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VERTICAL DISTRIBUTION OF MEIOBENTHOS IN THE ADIMALATHURA ESTUARY, *SOUTHWEST* COAST OF INDIA

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Abstract
Vertical distribution of meiofauna in the Adimalathura estuary on the southwest coast of India exposed to pollution from coconut husk retting and disposal of untreated sewage was analysed for one year. Distinct vertical zonation occurred at all regions in the estuary. More than 70% of the total meiofauna occurred in the upper 10 cm of the sediment. The fauna present in the upper 0-5 and 5-10 cm sections were more or less the same. Foraminifers, nematodes, oligochaetes, archiannelids, ostracodes and copepods were found in the entire 25 cm long core while turbellarians, amphipods, and arachnids were limited to the 20 cm and Kinorhynchs, polychaetes and bivalves to the upper 15 cm of the sediment. The fundamental difference in the physical environment of the substratum greatly influences vertical zonation.

Key Words: Meiobenthos, Vertical Distribution, Pollution.

Introduction

Meiobenthos constitute an important group in the trophic network of benthic environment, which are efficient recyclers of nutrient and important source of food for higher trophic levels. Inspite of the awareness on the ecology of meiobenthos, little is known about their vertical distribution in the sediment. Meiofauna in capillary sediments live in a three- dimensional environment which often extends to depths of 50 cm or more in aerobic sediments (Fenchel, 1978; Hicks and Coull, 1983). Species in such environments frequently display a distinct vertical zonation. The Adimalathura estuary, a small brackish water biotope in Kerala lying between 8^{0}20’- 8^{0}22’N latitude and 77^{0}01’-77^{s}03’E longitude on the southwest coast of India receive untreated domestic wastes from the thickly populated human settlement around and foul water from the near-by retting yards almost on a continuous basis. The present paper deals with the vertical distribution of meiofauna on a spatio-temporal scale in the Adimalathura estuary.

Materials and Methods

Quantitative samples for the study were taken from three selected stations in the Adimalathura estuary along a salinity gradient. Station I was located in the upper reaches in fresh water, station II at the intermediate zone of the estuary, where sewage and foul water joins the estuarine waters and station III in the lower reaches where the pollutants are comparatively diluted.

The present data are based on 108 core samples collected in triplicate during one year at monthly intervals from the three stations. Samples (top 25 cm) were collected with a 45 cm long cylindrical steel corer (5.5 cm inner diameter). Each core sample was sliced into five subsamples of 5 cm layer and preserved separately in 5 % neutral formalin and the fauna were extracted following Holme and McIntyre (1971).For separating meiofaunal organisms, the separated organisms were sieved through a set of 0.5 mm and 0.062 mm sieves and the residue retained on the 0.062 mm sieve were preserved in 5% neutral formalin. 1:500 Rose Bengal stain was added for staining specimens. All the specimens in the samples were manually separated under binocular microscope, identified to various taxonomic groups and the population density is expressed in $1m^2$ area.

Results and Discussion

Though meiofauna was present up to 25 cm in the estuary, the bulk of the fauna was restricted to the top 10 cm (Table I). In almost all samples analysed the surface and the second layers sample were richer in meiofauna than the other layers. The overall distribution of meiofauna within the surface and the second layers were more or less the same. At station I the surface layer was richer in meiofauna than the other layers while at stations II and III second layer (5-10 cm) was richer in meiofauna than the other layers. The richer concentration of meiofauna below the top layer may be due to the instability of the topmost layer of the sediment in estuarine conditions. More than 70% of the fauna in the in the whole estuary was found in the upper 10 cm and more than 88% in the upper 15 cm of the sediment. Below the 10 cm depth the fauna decreased progressively with increasing depth and only less than 3 % was found below 20 cm in the sediment. More than 80 % of the fauna at station I and more than 70 % of the fauna at station III was present within the upper 10 cm while less than 70 % of the fauna at station II was within the above 10 cm sediment layer. A general decrease in density of meiofauna with increasing depth is known (Coull, 1970; Damodaran,1973; Ansari, 1978; Rao, 1987; Ansari *et al*.,1990; Chattergi *et al*., 1995) and the explanation for such vertical distribution lies on the combined influence of grain size distribution, organic matter content and oxygen conditions (Rao, 1987; Ingole *et al*., 1987; Harkantra and Parulekar,1989;Ansari *et al.* 2014). The bulk of the fauna within the top layers can be ascribed to the availability of oxygen and abundant food in the surface layers. The concentration of meiofaunal density at the surface layers has noted widely (Jayasree, 1971; Rao, 1987; Ingole *et al*., 1987; Chatterji *et al*., 1995; Priyalakshmi and Menon, 2014).

