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Spatial and temporal variations in the community structure of meiobenthos in the mangrove area near the Karachi coast, Pakistan

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Abstract
Spatial and temporal variations in relation to environmental and biological parameters were carried out from three stations in Sands pit backwater along the coast of Karachi, Pakistan from January 1999 to December 1999. Various meiofauna taxa were identified from the sample procured during low tide. The total mean densities of meiofaunal were (30.42 ±6.81) and (3628 ± 5958) individuals per10 cm^2 in 500 µm and 63 µm size fractions respectively. Total densities were lowest during post monsoon (5890 ± 6145) and southwest monsoon periods (4844 ± 8399) and highest during (21247 ±16660) northeast monsoon period in 63 µm fraction. In 500 µm size fraction lowest densities were observed during post monsoon (7.96 ± 5.67) and highest during southwest monsoon periods (8.73 ±7510), there were significant differences between stations ($F_{2, 35}$ = 8.45, P<0.05) and seasons ($F_{3, 35}$ = 6.84, P<0.05) for meiofauna collected in 63 µm fraction. Nematodes contributed up to 88% of the total biomass followed by harpacticoid copepods, polychaetes, ostracods, turbellarians, and other meiofaunal taxa. The result of Bray-Curtis similarity measures, examining total meiofauna, and all ancillary environmental parameters (a biotic, biotic) and sediment properties were shown in four major clusters includes mollusks density, salinity water and pore, pH water and pore. A second cluster composed of root density, Eh water and pore, 500 µm fraction, percent moisture content, Porosity, standard deviation phi and kurtosis.

Keywords: Spatial and temporal, Meiofauna, mangrove, Karachi.

1. Introduction
Benthic invertebrates are used extensively as an indicator of estuarine environmental status Alves *et al*., (2013) [5] and trends because numerous studies have demonstrated that benthos respond predictably to many kinds of natural an anthropogenic stress (Pearson and Rosenberg 1978; Dauer 1993; Tapp *et al*. 1993; Wilson and Jeffery 1994; Frouin, 2000; Harkantra and Rodrigues, 2004) [36, 14, 45, 55, 22, 26]. Changes in meiofauna diversity, density, structure and functioning may indicate alterations in the system (Alves *et al*., 2013) [5]. Meiobenthos is an important group in the trophic network of the benthic environment (Mac Intyre, 1969; Tenore *et al*., 1977) [33, 46] refers to benthic animals smaller than macrobenthos but larger than microfauna (McIntyre, 1969; Preetha, 2000) [33, 37]. Meiobenthic organisms are one of most major components of mangrove communities (Mokievsky *et al*., 2011) [31]. They defined as ubiquitous and ecological important organisms and passing through 0.5 or 1 mm mesh sieve, but retained on 63 µm mesh (Qasim, 1982; Qureshi & Sultana, 1999) [38, 39] and have an intimate association with Soil/sediment and pore water throughout the life cycle (Fleeger *et al*., 1995; Fleeger & Carman, 2011) [19, 20]. Meiofauna it has been inferred that meiofauna may thus have a prominent role in the transformation and recycling of organic matter and important source of food for higher trophic levels (Sikora *et al*., 1985; Mokievskya, 1992; Weslawski *et al*., 1993 and 1999; Malinga *et al*., 2005) [44, 32, 52, 53, 29] it forms an important link between detrital production and commercially important finfish and decapods. Freshwater inflow can regulate the distribution of salinity and sediment transport within estuaries (Jones *et al*., 1990) [28]. In estuaries; sediment composition and salinity are a biotic factors that can influence the benthic community composition (Dittman, 2000; Aller and Aller 2004) [16, 1].
Soft sediment accommodates a relatively large no meiofauna and macrofauna sized species, but very few of intermediate size (Warwick, 1984) [49]. Sediment characteristics such as grain size analyses, grain shape, sorting and pore space are known to affect directly the numbers and types of species found in the soft bottom environment (Gray, 1974) [23]. Spatial and temporal distributions of meio benthic animals are affected by locally varying hydrodynamic

environments produced by current flow over transient bed frames (Eckman, 1979) [17], effects of physical disturbance (Aller and Aller 2004) [1], and effects of pollution (Warwick *et al.* 1990; Ólafsson*et al.* 1995; Dittman 2000; Armenteros*et al.,* 2008) [50, 35, 16, 9].

