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Zooplankton diversity and abundance of mangrove ecosystem of Kali estuary, Karwar, west coast of India

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Abstract

The present study conducted at the mangrove ecosystem of Kali estuary. Samples were collected from the three fixed stations for the period of thirteen months from January 2008 to January 2009 at regular monthly interval to identify and quantify the abundance, taxonomy and relative ratio of phytoplankton and zooplankton. In the present study of species diversity of zooplankton groups in the mangrove area, composed of twelve groups comprising fifty two species major share comes from the copepods which comprises about seventeen species. Protozoa taxa comprised by five species, coelenterata and cladocera by two species each, ctenophore comprised by single species whereas the larval forms comprised by fourteen species.

KEY WORDS: Zooplankton, Diversity, Abundance, Estuary, Mangrove, Karwar.

Introduction

Based on the earlier studies and usefulness of this mangrove ecosystem, the present study was undertaken in the mangrove habitats of Kali estuary. The importance of this ecosystem in escalating the productivity, harboring large faunal communities and highly rich fishing zone, so far no attempt has been made on the biotic community of this was undertaken. Keeping all these facts & figures in view, the present study was focused mainly on the zooplankton diversity of this ecosystem.

The Indian mangroves comprise approximately 59 species in 41 genera and 29 families. Of these, 34 species belonging to 25 genera and 21 families are present along the west coast. Thick belt of Rhizophora mucronata along the Goa and Karnataka coast exists in dominance. Zooplankton in Indian mangroves where found to consist mainly of copepods, in some seasons up to 95% (Kathiresan, 2000). In the mangrove zooplankton of an estuary in Northeastern Australia the dominant group was also copepods, possibly indicating their importance as a food source for juvenile fishes (McKinnon & Klumpp, 1998).

River Kali has vast area of Mangrove floral stretch distributed in more than 1200 acres on either banks of the river. Some of the important mangrove areas found in and around the Kali estuary are

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Mavinahole creek, Kanasgiri, Sunkeri, Kadwad and Kinnar. Information on resource partitioning among fish species is useful in comprehending the fishery resources of the ecosystem. A fundamental knowledge on the resources of fish community is necessary for studies on fish inter-specific inter actions and complexity in the water body and for further technology development on production of aquatic food.

Materials and methods

The River Kali originated in the Kusavali village in Supa taluka and after meandering about 185 km in the Sahyadri plateau and lastly joins the Arabian Sea at Karwar (14°50'21" N and 74°10'05"E). River Kali exhibits different type of biotopes such as estuary, backwater, fresh water and mangrove, grassland etc. Totally three study stations were selected and fixed in the mangrove ecosystem of Kali estuary, Karwar on West coast of India. The study stations are Mavinahole creek, Kanasgeri, Sunkeri. Samples were collected from the three fixed stations for the period of thirteen months from January 2008 to January 2009 at regular monthly interval. Samplings and analysis of sampling physicochemical were made as per the standard procedure (APHA, 2000).

Samplings of zooplankton were carried out from the surface water, by towing the zooplankton net (mouth diameter 0.35 m) made up of bolting silk cloths (Mesh size 158 Fm), for half an hour from three stations located at mangrove ecosystem of Kali estuary (Fig.1), during the present study period. The collected samples were preserved in 5% neutralized formalin for further analysis. The density was determined by numerical method using Sedgewick's counting chamber under the microscope. Various planktonic groups and their species were enumerated by examining 5-10% of the sub sample and the number of organisms computed per m^3 of water (Wickstead, 1965: NIO Manual, 2000). Zooplankton were identified using the standard works of Hustedt (1930), Venkataraman (1939), Cupp (1943), Subrahmanyan (1946), Prescott (1954), Desikachary (1959 and 1987), Hendey (1964), Steidinger and Williams (1970), Taylor (1976), Anand et al. (1986) and Santhanam et al. (1987), Davis (1955), Kasturirangan (1963), Newell and Newell (1986), Deboyd Smith (1977), Wimpenny (1966), Todd and Laverack (1991) and Perumal et al. (1998).