Monthly observations on vertical distribution (Table II) shows that more than 50 % of the population was always found in the surface 10 cm except during October at station I when considerable deeper penetration of the fauna was observed. At station I maximum concentration of the fauna within the surface layer was during November (72.73 %) and minimum during September (14.29 %). The 5-10 cm layer contributed its maximum (66.67%) during June and the minimum (11.75 %) during October. Within the 10-15 cm section maximum concentration (35.29 %) was during October. At this station the fauna was mainly concentrated between 0-15 cm and below this depth negligible quantities were found during most of the months. At station II, the maximum concentration within the surface layer (75 %) was during January while the maximum reported in 5-10 cm layer (50 %) was during March. Because of better drainage in coarse sand (Table III) and high atmospheric temperature and exposure, the fauna seem to migrate downward in the sand column at station III, but highly concentrated within the 0-15 cm depth. Within the surface layers at this station the maximum concentration (57.14%) was during June and within the 5-10 cm layer the maximum concentration (51.18 %) was during May. Seasonal trends show that the percentage of total meiofauna present within the same depth in all the three seasons was almost the same. During the premonsoon (Feb-May) and monsoon (June-Sept) periods maximum concentration was within the surface layers while during the postmonsoon period (Oct-Jan) the maximum concentration was within the 5-10 cm layer. In all the five sediment layers minimum density was during the monsoon period and maximum during the postmonsoon period. The seasonal fluctuation found in the vertical distribution of different meiofaunal groups coincided with that of total meiofaunal densities. The varying degrees of temperature, oxygen regime, and exposure account for the difference in faunal density during various seasons of the year.
The major faunistic composition was of similar nature at all the areas sampled, but differed in their percentage of occurrence at various depths (Figs. 2a-m). All the meiofaunal taxa showed a decrease in density with increasing depth. Foraminifers, nematodes, oligochaetes, archiannelids, ostracodes and copepods were encountered in the entire 25 cm deep core while other groups turbellarians, amphipods and arachnids were restricted to 20 cm limit whereas kinorhynchs, polychaetes and bivalves were limited to 15 cm in the sediment. These differences in the vertical movement of different groups were associated with their difference in response to various environmental factors such as oxygen, grain size, organic matter etc. Nematodes were occurred at all depths and constituted more than 43% of the total meiofauna. Their density also, however, decreased with increasing depth. Nematodes have been found capable of tolerating anaerobic conditions for prolonged period (Wieser, 1960; Sikora and Sikora, 1982) and this may explain the regular occurrence of this group in deeper layers. Also the slender shape of nematodes makes them better adapted to remain in fine interstices as observed by Damodaran (1973) and Ansari (1978). Nematodes showed their maximum concentration between 0-5 cm layers while foraminifers, copepods, archiannelids and amphipodswere abundant in the 5-10 cm layers at all stations. More than 70 % of the kinorhynchs were present in the surface layers whereas more than 60% of the polychaetes and bivalves were in the surface layers.