A great deal work has been done on the macro benthos community inhibiting the estuaries of the united states, India, Portugal and Australia (Armenteros*et al.,* 2008, Ansari *et al*., 2001; Alves*et al*., 2013; Mokievsky *et al*., 2011) [9, 8, 5, 31]. Benthic invertebrate communities, particularly in the coastal waters of Pakistan, there is a lack of information on spatial and temporal distribution of meiofauna. The published information from Pakistan is limited to old records of (Timm, 1963, 70) [47, 48] and recent work of (Maqbool and Nasira, 1998; Qureshi and Sultana 1999) [30, 39, 40]. The present study is the descriptive ecological study of the distribution and abundance of meiofauna from mangrove areas of Karachi. In this study temporal and spatial variations in the distribution, abundance and species composition of meiofauna as influenced by tropical monsoon and associated hydrographic parameters have been reported. A multi-faceted approach to discern the effects of different variables on the abundance and distribution of meiofauna has been used in an attempt to correlate the abundance with various environmental and biotic features.

2. Materials and Methods

The study was carried out at monthly intervals from January 1999 to December 1999 in an area located the backwaters of Manora Channel near Sands pit (24°50'N, 66°56'E) dominated with the dense vegetation of mangroves, the *Avicennia marina*. Three stations were selected along an exposure gradient: SP1, SP2 (both were connected to the main channel), and SP3 received water only by the tidal channels and was almost a dry station. Surface sediment samples (from first 2.5 cm) were collected in order to determine the granulometric characteristics (percent moisture content, percent porosity) and the proportion of organic matter. A 0.5 m^2 quadrat is placed at each site and replicate sediment samples were collected within the quadrat with the help of small corers (internal diameter was 2.7 cm) at low tides when exposed. All samples were collected at low tide, and cores were collected and placed in a jar and were then preserved in formalin stained with Rose Bengal. Within each quadrat crab burrows, roots (pneumatophore or aerial roots of mangroves, *Avicennia marina*) and mollusk (*Potamides cingulatus*) if present were counted. The salinity (using an optical refractometer with a correction of 1 ppt.), simultaneously, the pH and Eh values of the sediment were measured with a digital pH meter (field pH meter Hanna model 8314) of the overlying water were also collected.

2.1 Laboratory analyses

In the laboratory, meiofauna was extracted from sediment samples by manually elutriations with the help of flowing water and a beaker. Supernatant was passed through a set of 500 µm, 63 µm fraction sieves. 500 µm size fraction was used as the upper size limit of meiofauna; represents a fraction mainly consisting of juvenile macrofaunal organisms (temporary meiofauna) where as 63 µm size fraction was used as the lower size limit for the retention of meiofauna. The extracted temporary meiofauna (500 µm size fraction) data was included in this study for the comparison with true meiofauna. The three replicates of each sample were examined and fauna retained in the sieves, were counted and identified up to major taxonomic groups. Meiofaunal organisms were identified to higher taxonomic level, and densities were expressed as individuals / 10 cm^2. Undisturbed sediment core samples were brought to the laboratory and homogenized in a large petri dish. Three replicates of 1-2 g sediment samples were taken in pre-weighed crucible and wet weights were noted (using a microbalance, up to .001 g correction). The sediment samples were then dried for 24 hours at 70 ºC and dry weights were noted. Dried sediment samples were then ignited for four hours in the muffle furnace at 500 ºC and ash free dry weight was noted. Sediment properties like percent moisture, porosity and percent organic contents were estimated (Folk, 1974) [21].