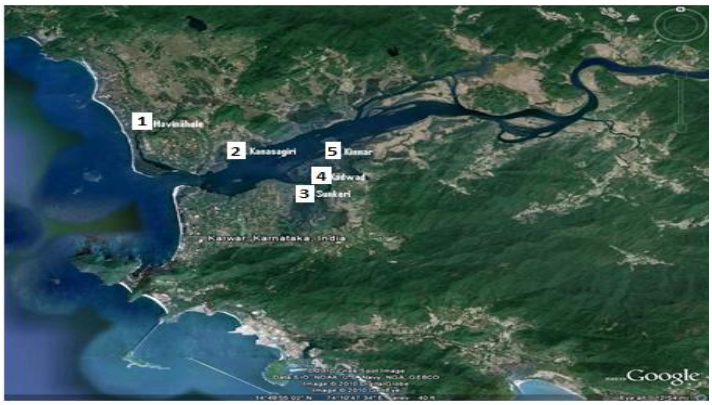

Figure 1: Map showing the location of the study stations in the Mangrove Ecosystems in the Kali Estuary, Karwar.

Bray Curtis similarity for species diversity for all species belonging to zooplankton was determined analytically by PRIMER-V5.

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Results and discussion

In the present study, various hydrographic parameters were studied to give a clear picture of the study site's environment to project the exact relationship exists between the hydrographic condition and the faunal community living in the mangrove ecosystem. The hydrographic results are (given in the Table 1).

Hydrography: The water temperature did not show any drastic variation either during the study period or among the seasons in all study stations 1-3. A lowest temperature was recorded in study stations 1, 2 & 3 during December (28^0, 29.04^0 & 28.1^0 respectively) and highest (31.52^0, 31.52^0 & 31.1^0 respectively) during May month shown in Table.1. Salinity showed wide range of variation during the study period in all stations with minimum 1.1‰ in station 3 and maximum 30.08‰ station 1. Seasonally it showed a wide range of variation in all stations with minimum (0.20 to 15.0‰) during southwest monsoon period and maximum (16.10 to 29.29 ‰) during pre monsoon period with an intermediate values being established during post monsoon season (13.75 to 27.06 ‰) shown in Table 1. The monthly fluctuation in Dissolved oxygen concentration of Kali estuary at different stations during different months were presented in Table No1. Dissolved oxygen did not showed vary much fluctuation between the months and the season. Dissolved oxygen concentration fluctuated between stations 1; 2 and 3: 2.91 to 4.33, 3.01 to 5.14, 3.14 to 6.47 respectively. The rich oxygenated condition prevailed in all the stations during the present study period (Table 1). The high oxygen content of station 3 (6.47 mg/l) suggests the lesser density of aerobic heterotrophics like microorganisms there in (Parsons et al., 1977) and rich growth of faunal community but the poor oxygenation of surface waters at station 1 (3.34 mg/l) denotes reduced sulphide containing zone underlying the oxidized layer of sediment surface (Fenchel, 1969, Fenchel and Riedl, 1970; Sudarshana, 1983. The monthly fluctuation in hydrogen ion concentration of Kali estuary at different stations during different months were presented in table No.1. Hydrogen ion concentration did not vary much between the months and the season. Hydrogen ion (pH) concentration fluctuated between stations 1; 2 and 3: 6.90-8.38, 7.03-8.70, 7.00-8.00 respectively. In the present study, the pH values ranged from 6.90 to 8.45. According to Perkins (1976), the range of pH of estuaries and coastal waters under normal and unpolluted conditions is between 6.7 and 9.25 respectively.

Diversity profile of zooplankton: In the present study of species diversity of zooplankton groups in the mangrove area, composed of twelve groups comprising fifty two species major share comes from the copepods which comprises about seventeen species. Protozoa taxa comprised by five species, coelenterata and cladocera by two species each, ctenophore comprised by single species whereas the larval forms comprised by fourteen species. The maximum number of genera were found at station 1 and 3 and mainly contributed by maximum genera from the copepods and larval forms. Based on the numerical abundance, it was found that among zooplankton groups represented in the study areas (mangrove ecosystem), the group larval forms, copepods and protozoans were the most dominant groups at station 1, 2 & 3.