The fundamental differences in the physical environment of the substratum also influence the vertical zonation in interstitial organisms. Analysis of vertical distribution at the different stations revealed that station with higher percentage of sand had a higher percentage of fauna in the deeper layers. On an average higher population density was seen in the 5-10 cm layer at stations II and III. It is possible that the greater admixture of sand in the sediment makes them less compact which is helpful for the migration of the animals to deeper layers. Meiofauna in sandy sediments generally appear to be concentrated at those levels where desiccation is not too severe and oxygen availability is not too low (Mc Lachlan et al., 1977; Fernando, 1987). Because of better drainage of coarse sand and higher atmospheric temperature and exposure the fauna at stations II and III seem to migrate downward into the sand column. Earlier workers have also observed a downward migration of meiofauna in sand column (Harris, 1972; Ansari et al 1990; Anita Patnaik and Rao, 1990).Concentration of fauna in the surface layer at the riverine station can be ascribed to the closely packed nature of the substratum which does not allow the vertical migration suffiently and the reduced oxygen concentration and food availability in the deeper layers. Normally the oxygen concentration reduces with sediment depth accompanied by a reduction in meiofaunal density. Aerobic organisms prefer the surface sediment because with increasing depth oxygen decreases, Eh decreases, sulphide increases and in general oxidised forms of nutrients decreases and reduced forms increases and the condition impose stress on the existing biota.

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Table 1: Vertical Distribution of Meiofauna (No. M $^{-2}$) at the Different Stations

Station	Total	0-5 cm	5-10 cm	10-15 cm	15-20 cm	20-25 cm
I	239	120	76	36	7	1
II	380	128	137	78	31	6
III	2258	785	817	405	190	61

Table 2: Monthly Variation (%) in Vertical Distribution of Meiofauna at the Different Stations

Months	Station I					Station II					Station III				
	0-5 cm	5-10 cm	10-15 cm	15-20 cm	20-25 cm	0-5 cm	5-10 cm	10-15 cm	15-20	20-25 cm	0-5 cm	5-10 cm	10-15 cm	15-20 cm	20-25
Feb	50	35.71	14.29	0	0	33.33	44.44	22.22	0	0	22.86	37.14	34.29	5.71	0
Mar	71.43	28.57	0	0	0	25	50	8.33	8.33	8.33	34.48	36.95	17.73	7.88	2.96
Apr	70.59	17.65	11.76	0	0	40	41.82	10.9	5.45	1.82	52.38	28.57	13.33	3.81	1.9
May	29.41	44.12	20.59	2.94	2.94	47.06	38.24	8.82	5.88	0	22.3	51.8	19.06	5.04	1.8
Jun	33.33	66.67	0	0	0	33.33	41.67	25	0	0	57.14	33.92	8.93	0	0
July	47.06	26.47	17.65	5.88	0	32.26	41.94	22.58	3.23	0	53.23	17.76	19.35	8.06	1.6
Aug	52.38	30.95	14.29	2.38	0	50	25	25	0	0	47.5	40	7.5	5	0
Sep	14.29	57.14	28.57	0	0	16	64	12	8	0	43.22	30.15	13.57	8.54	4.52
Oct	35.29	11.75	35.29	17.65	0	31.03	41.38	27.59	0	0	49.35	29.87	12.99	5.19	2.6
Nov	72.73	27	27	0	0	33.85	27.69	21.59	13.85	3.08	40.31	29.84	15.18	11.52	3.11
Dec	50	40	10	0	0	30.3	25.76	28.79	12.12	3.03	27.71	36.94	19.11	12.1	4.14
Jan	61.54	30.77	7.69	0	0	75	25	0	0	0	24.77	35.32	25.69	11.93	2.29