2.2 Statistical analyses

Statistical analyses were carried out using Minitab 13.30 (version). The word "Significant" or "Statistically significant" means that differences were detected at the 0.05 percent level of probability. For statistical analyses and to observe the seasonal shifts in distribution, abundance and biomass data were grouped into seasons following (Naz *et al*., 2012) [34]. Northeast monsoon (December to February), Pre-monsoon (March to May), Southwest monsoon (June to August) and Post-monsoon (September to November).

Completely randomized design (CRD) analysis of variance (ANOVA) was used to test all parameters for differences at station level and the levels of seasons. Density was log (x+1) transformed after testing for heterogeneity of variances. To present taxonomical and abundance similarity between the months of the two stations a hierarchical agglomerative clustering (CLUSTER) was applied (Field *et al*., 1982; Clarke and Warwick 1994; Walkusz *et al*., 2009) [18, 11, 54].

To compare the affinity between the meiofaunal abundance and ancillary environmental parameters the percentage similarity was computed using the Bray-Curtis multivariate cluster analysis (Ansari and Parlukear, 1993) [7]. Data were pooled for total meiofaunal abundance in both, 500 µm and 63 µm size fractions, with which all ancillary environmental parameters were compared. Samples were clustered using percentage similarity and dendrogram was constructed using agglomerative hierarchical clustering of variable into groups after average sorting of group using correlation distance matrices.

3. Results

3.1 Environmental factors

The salinity of the overlying waters ranged between 32-48 ppt and showed considerable fluctuations. Mean lowest values was observed 32 ppt and at SP1 and highest was observed 48 ppt at SP3. A significant difference was observed between stations ($F_{2, 35}$ = 8.02, P <0.05). Temperature of adjoining channel and overlying water showed a range of 22 ^{O}C to 40 ^{O}C the difference in temperature of pore water, stations ($F_{2, 35}$ = 8.28, P<0.05), and overlying was significant between stations and among seasons ($F_{2, 35}$ = 13.10, P<0.05), ($F_{3, 35}$ = 12.84, P<0.05) respectively. Redox potential (Eh) showed significant differences between stations ($F_{2, 35}$ = 6.50, P<0.05). The percent moisture content was significantly different between stations ($F_{2, 35}$ = 10.04, P<0.05). Similarly porosity and mean phi were also significantly correlated with station ($F_{2, 35}$ = 3.78, P<0.05) and ($F_{2, 35}$ = 3.02, P<0.05) respectively. The crab burrow densities were high in northeast monsoon season, and were likely related to the greater number of crabs that were observed during the winter at Sands pit. The number of burrows ranged from 12 to 660 burrow m^{-2}. The pneumatophores of mangrove (*Avicennia marina*) or roots ranged between 4 to116 m^{-2}. A definite seasonal trend in the density distribution of roots was not observed (Table 1).

3.2 Population density and structure

Seasonal variation in meiofaunal density was highest in 63 µm fraction as compared to in 500 µm size fraction. The total mean densities of meiofaunal collected in the 500 µm were counted (30.42 ± 6.81) ind. /10 cm^2 and ranged from (5.24 to 75.10) ind. /10 cm^2. Mean densities of meiofaunal 63 µm fractions 3628 ± 5958 ranged (523.9 to 22123) ind. /10 cm^2.

Total densities of meiofauna were highest at SP1 (262 ± 470) ind. /10 cm^2, and was lowest at SP3 (30.42 ± 23.60) ind. /10 cm^2 in 500 µm size fraction, whereas highest at SP1 (21085 ± 15956) ind. /10 cm^2 orders of magnitude higher, and was lowest at SP3 (3628 ± 5958) ind. /10 cm^2 in 63 µ size fraction (Table 2).

