

Fig. 4. MDS showing latitudinal distributions of (Similarity) Nematodes in the shelf sediments.

Copepoda: They constituted the second important group among meiobenthos. Mostly they represented the order Harpacticoida, which are typically benthic. They occurred in almost all depths, and their abundance was negatively correlated with increase in depth (copepod and depth $p<0.05$). The depth wise decline in abundance was 75% from 30 to 50m and 97% from 50 to 100m and 121% from 100m towards the edge of the shelf. Some of the species that could be identified were *Arenosetella* sp., *Pseudobradya* sp., *Harpacticus* sp., *Stenhelia* sp., *Ameira* sp., *Apodopsyllus* sp., *Orthopsyllus* sp. and *Leptostacus* sp.

Foraminifera: Foraminiferans formed the only protozoan group, which were abundant in the meiobenthic samples. They were present in comparatively higher densities in northern part of the west coast. Study of this group was limited to its quantitative aspect. Some of the major species observed included *Discorbis globularis, D. allomorphinoids; Discorbis* sp., *Bulimina fijiensis*,

Bulimina sp., *Bolivinia nobilis, B. marginata, B. interjuncta, Cibicides lobatulus, Planulina weullerstorfi, Planulina* sp., *Trochammina nitida, Operculina* sp., *Miliammina* sp., *Nonion scaphum* and *Marsiepella* sp.

Polychaeta and Oligochaeta: Polychaeta present in the sample were mainly temporary meiobenthos. Their density was poor and often did not occur in all stations. The young ones of the following polychaetes were identified (*Syllis* sp., *Magelona* sp., *Lumbrineris* sp.) since they were the common forms present along the shelf. The meiobenthic polychaetes identified were *Triolobodrillus* sp., *Mesonerilla* sp. and *Paranerilla* sp. They occurred in few stations in relatively lower densities. Oligochaeta was also represented in few numbers among stations and their study was limited to the quantitative aspect.

Kinorhyncha: They were not often encountered in meiobenthic samples. They were usually found to occur in fine sandy to muddy sediments from the eulittoral down to deep sea. In the present study, they were recorded in few numbers from certain stations only. *Cateria* sp., *Pycnophyes* sp. and *Echinoderilla* sp. were among the identified kinorhynchs from the shelf.

Halacarida (Acari) and Ostracoda: Despite their clear-cut diagnostic characters halacarids have been little investigated from Indian shelf sediments. In the present study halacarids were present in 22 stations in few numbers. Ostracods are usually found in shallower stations. Their density was rather poor in most of the stations particularly in deeper waters. Except a general observation regarding their quantitative aspects in different stations, details of both groups were not studied.

Discussion

The meiobenthic composition in the western shelf of India includes 8 taxa *viz*. Nematoda, Harpacticoida, Foraminifera, Polychaeta, Halacarida, Oligochaeta, Ostracoda, and Kinorhyncha. Of these, the most dominant and prevalent group was nematodes followed by harpacticoid copepods. Similar taxonomic composition were earlier reported by Ansari (1978) and Rodrigues *et al*. (1982) from Indian waters and elsewhere (Soltwedel, 2000). Numerically nematodes contributed 84% of the total fauna where as harpacticoids formed only 8%. This was in conformity to earlier studies (Ansari and Parulekar, 1998). Apart from foraminifera all other groups (ostracoda, halacarida, polychaeta, oligochaeta and kinorhyncha) were represented erratically in the shelf region.

The different taxons showed a decline in abundance with increase in depth. As a whole a declining trend was observed for most transects except nematodes in certain transects. This trend in faunal abundances and biomass with increasing water depth reflects an overall decrease in food availability for meiobenthos (Ansari *et al.*, 1980). The vertical zonation of the surface and subsurface assemblages of meiobenthos and nematodes in particular were controlled by the vertical profiles of environmental factors. An exception of this, along individual transects may fully, or partially, be explained by subsurface currents hindering the sedimentation of the rather light particulate organic matter. The depthwise decline in abundance along transects can be explained by variations in local productivity (Rowe, 1983). Differences in food availability both quantitative and qualitative, appear to be an important factor controlling total abundance and the faunal composition of the metazoan meiobenthos at the taxonomic level; richer communities are tending to develop in shallower areas where there is a higher overall input of organic matter (Vincx *et al.*, 1994; Soltwedel, 1997). Competition, both among individuals within a species as well as among species, can also play a major role in limiting faunal abundances and distribution. These factors, when combined with the effects of various physicochemical factors such as salinity, temperature, dissolved oxygen, sediment grain size, depth of the redox (reducing) layer within the sediments, and distribution along the depth gradient in sublittoral environments, result in very complex spatial and temporal patterns of nematode assemblages.

Most abundant group, nematodes were represented by 155 species of 97 genera, 29 families and 3 orders and 84 of them were new to the Indian waters. About 121 species were reported earlier by different workers from interstitial waters, estuaries or Island waters. (Gerlach 1962, 1963; Rao, 1986). However, literature regarding nematode species from various Indian shelf waters is scanty. When the shelf as a whole is considered, the most dominant families were Xyalidae, Desmodoridae, Oncholaimidae, Comesomatidae, Linhomoeidae and Selachinematidae.

The present study establishes a depth wise decline in both species number and families in the case of nematodes, especially with respect to dominant ones such as *Dorylaimopsis, Desmodora, Tricoma* sp. and *Theristus* sp. This has been observed by Soltwedel (2000).

Latitudinal variation was less distinct in the case of total faunal composition and nematode species. However, a prominent variation was noticed in nematode species abundance along the entire shelf. Southwest showed higher number followed by central west region and northwest region and the corresponding centres mentioned earlier. The different zones showed much similarity in the species

composition even though their proportion of abundance varied. The MDS showed the similarity with a slightly higher but reliable stress value. However, the high average abundance of meiobenthos in certain northern transects which in present case is contributed by nematodes alone. The studies of nematode abundance in various deeper waters of Arabian Sea support the hypothesis that low oxygen (0.13ml/l) does not affect the abundance of nematodes. (Cook *et al*., 2000). High proportion of nematode abundance in northern transects can be addressed by the robustness of nematodes to such conditions as similar observations were already been reported (Vincx et *al*., 1994; Soltwedel, 1997).

The dominance of nematode species among the three regions of the shelf also showed no much difference although the individual contribution to the total density varied. The most common species showed more abundance in the central west region than southwest or northwest. With the results of the study the latitudinal similarities or dissimilarities in species composition among three zones can only be addressed by prevailing biological and environmental conditions.

Other groups of the meiobenthos such as polychaetes (temporary meiobenthos) forms were also poorly represented often ranking fourth in meiobenthic samples in various depth ranges. Foraminiferans were recorded maximum from 51 to 75 m depth and noticeably towards the northern part of the western shelf. Ostracods were poorly represented throughout, as they prefer surface sandy sediments of shallow bottoms (Giere, 1993). Acari also were poorly represented, owing to their limited abundance in fine sand and muds and limited supply of oxygen (Giere, 1993). Thus the composition of the meiobenthos in the shelf displays a similar taxonomic grouping reported from continental shelves elsewhere and their observed qualitative distribution pattern in accordance with prevailing biological *i.e.* primary productivity related food sources and hydrographical parameters.

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