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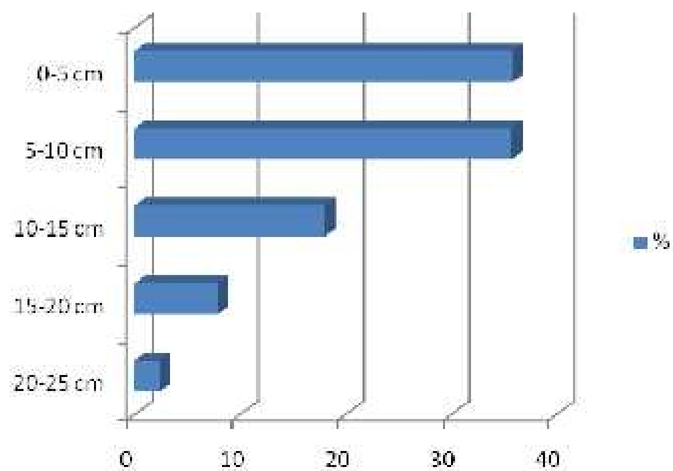
Table 3: Seasonal and Annual (Mean) Observations on Sediment Characteristics of the Adimalathura Estuary

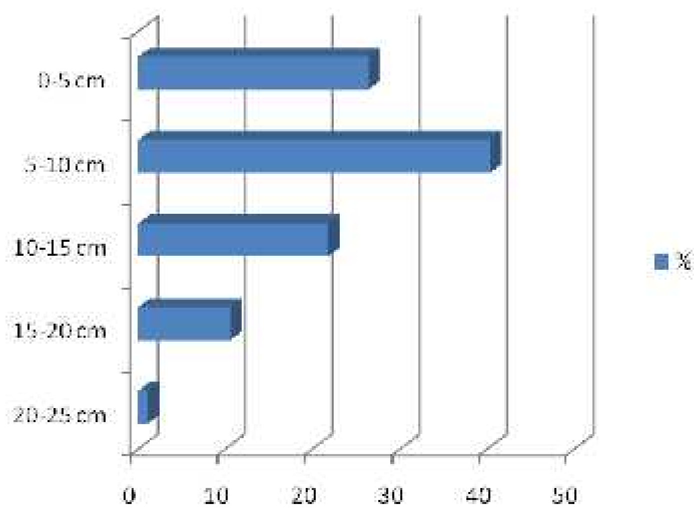
Stations	Seasons	Temperature(^{0}C)	Organic Carbon	Sand (%)	Silt (%)	Clay (%)
I	Premonsoon	29.63	1.61	60.72	28.78	10.5
	Monsoon	28.53	1.06	54.05	34.76	11.19
	Postmonsoon	29.13	1.33	44.53	37.65	17.82
	Annual	29.09	1.33	53.1	33.73	13.1
II	Premonsoon	31.05	1.73	37.93	52.23	9.84
	Monsoon	28.53	1.19	60.31	29.32	10.37
	Postmonsoon	29.7	1.51	27.38	57.25	15.37
	Annual	29.76	1.48	41.87	46.27	11.86
III	Premonsoon	30.35	2.38	59	19.75	18.63
	Monsoon	27.75	0.95	90.5	5.75	3.75
	Postmonsoon	29.55	1.05	78.04	13.58	8.38
	Annual	29.22	1.46	75.84	13.02	10.24

Figs.1a-m. Vertical distribution (Annual mean %) of total meiofauna and various meiofaunal groups