Total densities were lowest during southwest monsoon (4844 ± 8399) ind. /10 cm^2 and post monsoon periods (5890 ± 6145) ind. /10 cm^2 and highest during (21247 ± 16660) the ind. /10 cm^2 northeast monsoon period in > 63 µm fraction. In 500 µm size fraction lowest during post monsoon (7.96±5.67) ind. /10 cm^2 and highest during north east monsoon periods (278 ± 484) ind. /10 cm^2 (Table 2) there were no significant differences between stations and seasons for meiofauna collected in 500 µm fraction, but differences between stations ($F_{2, 35} = 8.45$, $P < 0.05$) and seasons ($F_{3, 35} = 6.84$, $P < 0.05$) for meiofauna collected in > 63 µm fraction.

Seasonality also effected on the density of meiofauna on each station lowest density were observed in the post monsoon at SP1 (9.90 ± 8.96), SP2 (7.57 ± 2.67) and SP3 (6.40 ± 5.61) ind. /10 cm^2 and highest during the northeast monsoon at SP1 (510 ± 830), SP2 (295 ± 268) ind. /10 cm^2 and southwest monsoon at SP3 (51.2 ± 26.5) ind. /10 cm^2 in 500µm size fraction. Lowest density was observed in the southwest monsoon at SP1 and SP2 (10596 ± 14329) ind. /10 cm^2 and (1659 ±400) ind. /10 cm^2 and post monsoon at SP3 (1048 ±1386) ind. /10 cm^2 and highest during the pre monsoon at SP1 (34029 ± 7426) individual's /10 cm^2 and northeast monsoon at SP2 and SP3 (28411 ±7703) ind. /10 cm^2 and (9150 ±11266) ind. /10 cm^2 respectively in 63µm size fraction. (Table 2)

The meiofaunal community typically composed of 15 and 14 genera in 500 µm and 63µm size fraction at all three stations, of which nematodes gastropods formed the dominant group Table 4 illustrates the relative abundances (%) and SIMPER (similarity percentage) analysis of the meiofauna groups. Among the meiofauna groups, Nematodes were usually the most dominant taxon, numerically and were found in all stations and nearly in all months. Nematodes were found (46.30%) at SP1, Gastropod larvae (49.23% and 61.60%) at SP2 and SP3 in 500 µm size fraction. Nematodes also formed the dominant group in a 63µm size fraction all three stations and relative abundance at SP1 (88.53%), SP2 (78.97%) and SP3 (62.75%). Nematodes were followed with harpacticoid copepods, formed the second most dominant group SP1 (3.30%), SP2 (5.04%) and SP3 (14.52%) and followed by polychaetes, ostracods, turbellarians other meiofaunal taxa. SIMPER similarity percentage analysis of the meiofauna groups also revealed that similarity during the whole year 99% in both size fractions.

The result of Bray-Curtis similarity measures, examining total meiofauna, and all ancillary environmental parameters (a biotic, biotic and sediment properties) was shown in Figure 5. Four major clusters were appeared; one of the clusters includes mollusks density, salinity, water and pore, pH water and pore. A second cluster composed of root density, Eh water and pore, 500µm, percent moisture content, Porosity, standard deviation phi and kurtosis. Among this cluster, standard deviation phi and kurtosis showed highest similarity (98.30 %). 500µm and standard deviation phi showed (67.01%) 63 µm and crab burrows showed (52.03%), and 63 µm 500µm size fractions and root density showed (49.65%). Third cluster comprised Crab burrows, 63 µm size fraction, and skewness. Cluster four includes temperature air, water and pore median and mean phi of sediments.