Zooplankton reflect the ecological and environmental status and were calculated in terms of number of individuals / specimens (N), number of species (S), total abundance (A), Margalef species richness, (d'), Pielou's evenness (J'), Shannon index (H') at each sites (Clarke and Gorley, 2001). Table 2 & 3 explains the diversity and similarity profile of zooplankton at study station 1. The species

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diversity of zooplankton was estimated based on Margalef species richness (d) and Shannon index (H'). During the period of thirteen months, species richness value ranged from 3.9230 to 6.6803 (August & November). Shannon index (H') values ranged from 2.0589 to 2.963 during July and January'09 of the study period. The Pielou's evenness (J') value also varied considerably among the months in this station, the minimum and maximum values were recorded during the April (0.583) and January'09 (0.749).

The species richness (d) showed considerable variation in months at station 2 (Kanasgeri), and in this station, the Margalef's species richness values varied between 3.389 and 6.632 in August and October months. The Shannon index values showed marked variation with respect to months and its value ranged from 1.121 to 2.782 in August and January'09 months respectively. The values of species evenness showed marked variation with months ranging from 0.344 (August) to 0.707 (January'09) (Table 4 and 5).

The species richness (d) showed considerable variation in months at station 3 (Sunkeri). The values ranged from 2.540 to 5.915 in August and December months respectively. The Shannon index values varied between 1.455 and 2.076 in August and December (Table 6 & 7). In continuation with this, the species evenness of zooplankton varied between 0.440 (April) and 0.588 (July) respectively.

The diversity is a measure of the degree of organization and efficiency with which materials space and time are used in a community (Payne, 1986). Diversity studies form an important and basic aspect of community dynamics in aquatic ecosystems. Indices such as diversity, richness, evenness and dominance are useful tool in the critical appreciation of the distribution of populations with respect to space and time.

Similarity index of zooplankton: On the basis of Bray Curtis similarity index, this is applied for zooplankton species abundance at each study stations during the different months of the year. Overall percentile of similarity varied between 59.63 and 98.68. At study station 1, more than 95% similarity indices were noticed during August and September. June & November and January'08 & January'09; were grouped into two cluster registering more than 98% respectively. In rest of the months were dissimilar at this level (Table 3 and Figure 2) respectively. Figure 6 shown the similarity cluster between the months September & August; July & October; June & November and, January'08 &, January'09 at 0.01 stresses.

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Table 1. Monthly variation in hydrological parameters at all Study Stations

Parameters	Stn	Jan-08	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan-09
Water temp. (^{0}C)	1	30.05	31.07	31.11	31.18	31.52	31.01	30.02	28.01	29.32	31.03	28	28	30
	2	29.0	30	30.8	31.1	31.5	30.0	29.0	27.0	29.0	30.0	28.0	29.0	32.0
	3	28.0	28.7	29.1	29.5	31.1	29.1	28.3	27.4	28.1	29.2	29.6	28.1	28.6
Salinity (‰)	1	29.1	30.0	28.5	29.0	30.0	15.0	11.7	10.3	21.7	25.5	26.1	27.1	29.5
	2	28.9	30.1	29.5	28.1	24.5	8.0	4.9	4.1	21.7	25	25.5	28.5	29.1
	3	24.5	26.2	27	29.1	30.0	4.1	3.3	1.1	1.8	30.1	22.4	23.3	24.2
DO (mg/l)	1	2.98	2.46	3.33	3.42	3.01	4.01	4.15	4.33	2.91	3.14	3.37	3.22	3.06
	2	3.38	3.12	3.26	3.01	3.80	4.22	4.37	5.14	3.11	3.72	3.61	3.74	3.12
	3	4.11	3.88	3.24	3.63	3.81	6.47	5.50	6.10	5.82	3.14	3.56	3.42	3.14
pH	1	7.00	7.30	7.53	7.22	7.10	7.20	6.9	7.20	6.90	8.38	7.80	7.20	7.90
	2	7.53	7.30	7.54	7.20	7.03	7.65	8.10	8.15	8.22	8.26	8.70	8.10	7.30
	3	7.40	7.50	7.54	7.10	7.20	7.50	8.00	7.75	7.30	7.89	7.11	7.00	7.40

