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Identification of Major Taxa of Meiobenthos in Hatiya Coast of the Bay of Bengal: Spatio-Temporal Abundance

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Abstract: Identification of major taxa of meiobenthic fauna in relation to sediment gradients and water quality characteristics were carried out to the south-central coast of the Bay of Bengal (Hatiya, Noakhali), Bangladesh. Meiobenthic faunas were distributed more heterogeneously at a large-scale during pre-monsoon than post-monsoon. The higher abundance of meiobenthos was (372,690±50,147 ind/m^2) during pre-monsoon than (282,351±33.783 ind/m^2) in post-monsoon and more abundance of meiobenthos was found at Station-4 (Char Ishwar) and less abundance at Station-1 (Nalchira Ghat) during pre-monsoon and post-monsoon.

Key words: Meiobenthos · Spatial Variation · Temporal Variations · Hydrological Parameters · Meghna River · Hatiya Island

INTRODUCTION

Climatologically, Bangladesh is in the Tropical Monsoon region. The Southernmost part of Bangladesh is bordered by about 710 km long coastal belt of the Bay of Bengal [1]. The present study was carried out in Hatiya Island is situated at the mouth of the Meghna River where, one of the largest estuaries of the world is situated to work out the spatial and temporal variability of meiobenthos. It has long been recognized that tropical regions, by and large, support a more diverse fauna than do regions of higher latitude [2]. There are several groups of benthos commonly distinguished by the body size of organisms: macro-, meio-, microbenthos [3, 4]. Each of these size groups includes certain taxa and can be considered as a distinctive ecological unit, which has a peculiar set of adaptations as well as specific scales of spatio-temporal perception [5-8]. Meiobenthos consists of a broad taxonomic groups which includes nematodes, harpacticoid copepods, kinorhynchs, tardigrades and some of the micro invertebrate species living within the sediment grains temporarily as part of their life cycles [9]. Pronounced spatio-temporal variability has been demonstrated for all the meio- and microbenthic taxa and can be treated as their common feature [10-15], but direct comparisons of the variability between groups are rare [16-19]. Approximately 98% of all marine species are supposed to be the benthos [20]. During the last three decades, vegetation of Hatiya Island has changed dramatically, and this has happened mainly due to the reforestation and cultivation program. Hatiya Island is in the lower Meghna estuary and consists of quaternary alluvial deposits of silt, sand and clay. Morphological behavior of the island is changing rapidly as a result of river discharge, tide and coastal hydrology of the region [21]. Meiobenthos grows in all types of sediments and is thus able to reside in a wide variety of habitats (subtidal and intertidal areas). However, the texture of the sediment is an important variable for structure and distribution of meiobenthic community [22, 23]. Fine grain sediment is responsible for the colonization of higher benthic organisms due to a concurrent increase in the availability of food [24]. In mudflats, nematodes are consistently considered the most abundant meiobenthic taxa [25]. Meiobenthos are actively participating in the biogeochemical cycles by their metabolic consumption and they affect the microbial state spatially and temporally by affecting chemical flows in sediments [26].

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The meiofauna, comprising a variety of taxonomic groups, occupy a position of considerable significance in the bio-degradative processes occurring in estuaries [27, 28]. Meiofauna are also considered as sensitive indicators of environmental excitation and having great potential as pollution indicators because of their species diversity, abundance and biomass. Therefore, the most prominent objectives of our study were: to know the spatial and temporal distributions and abundance of meiobenthos of the south-central coast of Bangladesh (Hatiya, Noakhali). The findings of this study could serve as background information for this area.

MATERIALS AND METHODS

Study Area and Study Period: The Study was carried out at Hatiya Island (22.3667°N to 91.1250°E) whose morphological behavior is changing rapidly as a result of river discharge, tide and coastal hydrology of the region [29] is located in the administrative territory of Noakhali district of Bangladesh. Collection of samples for the present investigation were carried out in a total 15 sub-stations under 5 main stations (Fig. 1). The sampling area is ranged from off Nalchira ghat to Jahajmara. Five stations were 100m apart from each other.

Table 1: Details of sampling stations

Station No.	Name	Latitude (°N)	Longitude (°E)
1	Nalchira Ghat	22.34393	91.12734
2	Char king	22.37201	91.08191
3	Jahajmara	22.29687	91.03902
4	Char Ishwar	22.27522	91.18405
5	Tamuruddin	22.29422	91.07353

The location and GPS of all the sampling stations have been provided in Table 1 and Fig. 1, respectively. The samples were collected in two seasons the post-monsoon dry winter season (December 2018) and the pre-monsoon hot summer season (March 2019). At each sampling station, three replicates were collected.