Table 1: Variation (mean ± SD) in Environmental Parameters, biotic factor and sediment properties collected from Sands pit backwater mangrove area during January to December. 1999

Biotic parameters	n	SP1	SP2	SP3
Biotic parameters Mollusks (m^2)	12	315.7 ±174.9	143.7 ±92.7	394.0 ±138.6
Root density (m^2)	12	29.33±18.48	36.00±33.77	14.00±12.82
Crab burrows (m^2)	12	162.0±132.8	113.0±174.8	56.0±37.5
Environmental Parameters				
Tempe pore (C°)	12	27.98 ±4.67	27.47±3.74	28.83± 4.36
Salinity pore (ppt)	12	37.58±3.58	37.417±3.232	48.83 ±10.62
pH pore	12	7.772±0.349	7.3100±0.2873	7.643 ±0.395
Eh pore	12	-40.5±38.0	-23.42 ±17.90	-34.08 ±32.12
Sediments properties				
% moisture content	12	21.331±2.309	35.00 ±14.88	27.21±15.16
Porosity	12	55.15 ± 5.97	90.5 ± 38.5	70.3±39.2
Median phi (Md)	12	1.343±0.708	1.088 ±0.462	1.3775±0.0706
Mean phi (Mz)	12	1.802±0.399	1.6428±0.3138	1.4842±0.0712
St.dv phi	12	1.4132±0.2825	7.43±9.88	2.85±6.52
Skewness (Sk)	12	0.404 ±0.368	0.357±0.58	0.2805± 0.206
Kurtosis (K)	12	1.628±0.588	11.75±17.82	3.78±8.25
% organic content	12	2.719±1.877	4.201±2.927	3.268±2.797

Table 2: Seasonal variation (mean ± SD) in density of meiofauna 500 µm and 63 µm size fraction collected from Sands pit back waters (SP1,

SP2 and SP3) mangrove areas during January1999 to December 1999.

500 µm	N	N E monsoon	Pre monsoon	SW monsoon	Post monsoon	Stations mean N=12
SP1	3	510 ± 803	487 ± 431	40.2 ± 28.6	9.90 ± 8.96	262±470 (0-1469)
SP2	3	295 ± 268	257.9 ± 130.2	43.1 ± 18.0	7.57 ± 2.67	150.9±183.9 (5.2-602.6)
SP3	3	30.3 ± 22.2	33.8 ± 17.5	51.2 ± 26.5	6.40 ± 5.61	30.42 ±23.60 (0-75.10)
Seasons mean N=9		278±484 (17-1469)	259.5±298.7 (15.7-962.4)	44.84±22.03 (8.73-75.10)	7.96±5.67 (0-17.47)	
63µm						
SP1	3	26179± 24310	34029 ±7426	10596±14329	13536±2826	21085±15956 (1048-53969)
SP2	3	28411 ± 7703	23840 ± 14795	1659 ± 400	13536± 2826	14249±14450 (699-40869)
SP3	3	9150 ± 1126	2038 ± 1485	2776 ± 1398	1048± 1386	3628 ±5958 (0-22123)
Mean	9	21247 ±16660 (1834-53969)	19969 ±16413 (524-40869)	4844 ±8399 (1048-27072)	5890 ±6145 (0-16767)	3628 ±5958 (523.9-22123)

Table 3a: Results of SIMPER (similarity percentage) analysis demonstrating taxa that accounted the most to the similarities within 500 µm size fraction and relative abundance (RA) and cumulative abundance (CF).

Sp1	%	CF	Sp2	%	CF	Sp3	%	CF
Nematoda	46.30	46.30	Gastropod	49.23	49.23	Gastropod	61.60	61.60
Polychaetes	32.76	79.05	Nematoda	25.19	74.42	Nematoda	12.66	74.26
Oligochaeta	12.52	91.57	Oligochaeta	10.73	85.14	Other	10.13	84.39
Copepoda	3.32	94.89	Polychaetes	8.90	94.04	Oligochaeta	9.28	93.67
Turbellaria	1.71	96.60	Amphipoda	3.74	97.78	Polychaetes	2.53	96.20
Gastropod	1.23	97.84	Copepoda	1.37	99.15	Copepoda	1.69	97.89
Egg	0.67	98.51	Egg	0.25	99.40	Egg	1.27	99.16
Evadne	0.38	98.89	Evadne	0.12	99.53	Cnidaria	0.42	99.58
Ostracods	0.38	99.27	Turbellaria	0.12	99.65	Ostracods	0.42	100.00
Foraminifera	0.28	99.55	Thaloid shape	0.08	99.74			
Thaloid shape	0.26	99.81	Doris larvae	0.08	99.82			
Doris larvae	0.19	100.00	Nemertins	0.06	99.88			
			Cnidaria	0.04	99.92			
			Eggs 2	0.04	99.96			
			Pinnella	0.04	100.00			
Similarity:	**99.63**			**99.81**			**99.34**	