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Table 2. Monthly variation in the species diversity and richness of Zooplankton fauna at Study Station 1

	S	N	d	J'	Brillouin	Fisher	H'(loge)	1-Lambda'
Jan.08	52	2752	6.4393	0.6010	2.3344	9.0984	2.3748	0.7726
Feb.	52	3358	6.2814	0.6014	2.3420	8.7327	2.3764	0.7684
Mar.	51	3764	6.0729	0.5984	2.3216	8.3411	2.3530	0.7497
Apr.	51	4265	5.9821	0.5829	2.2636	8.1431	2.2919	0.7360
May	49	5208	5.6088	0.6385	2.4604	7.4849	2.4852	0.7695
Jun.	39	2130	4.9583	0.6246	2.2483	6.7787	2.2885	0.7572
Jul.	32	1529	4.2278	0.5940	0.0155	5.7228	2.0589	0.7190
Aug.	28	975	3.9230	0.6465	2.0972	5.3789	2.1544	0.7603
Sept.	36	1058	5.0257	0.7020	2.4466	7.2056	2.5159	0.8181
Oct.	48	1484	6.4361	0.6900	2.6038	9.4884	2.6713	0.8143
Nov.	52	2068	6.6803	0.7170	2.7768	9.6865	2.8330	0.8418
Dec.	52	2425	6.5438	0.7409	2.8776	9.3488	2.9277	0.8640
Jan.09	52	2680	6.4609	0.7498	2.9164	9.1496	2.9630	0.8679

Table 5 and Figure 7, which describes the similarity in zooplankaton community at study station 2 during months. Overall, the similarity values varied between 65.6 and 98.32%. More than 90% similarity was recorded during February & March; January'08 & January'09; June & December and July, August & October. But the maximum similarity of 97% has formed group of two cluster between, January'08 & Janauary'09 and July, August & October months. The second group of cluster was noticed during February & March respectively. In remaining months were dissimilar at this level (Table 5 and Figure 3) respectively.

Table 7 and Figure 4 explain the similarity of density between the months. The overall values ranged from 76.87 to 99.45%. Maximum similarity of 99% was observed during June & October, which is followed by and 98% during August & September whereas the third group of cluster of 97% was noticed during in March & December months. At 0.01% stress, the cluster of groups is shown in the at study station 3.

Species composition and monthly abundance of copepods in relation to environmental variations were studied in mangrove ecosystem of Kali estuary. The study of zooplankton abundance and distribution in the mangrove ecosystem of Kali estuary revealed marked monthly and seasonal variations. The high abundance of zooplankton observed during the pre monsoon (April-May) and post monsoon seasons and thus bimodal distribution of zooplankton was observed. Two peaks of abundance were noticed the first one during April-May and the second one in October-December. Such a bimodal periodicity of zooplankton over an yearly cycle has been well documented by several workers (Anderson et al., 1955; Ayyappan and Gupta, 1980; Nair and Prabhoo, 1980; Saxena 1982, Sharma 1983; Moza 1992 and Joseph, 1994).