Sample Collection and Preparation: Samples of the 10 cm of sand were collected using plastic mud corers (5 cm diameter) and 200 g sediment sample was taken in polyethylene bag and labelled for the analysis of grain size. At the same time the remaining sediment samples were poured in a bucket with water, mixed well and the sample was then ready to pass through hand-sieves having two different mesh sizes (45 and 500 µm). At first, the mixed sample was passed through a hand-sieve with mesh size of 500 µm. The filtrate was then passed through 45 µm mesh size sieve.

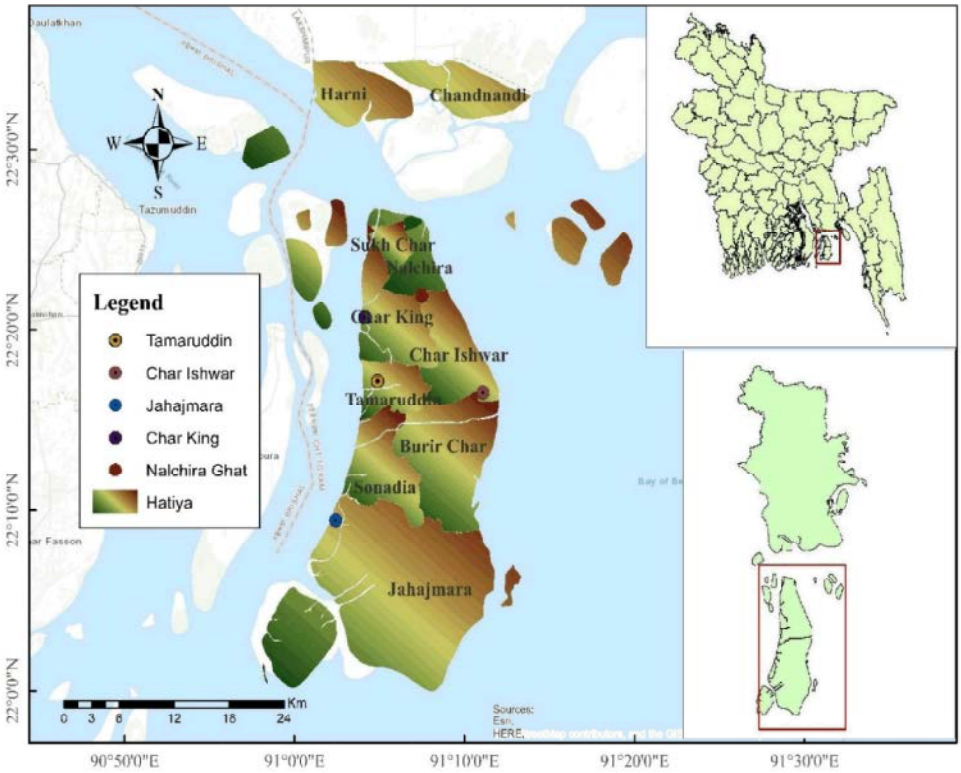


Fig. 1: Locations of the sampling stations in Hatiya Island.

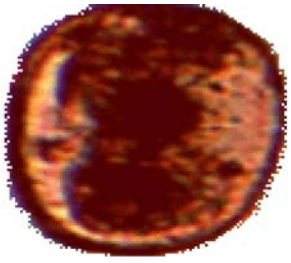
Sample Preservation and Identification: Organisms that are present on the sieve of definite mesh size were preserved in 250ml screw capped plastic container with 10% commercial formalin. Small amount of "Rose Bengal" powder after dissolving with distilled water and the added to the sample for the purposes of increasing visibility. The organisms absorbed Rose Bengal and by changing body color turned into pink. A small amount of sample was taken on a transparent glass slide and placed under the digital stereomicroscope. Microscopic images were taken for all the colored organisms and their dimensions were recorded. An effort has been made to identify the meiobenthos up to species level wherever possible with the help of relevant literatures. The organisms were counted, and the data were back calculated to represent their density ind/m^2 of the original habitat.