a. Total meiofauna



b. Foraminifera



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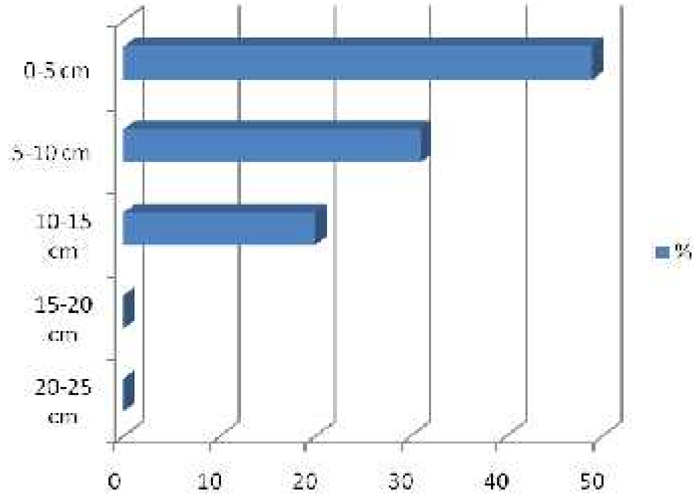
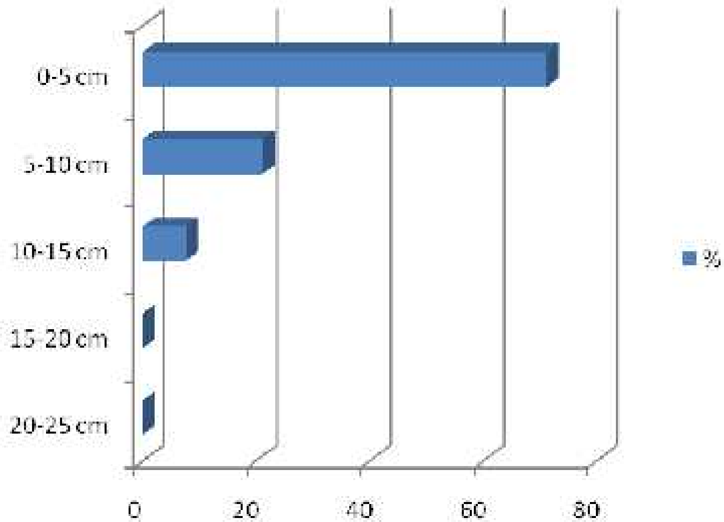
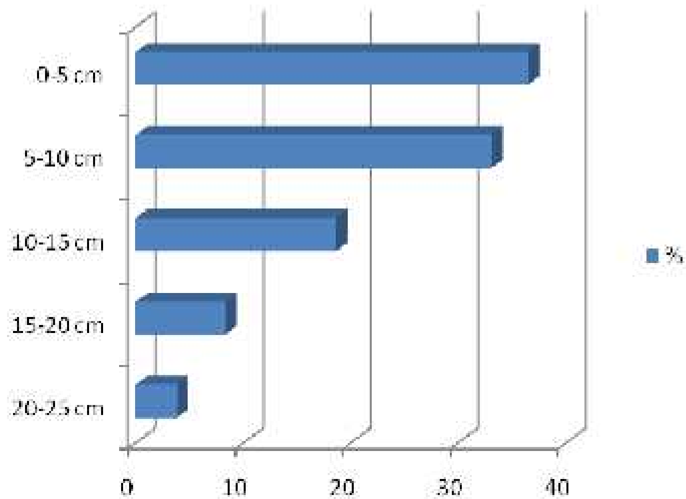
c. Turbellaria