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Table 3: Monthly variation in the similarity indices of Zooplankton fauna at Station 1

	Jan. 08	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.09
Jan.08	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb.	90.3058	0	0	0	0	0	0	0	0	0	0	0	0
Mar.	84.7744	94.3898	0	0	0	0	0	0	0	0	0	0	0
Apr.	78.8369	88.2954	93.8635	0	0	0	0	0	0	0	0	0	0
May	69.6161	78.6945	84.1124	90.1532	0	0	0	0	0	0	0	0	0
Jun.	87.2510	77.8471	72.6200	67.0460	58.5991	0	0	0	0	0	0	0	0
Jul.	71.6198	62.9598	58.2558	53.3233	46.0057	83.7810	0	0	0	0	0	0	0
Aug.	52.9670	45.7586	41.9459	38.0231	32.3446	63.5273	78.4558	0	0	0	0	0	0
Sept.	56.4865	48.9597	44.9563	40.8208	34.8268	67.3859	82.2102	95.5528	0	0	0	0	0
Oct.	70.8361	62.3009	57.6028	52.6931	45.4227	82.3580	97.8165	79.1366	83.4288	0	0	0	0
Nov.	86.1965	76.8158	71.5353	66.0232	57.5863	98.1321	84.7522	64.3973	68.3433	84.0780	0	0	0
Dec.	93.8286	84.2330	78.8049	73.0219	64.1256	93.3080	77.3351	57.8672	61.5947	76.6738	92.2969	0	0
Jan.09	98.6832	89.0077	83.4965	77.5901	68.4412	88.4969	72.7857	53.9592	57.5369	72.1314	87.4846	95.1408	0

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Table 4: Monthly variation in the species diversity and richness of Zooplankton fauna at Study Station 2

	S	N	d	J'	Brillouin	Fisher	H'(loge)	1-Lambda'
Jan.08	51	2680	6.3342	0.5267	2.03338	8.9368	2.0709	0.6906
Feb.	50	3087	6.0983	0.5393	2.0759	8.4734	2.1099	0.7000
Mar.	49	3330	5.9180	0.5582	2.1395	8.1453	2.1725	0.6978
Apr.	50	4048	5.8993	0.5323	2.0543	8.0328	2.0825	0.6788
May	48	5001	5.5181	0.5702	2.1830	7.3585	2.2074	0.6997
Jun.	35	2438	4.3595	0.5757	1.9095	5.7896	1.9404	0.6784
Jul.	29	1667	3.7742	0.4947	1.6315	4.9871	1.6659	0.6088
Aug.	26	1597	3.3894	0.3440	1.0912	4.4108	1.1208	0.4003
Sept.	44	1190	6.0719	0.5715	2.0992	8.9927	2.1627	0.7469
Oct.	50	1617	6.6320	0.6227	2.3753	9.7763	2.4361	0.7803
Nov.	50	2049	6.4261	0.6633	2.5431	9.2508	2.5949	0.8128
Dec.	50	2276	6.3387	0.6906	2.6525	9.0369	2.7017	0.8228
Jan.09	51	2564	6.3699	0.7075	2.7351	9.0213	2.7820	0.8284