Data Processing and Analysis: The mean abundance and standard deviation (SD) of each group of each station were calculated from the estimates of total abundance in each replicate. The mean abundance with the standard deviation of each group was calculated and the data were compared with different study stations of the area.

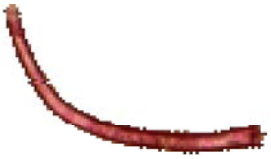
RESULTS AND DISCUSSION

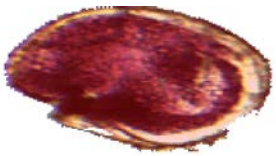
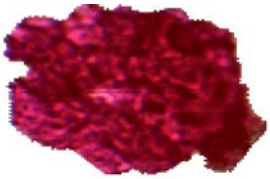
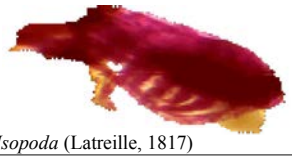
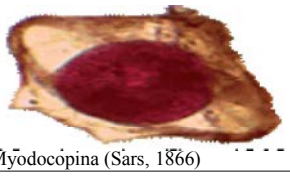
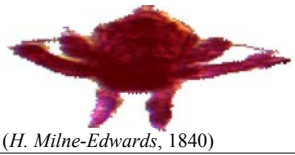
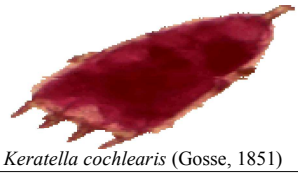
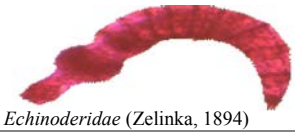
Identification of Taxa/Groups:

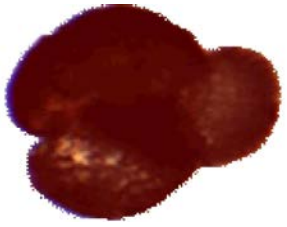
No.	Classification	Identified Species
1	Kingdom: Animalia Phylum: Nematoda Class: Chromadorea Order: Rhabditida Family: Rhabditidae Genus: *Caenorhabditis* Species: *C. elegans*	 *Caenorhabditis elegans* (Maupas, 1900)
2	Kingdom: Animalia Phylum: Nematoda Class: Chromadorea Order: Spirurida Super Family: Dracunculoidea Family: Dracunculidae Genus: *Dracunculus* Species: *D. medinensis*	 *Dracunculus medinensis* (Linnaeus, 1758)
3	Kingdom: Animalia Phylum: Nematoda Class: Chromadorea Order: Rhabditida Family: Ancylostomatidae Genus: *Ancyclostoma* Species: *A. duodenale*	 *Ancylostoma duodenale* (Dubini, 1843)
4	Kingdom: Animalia Phylum: Nematoda Class: Chromadorea Order: Rhabditida Family: Ancylostomatidae Genus: *Ancyclostoma* Species: *A. braziliense*	 *Ancylostoma braziliense* (Gomes de Faria 1910)
5	Kingdom: Animalia Phylum: Nematoda Class: Rhabditea Order: Oxyurata Family: Oxyuridae Genus: *Enterobius*	 *Enterobius sp*. (Baird, 1853)
6	Kingdom: Animalia Phylum: Nematoda Class: Chromadorea Order: Rhabditida Family: Oxyuridae Genus: *Enterobius*	 *Enterobius* (Baird, 1853)