d. Kinorhyncha



e. Nematoda



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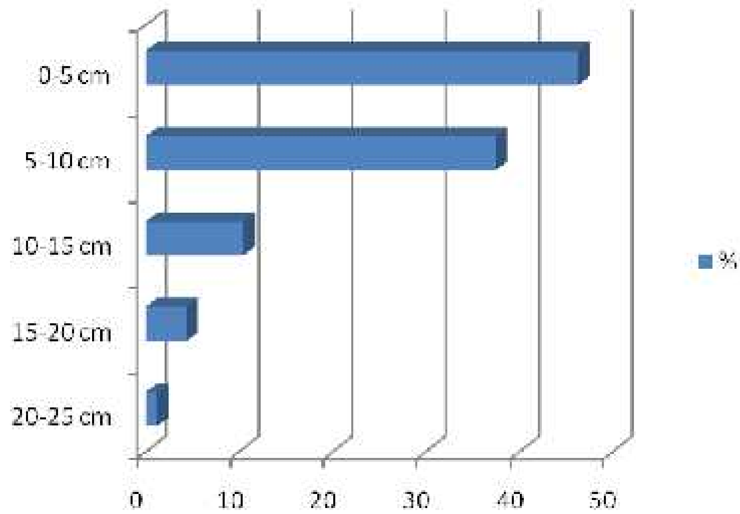
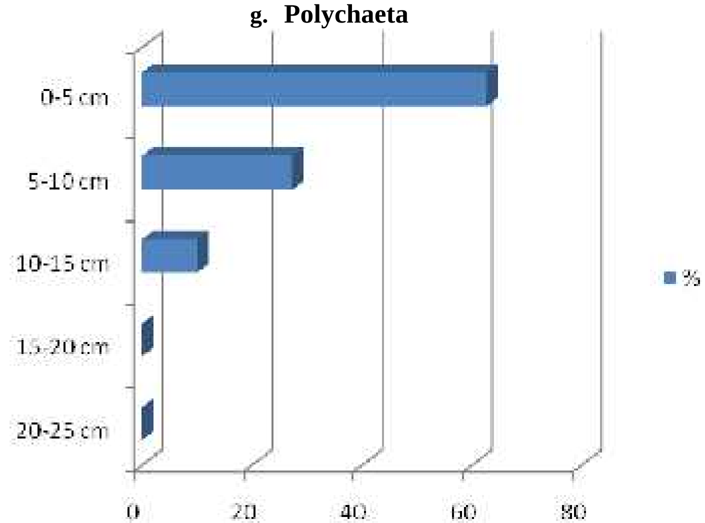
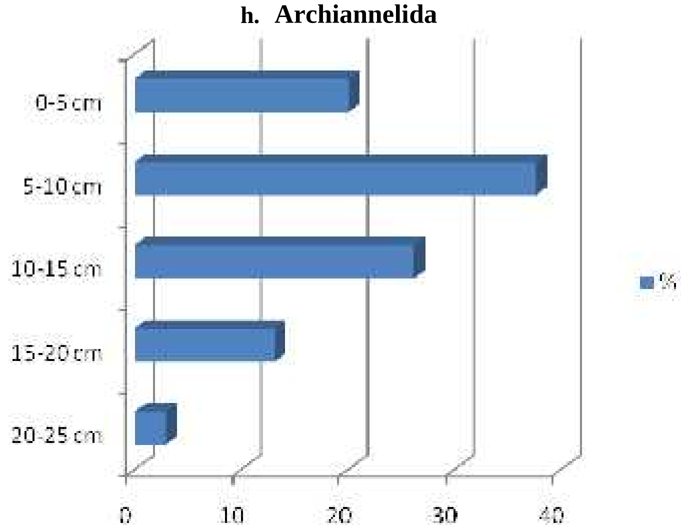
f. Oligochaeta