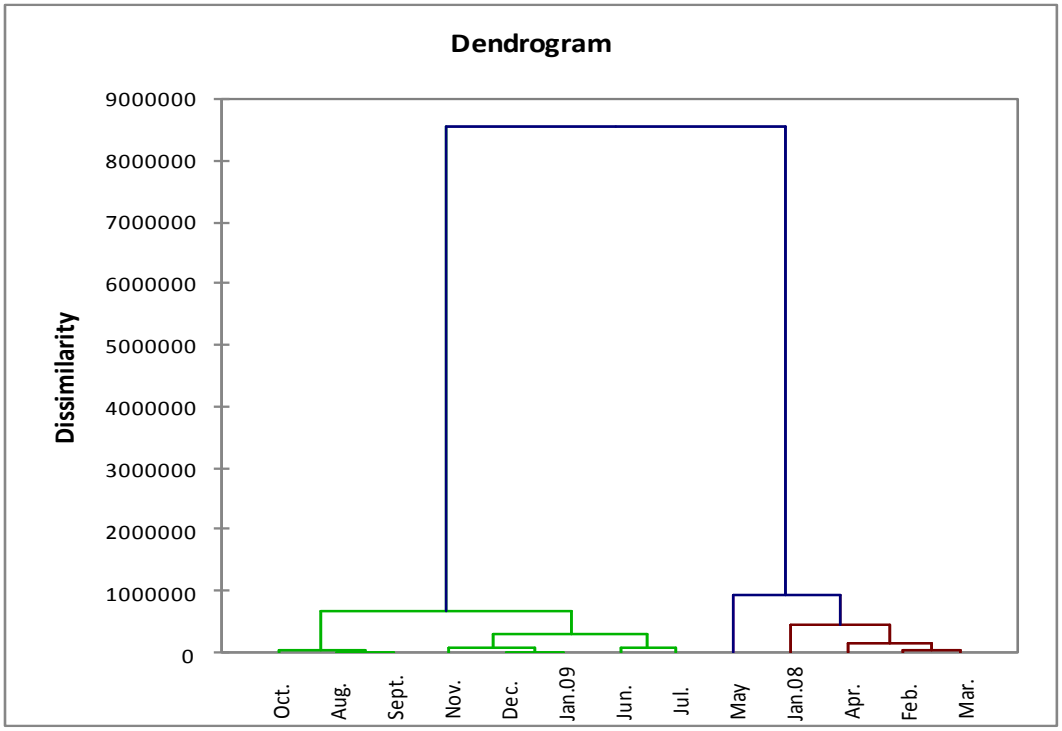

Figure 2: Dendrogram similarity of Zooplankton density at station 1

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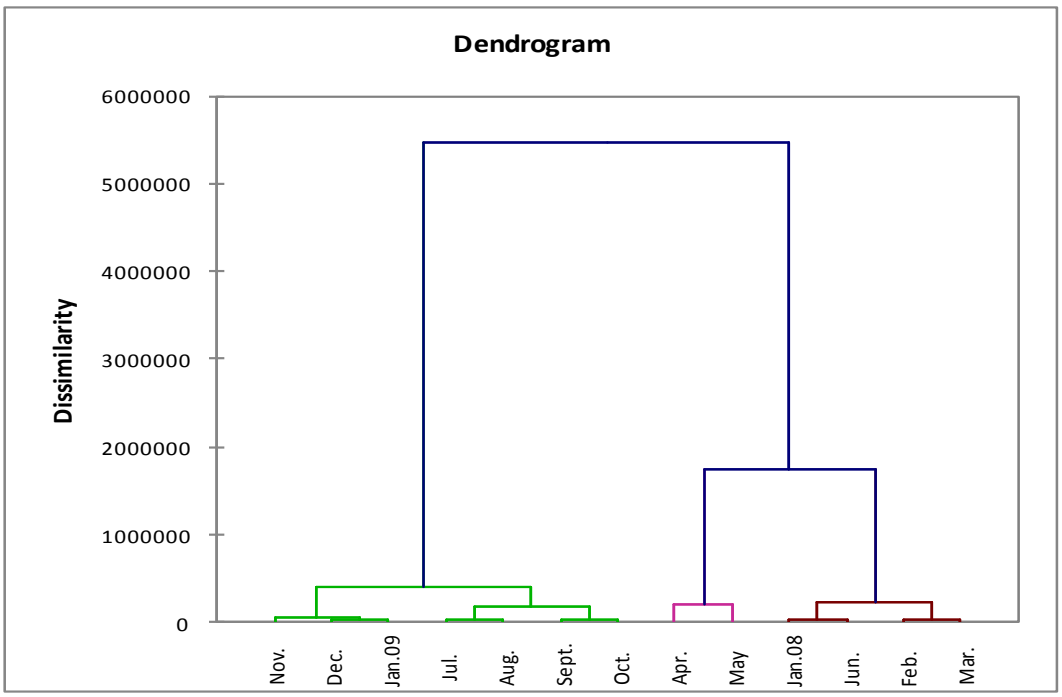