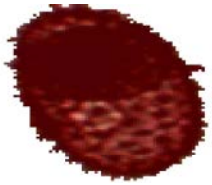
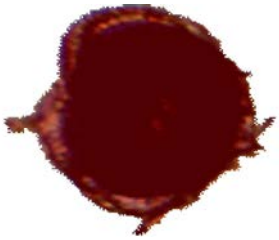
7	Kingdom: Animalia Phylum: Nematoda Class: Chromadorea Order: Rhabditida Family: Ancyclostomatidae Genus: *Ancyclostoma* Species: *A. caninum*	 *Ancylostoma caninum* (Ercolani, 1859)
8	Kingdom: Animalia Phylum: Nematoda Class:Chromadorea Subclass: Chromadoria Order: Desmoscolecida Suborder: Desmoscolecina Superfamily: Desmoscolecoidea Family: Desmoscolecidae Subfamily: Tricominae Genus: *Tricoma sp.*	 *Tricoma sp.* (Cobb, 1894)
9	Animalia: Kingdom Phylum: Nematoda Class: Chromadorea Subclass: Chromadoria Order: Plectida Suborder: Plectina Superfamily: Leptolaimoidea Family: Leptolaimidae Subfamily: Leptolaiminae Genus: Leptolaimus	 *Leptolaimus* (de Man, 1876)
10	Kingdom: Animalia Phylum: Arthropoda SubPhylum: Crustacea Class: Malacostraca Suborder: Peracarida Order: Isopoda	 (Latreille, 1817)
11	Kingdom: Animalia Phylum: Tardigrada Class: Heterotardigrada Order: Arthrotardigrada Family: Neostygarctidae Genus: *Neostygarctus*	 Neostygarctus (Grimaldi de Zio, D'Addabbo Gallo & Morone De Lucia, 1982)
12	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Hexanauplia Subclass: Copepoda Order: Mormonilloida Family: Mormonillidae	 (Boxshall, 1979)
13	Kingdom: Animalia Phylum: Arthropoda Sub Phylum: Crustacea Superclass: Oligostraca Class: Ostracoda Subclass: Platycopa Order: Platycopida Superfamily: Cytherelloidea Family: Cytherellidae Genus: Keijcyoidea Species: *K. infralittoralis*	 *Keijcyoidea infralittoralis* (Tsukagoshi, Okada and Horne, 2006)

14	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Maxillopoda Subclass: Copepoda Order:Cyclopoida Family: Cyclopidae Genus: Acanthocyclops	 (Kiefer, 1927)
15	Kingdom: Animalia Phylum: Arthropoda Sub Phylum: Crustacea Superclass: Multicrustacea Class: Malacostraca Subclass: Eumalacostraca Order: Isopoda Family: Cirolanidae Genus: Politolana	 *Politolana polita* (Stimpsom, 1853)
16	Kingdom: Animalia Phylum: Arthropoda Sub Phylum: Crustacea Class: Ostracoda Superclass: Oligostraca Order: Platycopida Family: Cytherellidae	 (G. O. Sars, 1866)
17	Kingdom: Animalia Phylum: Mollusca Class: Bivalvia Subclass: Heterodonta Infraclass: Euheterodonta Order: Lucinida Superfamily: Lucinoidea Family: Lucinidae	
18	Kingdom: Animalia Phylum: Arthropoda Sub Phylum: Crustacea Superclass: Oligostraca Class: Ostracoda	
19	Kingdom: Animalia Phylum: Mollusca Class: Bivalvia Subclass: Heterodonta Infraclass: Euheterodonta Order: Lucinida Superfamily: Lucinoidea Family: Lucinidae	
20	Kingdom: Animalia Phylum: Arthropoda Sub Phylum: Crustacea Superclass: Oligostraca Class: Ostracoda	
21	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Superclass: Multicrustacea Class: Hexanauplia Subclass: Copepoda Order: Cyclopoida Family: Cyclopidae Genus: Acanthocyclops	 (H. Milne-Edwards, 1840)

22	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Maxillopoda Subclass: Copepoda Order:Poecilostomatoida Family: Sapphirinidae Genus: Sapphirina	 *Sapphirina* (J. Thompson, 1830)
23	Kingdom: Animalia Phylum: Annelida Class: Polychaeta Family: Opheliidae Genus: Ophelina	
24	Kingdom: Animalia Phylum: Arthropoda Class: Ostracoda Order: Podocopida Family: Macrocyprididae	
25	Kingdom: Chromista Subkingdom: Harosa Phylum: Foraminifera Class: Globothalamea Order: Rotaliida	
26	Kingdom: Chromista Subkingdom: Harosa Phylum: Foraminifera Class: Globothalamea Subclass: Textulariia Order: Textulariida	 *Textulariida* (Lalicker, 1935)
27	Kingdom: Animalia Phylum: Mollusca Class: Bivalvia	
28	Kingdom: Animalia Phylum: Annelida Class: Clitellata Subclass: Oligochaeta	
29	Kingdom: Animalia Phylum: Molluska Class: Scaphopoda	 (Bronn, 1862)
30	Kingdom: Animalia Phylum : Annelida Class: Clitellata Order: Oligochaeta Family: Naididae Subfamily: Tubificinae Genus: Tubifex	
31	Kingdom: Animalia Phylum: Arthropoda Sub Phylum: Crustacea Class: Malacostraca Subclass: Eumalacostraca Superorder: Peracarida Order: Isopoda Suborder: Asellota	