g. Polychaeta



h. Archiannelida



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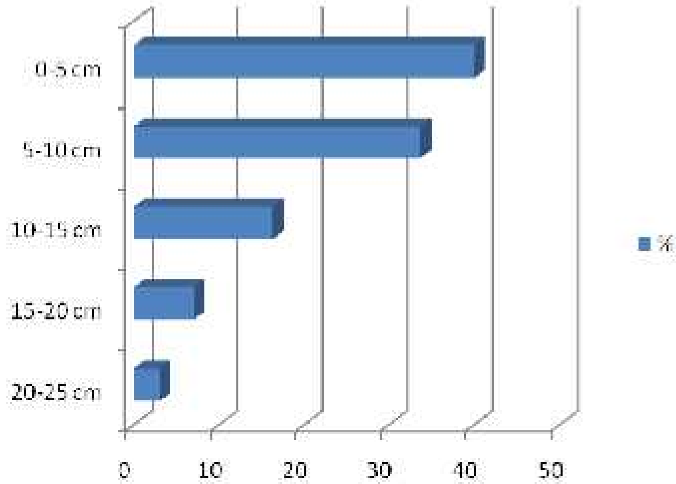
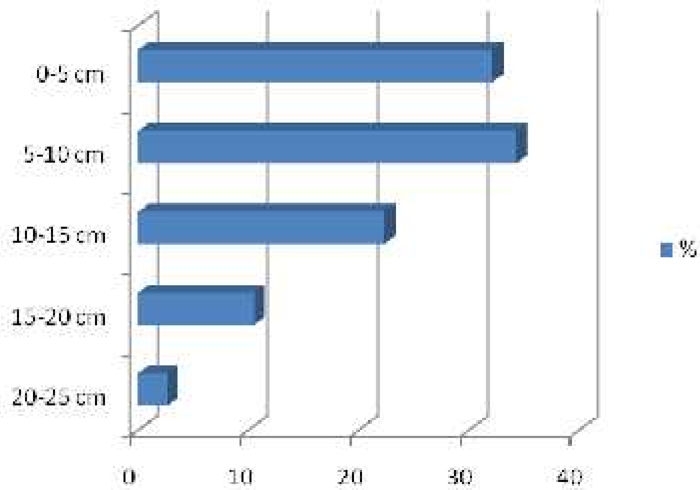
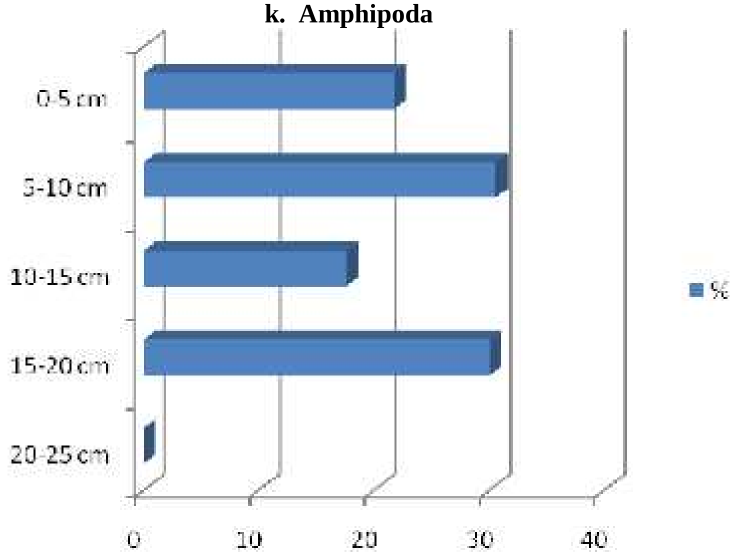
i. Ostracoda



j. Copepoda



k. Amphipoda



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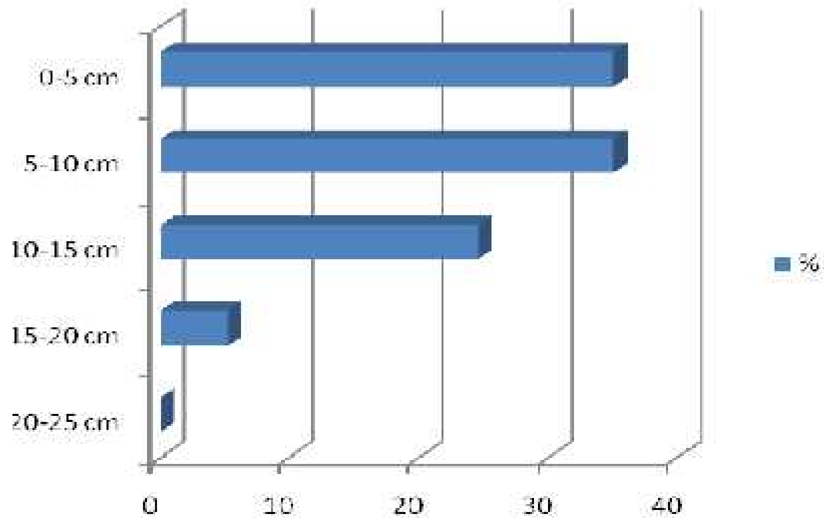
l. Arachnida



m. Bivalvia