Table 3b: Results of SIMPER (similarity percentage) analysis demonstrating taxa that accounted the most to the similarities within 63 µm size fraction and relative abundance (RA) and cumulative abundance (CF).

	Sp1			Sp2			Sp3		
	Organisms	**%**	**CF**	**Organisms**	**%**	**CF**	**Organisms**	**%**	**CF**
1	Nematoda	88.53	88.53	Nematoda	78.97	78.97	Nematoda	62.75	62.75
2	Copepoda	3.30	91.83	Egg	6.54	85.51	Copepoda	14.52	77.27
3	Oligochaeta	3.07	94.90	Copepoda	5.04	90.55	Egg	8.18	85.44
4	Foraminifera	1.82	96.72	Foraminifera	3.03	93.59	Radiolarians	3.03	88.48
5	Thaloid shape	1.23	97.95	Thaloid shape	2.14	95.73	Thaloid shape	2.92	91.40
6	Egg	0.84	98.79	Oligochaeta	1.90	97.62	Oligochaeta	2.53	93.92
7	Polychaetes	0.48	99.27	Amphipoda	0.76	98.38	Polychaetes	2.17	96.09
8	Doris larvae	0.20	99.47	Turbellaria	0.39	98.77	Tribella	2.02	98.11
9	Turbellaria	0.20	99.67	Doris larvae	0.38	99.15	Doris larvae	1.52	99.63
10	Protozoea	0.13	99.80	Nemertins	0.28	99.43	Foraminifera	0.37	100.00
11	Gastropod	0.10	99.9	Gastropod	0.14	99.57			
12	Sarcomastigophora	0.10	100.0	Polychaetes	0.14	99.72			
13				Eggs 2	0.14	99.86			
14				Other	0.14	100.00			
	99.51			98.65			98.59		

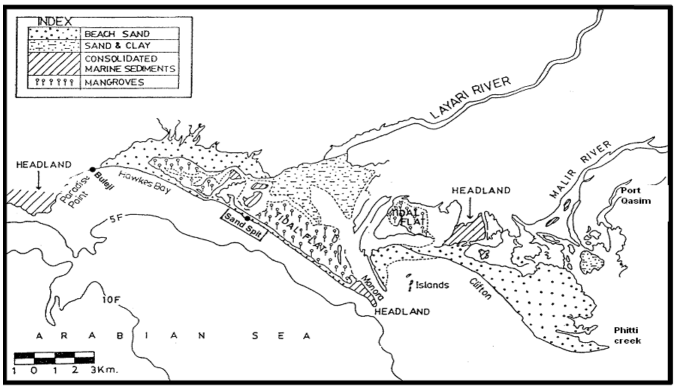

Fig 1: Map of the Karachi coast showing sampling stations, Sands pit back water (SP1, SP2 and SP3) mangrove areas during January1999 to December 1999.