32	Kingdom: Animalia Phylum: Tardigrada Class: Eutardigrada Order: Apochela Family: Milnesiidae Genus: Milnesium Species: *M. tardigradum*	 *Milnesium tardigradum* (Doyère, 1840)
33	Kingdom: Animalia Phylum: Arthropoda Sub Phylum: Crustacea Superclass: Oligostraca Class: Ostracoda Order: Myodocopida Suborder: Myodocopina	 *Myodocopina*, (Sars, 1866)
34	Kingdom: Chromista Subkingdom: Harosa Infrakingdom: Rhizaria Phylum: Foraminifera Class: Foraminifera incertaesedis Order: Lagenida Superfamily: Nodosarioidea Family: Chrysalogoniidae	 *Chrysalogoniidae* (Mikhalevich, 1993)
35	Kingdom: Animalia Phylum: Arthropoda Sub Phylum: Crustacea Class: Malacostraca Superorder: Peracarida Order: Isopoda	 *Isopoda* (Latreille, 1817)
36	Kingdom: Animalia Phylum: Arthropoda Sub Phylum: Crustacea Superclass: Oligostraca Class: Ostracoda Order: Myodocopida Suborder: Myodocopina	 Myodocopina (Sars, 1866)
37	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Superclass: Multicrustraca Class: Hexanauplia Subclass: Copepoda	 (*H. Milne-Edwards*, 1840)
38	Kingdom: Animalia Phylum: Rotifera Class: Monogononta Order: Ploima Family: Brachionidae Genus: Keratella Species: K. cochlearis	 *Keratella cochlearis* (Gosse, 1851)
39	Kingdom: Animalia Phylum: Kinorhyncha Class: Incertae sedis Order: Cyclorhagida Family: Echinoderidae	 *Echinoderidae* (Zelinka, 1894)
40	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Maxillopoda Subclass: Copepoda Order: Calanoida Family: Paracalanidae Genus: Paracalanus Species: P. parvus	 *Paracalanus parvus* (Claus, 1863)

41	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Maxillopoda Subclass: Copepoda Order: Harpacticoida Family: Porcellidiidae	
42	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Maxillopoda Subclass: Copepoda Order: Cyclopoida Family: Cyclopidae Genus: Acanthocyclops Species: A. americanas	 *Acanthocyclops americanus* (Marsh, 1893)
43	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Maxillopoda Subclass: Copepoda Order:Calanoida Family: Acartiidae Genus: Acartia	 *Acartiam* (Dana, 1846)
44	Kingdom: Animalia Phylum: Arthropoda Sub Phylum: Crustacea Superclass: Multicrustraca Class: Malacostraca Subclass: Eumalacostraca Order: Cumacea Family: Diastylidae	 *Diastylidae* (Bate, 1856)
45	Kingdom: Chromista Subkingdom: Harosa Infrakingdom: Rhizaria Phylum: Foraminifera Class: Globothalamea Order: Rotaliida Superfamily: Planorbulinoidea Family: Cibicididae Genus: Cibicides	
46	Kingdom: Chromista Subkingdom: Harosa Infrakingdom: Rhizaria Phylum: Foraminifera Class: Globothalamea Order: Rotaliida Superfamily: Planorbulinoidea Family: Globigerinidae Genus: Globigerina Species: *G. bulloides*	 *Globigerina bulloides* (d'Orbigny, 1826)
47	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Hexanauplia Subclass: Copepoda Order: Harpacticoida	 *Harpacticoida*, (G. O. Sars, 1903)