Figure 3: Dendrogram showing similarity of Zooplankton density at station 2

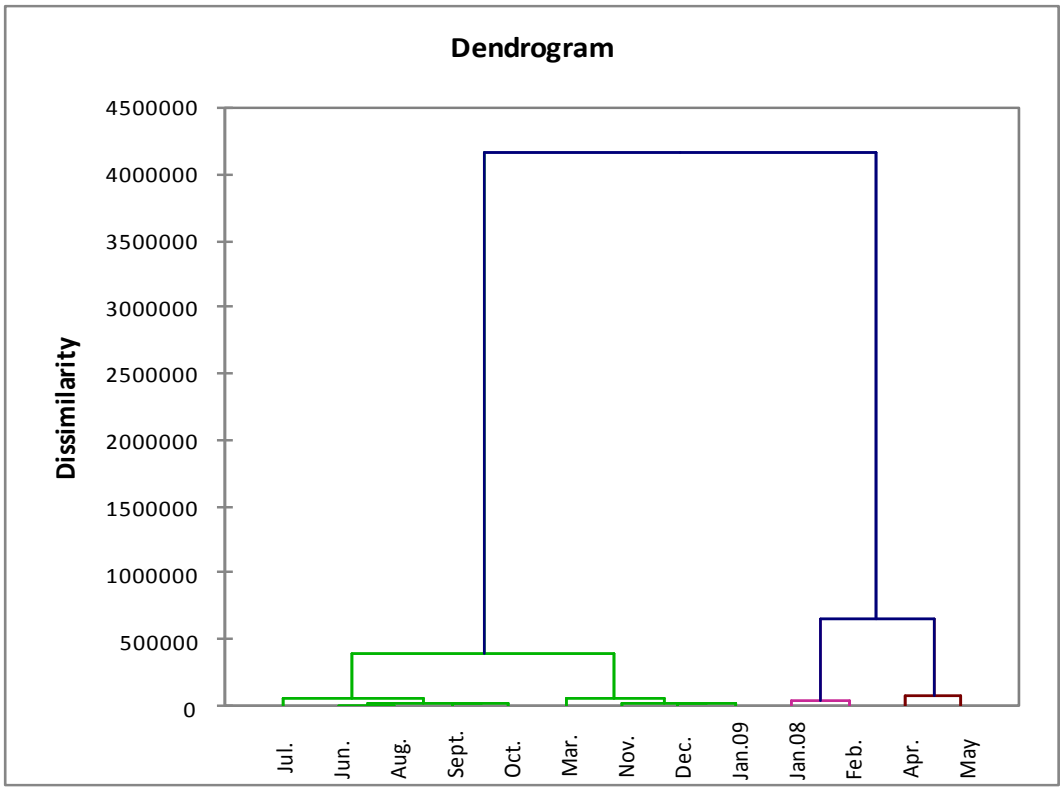

Figure 4: Dendrogram showing similarity of Zooplankton density at station 3

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Table 5: Monthly variation in the similarity indices of Zooplankton fauna at Station 2

	Jan. 08	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.09
Jan.08	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb.	93.0812	0	0	0	0	0	0	0	0	0	0	0	0
Mar.	89.3751	96.2680	0	0	0	0	0	0	0	0	0	0	0
Apr.	80.0492	86.7792	90.4289	0	0	0	0	0	0	0	0	0	0
May	70.2430	76.6803	80.2357	89.5875	0	0	0	0	0	0	0	0	0
Jun.	94.9729	88.1530	84.5349	75.3374	65.8629	0	0	0	0	0	0	0	0
Jul.	76.6310	70.2468	66.9237	58.6691	50.4423	81.4393	0	0	0	0	0	0	0
Aug.	94.5097	68.2045	64.9296	56.8160	48.7594	79.2904	97.7443	0	0	0	0	0	0
Sept.	62.6188	56.8482	53.8795	46.6603	39.6195	66.2712	83.1472	84.9436	0	0	0	0	0
Oct.	75.9968	69.6154	66.2557	58.0784	49.8297	79.8125	97.6362	98.3189	85.2262	0	0	0	0
Nov.	86.9954	80.2910	76.7268	67.9091	58.8562	91.0821	89.2407	87.0165	74.3287	88.6344	0	0	0
Dec.	92.0262	85.2277	81.5967	72.5472	63.1770	96.1951	84.2490	82.0570	69.6466	83.6377	94.9087	0	0
Jan.09	97.8131	90.9146	87.2299	77.9685	68.2814	97.0887	78.6435	76.5010	64.4715	78.0485	89.1415	94.1987	0