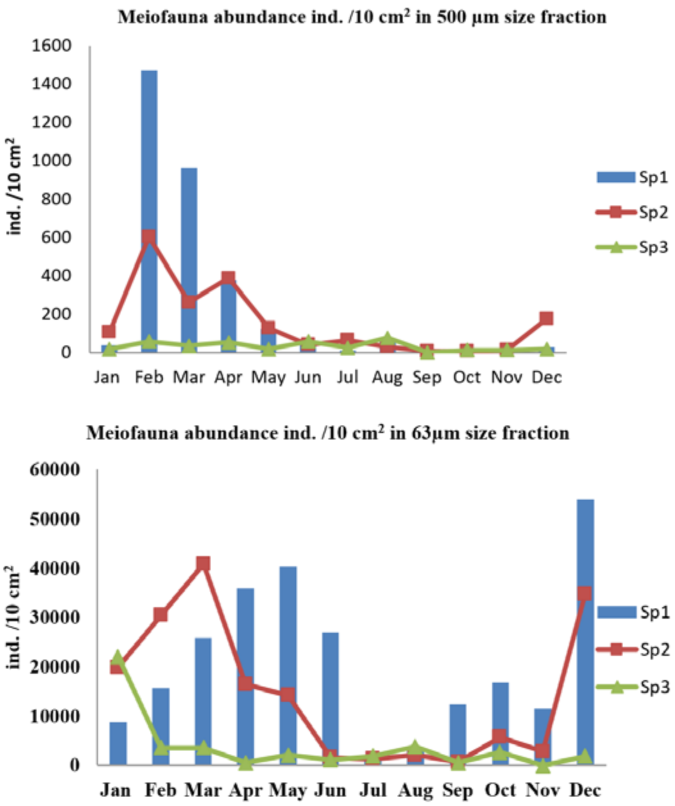

Fig 2: Variation in density of meiofauna abundance collected from Sands pit back water mangrove areas during January1999 to December 1999.

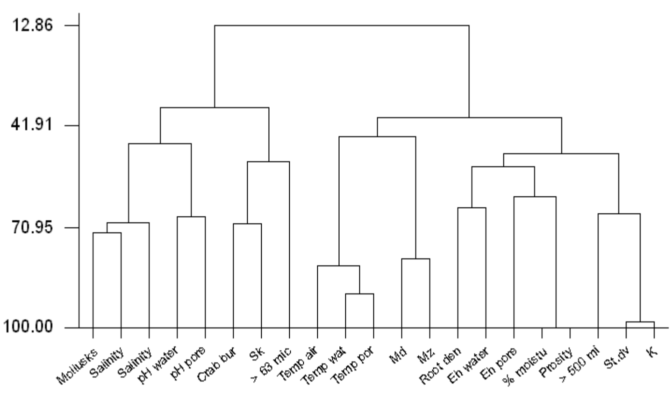

Fig 3: Bray–Curtis similarity measures, examining total meiofauna abundance, and all ancillary environmental parameters (a biotic, biotic and sediment properties) Sands pit back water mangrove areas during January1999 to December 1999.