48	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Hexanauplia Subclass: Copepoda Order: Calanoida Family: Calanidae Genus: Calanus Species: *C. finmarchicus*	 *Calanus finmarchicus* (Gunnerus, 1770)
49	Kingdom: Animalia Phylum : Arthropoda Sub Phylum: Crustacea Superclass: Multicrustacea Class: Malacostraca Subclass: Eumalacostraca Order: Isopoda Suborder: Flabellifera	 *Flabellifera* (Sars, 1882)
50	Kingdom: Protista or Protozoa Infrakingdom: Alveolata Phylum: Ciliophora	
51	Kingdom: Animalia Phylum: Mollusca Class: Gastropoda Order: Littorinimorpha Superfamily: Naticoidea Family: Naticidae	 *Naticidae* (Guilding, 1834)
52	Kingdom: Animalia Phylum: Annelida Class: Clitellata Order: Oligochaeta Family: Naididae Genus: Tubifex Species: *T. tubifex*	 *T. tubifex* (Hrabe 1981)
53	Kingdom: Chromista Subkingdom: Harosa Infrakingdom: Rhizaria Phylum: Foraminifera Class: Globothalamea Order: Rotaliida Superfamily: Nummulitoidea Family: Nummulitidae	 *Nummulitidae* (Blainville, 1827)
54	Kingdom: Animalia Phylum: Arthropoda SubPhylum: Crustacea Superclass: Oligostraca Class: Ostracoda Subclass: Podocopa Order: Podocopida Suborder: Cytherocopina Superfamily: Cytheroidea Family: Thaerocytheridae Genus: Poseidonamicus Species: *P. yasuharai*	 *Poseidonamicus yasuharai* (Brandão & Päplow, 2011)

Meiobenthic Abundance:

Table 2: Individuals/m^2 at each station during pre-monsoon

	ind./m^2					
Group	St1	St2	St3	St4	St5	Mean±SD
Nematoda	45866	180466	142683	240000	208550	163513±74901.11
Foraminifera	51250	56250	119383	100450	63116	78089±30110.94
Ostracoda	23450	48016	53500	39183	16450	36119±15814.54
Copepoda	4083	43883	46633	63400	60366	43673±23685.36
Isopoda	1366	9600	23316	15083	9600	11793±8092.35
Polychaeta	4100	5483	1366	18600	5466	7003±6696.39
Oligochaeta	0	10950	17816	19200	5483	10689±8134.14
Bivalvia	16450	10950	8233	6850	9600	10416±3702.77
Gastropoda	5483	6850	0	6200	10966	5899±3925.59
Harpacticoida	2733	2733	8216	6850	6850	5476±2565.71
Larvae	23183	24700	24700	8216	8216	17803±8773.58
Unidentified	2733	19200	10966	16466	16466	13166±6555.09
Total	180,700	419,083	456,816	540,500	421,133	403,646±133,982.35

Table 3: Individuals/m^2 at each station during post-monsoon

	ind./m^2					
Group	St1	St2	St3	St4	St5	Mean±SD
Nematoda	28666	65333	86066	117600	173466	94226±54828.88
Foraminifera	43600	68800	139200	61200	76800	77920±36390.54
Ostracoda	25666	40800	40000	98400	23200	45613±30583.34
Copepoda	14033	40400	22800	43600	38400	31846±12780.99
Isopoda	400	4000	13533	11600	7466	7399±5380.93
Polychaeta	3166	4033	2000	14800	3600	5519±5242.79
Oligochaeta	2000	8000	12350	15200	2400	7950±5746.36
Bivalvia	400	6800	2800	6000	7466	4693±2993.76
Gastropoda	1833	2733	400	4933	2000	2379±1658.81
Harpacticoida	2000	1366	800	3200	16466	4766±6600.71
Larvae	10000	16466	6000	16800	6600	11173±5213.79
Unidentified	3200	5700	8000	8383	12000	7456±3278.73
Total	13496	264433	333950	401716	369866	276,692±155734.78

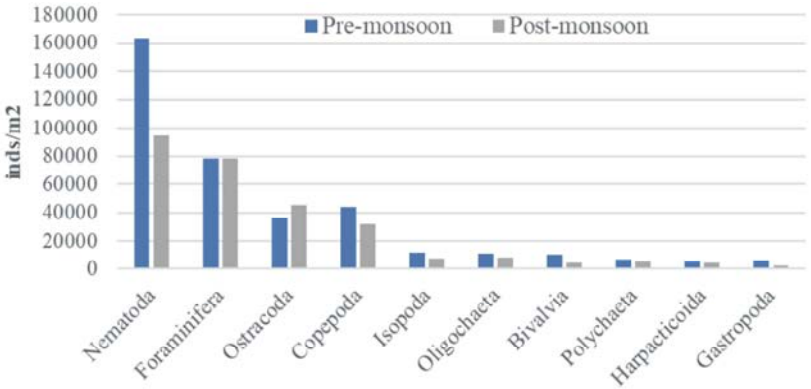


Fig. 2: Seasonal abundance (ind./m^2) of total meiobenthic organisms during this study