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Table 6: Monthly variation in the species diversity and richness of Zooplankton fauna at Study Station 3

	S	N	d	J'	Brillouin	Fisher	H'(loge)	1-Lambda'
Jan.08	39	3484	4.6591	0.4787	1.7301	6.1502	1.7540	0.6124
Feb.	35	3771	4.1286	0.4768	1.6745	5.3333	1.6952	0.5931
Mar.	33	3213	3.9628	0.5507	1.9019	5.1218	1.9256	0.6740
Apr.	46	4459	5.3554	0.4404	1.6647	7.1452	1.6862	0.5820
May	49	5030	5.6317	0.4869	1.8729	7.5320	1.8949	0.6297
Jun.	34	2705	4.1757	0.5783	2.0101	5.4806	2.0395	0.6853
Jul.	24	2308	2.9699	0.5882	1.8447	3.7334	1.8696	0.6807
Aug.	21	2624	2.5405	0.4782	1.4371	3.1172	1.4558	0.5492
Sept.	22	2554	2.6767	0.5199	1.5874	3.3081	1.6071	0.6164
Oct.	35	2734	4.2964	0.5370	1.8821	5.6617	1.9092	0.6668
Nov.	48	3009	5.8681	0.5071	1.9391	8.1094	1.9630	0.6601
Dec.	49	3341	5.9156	0.5335	2.0466	8.1399	2.0764	0.6900

Table 7: Monthly variation in the similarity indices of Zooplankton fauna at Station 3

	Jan	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec
Jan.08	0	0	0	0	0	0	0	0	0	0	0	0
Feb.	96.025	0	0	0	0	0	0	0	0	0	0	0
Mar.	95.893	92.076	0	0	0	0	0	0	0	0	0	0
Apr.	87.793	91.583	83.769	0	0	0	0	0	0	0	0	0
May	81.950	85.677	78.015	94.020	0	0	0	0	0	0	0	0
Jun.	87.510	83.752	91.522	75.675	70.144	0	0	0	0	0	0	0
Jul.	79.675	76.031	83.644	68.255	62.992	91.951	0	0	0	0	0	0
Aug.	85.728	82.001	89.761	73.979	68.490	98.162	93.575	0	0	0	0	0
Sept.	84.453	80.741	88.474	72.766	67.321	96.860	94.941	98.631	0	0	0	0
Oct.	88.053	84.281	92.026	76.194	70.646	99.447	91.411	97.621	96.319	0	0	0
Nov.	92.627	88.686	96.464	80.860	75.248	94.467	86.483	92.645	91.350	95.014	0	0
Dec.	97.740	93.782	97.761	85.834	80.128	89.364	81.473	87.552	86.272	89.901	94.859	0

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Table 7 and Figure 4 explain the similarity of density between the months. The overall values ranged from 76.87 to 99.45%. Maximum similarity of 99% was observed during June & October, which is followed by and 98% during August & September whereas the third group of cluster of 97% was noticed during in March & December months. At 0.01% stress, the cluster of groups is shown in the at study station 3.

Species composition and monthly abundance of copepods in relation to environmental variations were studied in mangrove ecosystem of Kali estuary. The study of zooplankton abundance and distribution in the mangrove ecosystem of Kali estuary revealed marked monthly and seasonal variations. The high abundance of zooplankton observed during the pre monsoon (April-May) and post monsoon seasons and thus bimodal distribution of zooplankton was observed. Two peaks of abundance were noticed the first one during April-May and the second one in October-December. Such a bimodal periodicity of zooplankton over an yearly cycle has been well documented by several workers (Ayyappan and Gupta, 1980; Nair and Prabhoo, 1980; Saxena 1982, Sharma 1983; Moza 1992 and Joseph, 1994).

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