4. Discussion

In the present study the salinity and Redox potential (Eh) were showing significant differences between stations and temperature was showing significant between both station and seasons. The sediment properties like percent moisture, porosity and mean phi were significantly correlated with the station. Guidi *et al.*, (1985) [25] have been related small variability in meiofaunal densities to the local sedimentological and hydrological processes and mean abundance to the physical-chemical factors. In present study highest density were observed at SP1 and SP2 in when salinity and pour water temperature lowest as compared to station SP3 where lowest density was observed and agree to other authors who observed that mean abundance is influenced by physical-chemical factors (Alongi, 1987; Santos *et al.*, 1996; Rosa and Bemvenuti, 2005) [2, 42, 41].The average estimates of total meiofaunal abundance were on the higher side compared to estimates from other mangrove areas. Meiofaunal numbers were typically average 10^6 individual m^{-2} in marine sediments (McIntyre 1969, Coull and Bell 1979, Castel 1992) [33, 13, 10].Total densities were lowest during southwest monsoon and post monsoon periods and highest northeast monsoon period in 63 µm fraction. In 500 µm size fraction lowest during post monsoon and highest during north east monsoon periods. Sasekumar (1994) [43] reported highest density from the *Avicennia* station on the lower shore and the high shore *Bruguiera* station had the lowest density. The reduction in meiofauna numbers and biomass on the high shore was attributed to habitat instability arising from intense salinity fluctuations, infrequent tidal cover and water stress (Sasekumar 1994) [43]. The other source of variation has been related to time of the year, i.e. seasonal or temporal variation in the abundance and distribution of meiofauna. These seasonal effects were demonstrated by all abiotic and biotic variables. The decrease in meiofaunal densities from northeast monsoon to southwest monsoon and post-monsoon period were observed. These differences were very likely related to monsoonal pattern, input of organic matter and consequently increased reproductive activities (De Bovee *et al.*, 1990) [15]. In the interpretation of results a most important trend was noted that the definite seasonality in the abundance and distribution of meiofauna along with certain environmental parameters that likely controls distribution and abundance. In the tropics, monsoon and its related stresses influence meiofaunal abundance and this is reflected in the seasonality of distribution that has been observed. Angsupanich *et al.* (1997) [6] observed the lowest densities of meiobenthos were found in the low temperature season (January) Pre monsoon and highest density of meiobenthos were found in (October) Post monsoon when the salinity decline. The decreased in salinity was accompanied by an increased number of individuals may be due to the abundance of dissolved organic substances in fresh water runoff contributed much to the growth of interstitial organisms (Harkantra and Rodrigues, 2004) [26]. In the present study the decrease in meiofaunal a density during south west monsoon season and was the highest during Pre monsoon season. Various authors (Chatterji *et al.*, 1995; Preetha and Pillai, 2000; Ansari *et al.*, 2001) [12, 37, 8] have also reported declining meiofaunal account during the southwest monsoon with the highest density in Pre and Post monsoon and low density in monsoon. These differences were very likely related to monsoonal pattern, input of organic matter and consequently increased reproductive activities (De Boveeet *al.*, 1990) [15]. The meiobenthos of the present study consisted of five taxa of high rank, Nematoda, Copepoda (Harpacticoida), Oligochaeta, and Turbellaria, among protozoans we recorded only foraminiferans. All the samples were dominated by nematodes. The second place, in terms of population density, in samples collected was occupied by copepods. Analyses of samples reveal that meiofauna showed considerable spatial variability; in order of magnitude difference between stations and that this pattern was more likely controlled by the distribution of nematodes, as nematodes densities were similarly high. Nematodes accounted for up to 88.53% of total densities; other commonly found taxa were copepods, turbellarians, oligochaetes, polychaetes, ostracods and rotifers. Our studies revealed an average dominance of nematodes with significant seasonal variations. It has been reported that nematodes comprise 80 to 90% of total meiofauna in the muddy habitats (McIntyre 1969) [33] and 60% to 65% Turbellarians15 to 21% and Harpacticoid copepods contribute 7% to 9% in the west coast of India (Ansari *et al*., 2001) [8]. Nematodes were also the most abundant in Australian mangroves (Hodda and Nicholas 1985) [27]. Nematodes regularly dominate the meiofauna different biotopes usually comprising >50% of the total meiofauna. Harpacticoid copepods are second most dominant, but occasionally another taxon may rank second after nematodes. The other constituents were polychaete larvae, ostracods and oligochaetes. Oligochaetes have been reported to contribute a major share to meiobenthos only at the station in the proximity of the sewage outlet (Goldin *et al.*1996) [24]. Harpacticoid copepods and Polychaetes were the second and the third most abundant groups in Portugal, (Alves *et al*., 2009) [4]. Meiofaunal composition of the Marina beach Chennai India mainly consists of nematodes, polychaetes, oligochaetes, and harpacticoid copepods (Altaf *et al*., 2005) [3]. The vertical distribution of the meiobenthos was characterized by a pronounced maximum in the upper ground layer where 70-90% of nematodes, 90-96% of harpacticoida, and 66-80% of oligochaetes were concentrated in Nha Trang Bay (Vietnam) in the South China Sea (Mokievsky *et al*., 2011) [31]. This study emphasizes on the abundance and distribution of meiofaunal communities as well as environmental and sedimentary parameters.

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