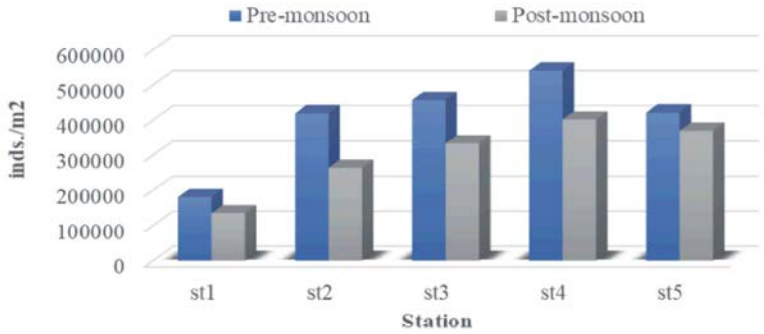


Fig. 3: Seasonal Abundance (ind./m^2) of meiobenthic fauna at each station

DISCUSSION

Meiobenthic Community Distribution: In the present study the abundance of meiobenthic organisms were in the sequence of Nematoda > Foraminifera> Ostracoda >Copepoda > Isopoda > Oligochaeta > Bivalvia> Polychaeta> Harpacticoida>Gastropoda which dicussed above Table 2 and 3. Study revealed that meiobenthos abundance and distribution on the Black Sea shelf and the upper slope area off the Bosporus Strait outlet was studied along a depth transect from 75 to 300 m water depth and he found 21 taxa of meiobenhic organisms and among these the Nematoda was the dominant taxon [30]. In the Meghna River estuary Hatiya, during the study period it was seen that nematodes were the dominant species all the stations and it constituted 40% and 31% during pre-monsoon and post-monsoon. Study showed that quantitative distribution of meiofauna in the depth range 20 to 1000 m of the Gulf of Martaban, Andaman Sea and during his study he found that three taxa of meiofauna was dominated by: free living nematodes (80%) benthic copepods (5.9%) and foraminiferans (2.8%). The quantitative distribution of meiobenthic fauna of Varsova (Bombay, Maharashtra, India) found the fauna was constituted mostly by nematodes (52.90%), foraminifera (33.97%), polychaetes (4.05%) and crustaceans (6.15%) [31]. Other groups, viz., Radiolaria, Turbellaria, Kinorhyncha, Pycnogonida, Pelecypoda and Gastropoda were occasional inhabitants of the area.

Meiobenthic Species Abundance: During the present study, it is clearly found that the maximum abundance of meiobenthic organisms was found during pre-monsoon season and it was minimum abundance during the post-monsoon season. The maximum abundance during the pre- monsoon season was 372,690 individuals per square meter and the value was 282,351 ind./m^2 during the post-monsoon. The mean abundance of seasonal meiobenthos was found 65,504±63879.32 ind./m^2. Tietjen [16] showed quantitative information on the abundance of deep-sea metazoan meiobenthos, Abundance of the deep Atlantic, Pacific and Indian Oceans generally range between 100 and 1000 x 10^3 individuals m^{-2}. It was showed spatial and temporal patterns of meiofauna community from a Brazilian sandy beach were investigated [31]. The meiofauna mean density varied from 1556.25-13125.25 ind.10 cm^{-2}, with the highest densities in December. Another study mentioned that the meiofaunal communities in the Muthupettai mangrove forest, East coast of India and he found that the meiofaunal density varied between 12029-23493 individuals/10 cm^2 [32].

From the present study we discussed above that the dominant meiobenthic organisms were nematoda, foraminifera and ostracoda following other groups [33]. It was found that macrofauna and meiobenthic fauna in Yoldiabukta, a glacial bay off west Spitsbergen and they showed the total abundance and biomass of meiobenthos were low in the littoral and its taxonomic composition was very diverse and did not show any regular pattern but in the sublittoral (10-95m) both macrofauna and meiofauna were abundant. Nematoda and Harpacticoida dominated the meiofauna [34].

CONCLUSION

In some of the replicated samples from different study stations organisms belonging to Tardigrada, Kinoryncha, Amphipoda and Ciliopora and various types of larvae and some unidentified taxa were recorded. The maximum abundance of meiobenthic fauna was recorded at Station-4 during pre-monsoon and post-monsoon. Meiobenthic population in the Hatiya Island were significantly different among stations and seasons as it was shown by the record of their diversity.

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