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Comparative Ecology of Backwater and Mangrove Environments of Kayamkulam Lake, Kerala

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Abstract

Water quality, sediment characteristics and biotic components (plankton and benthos) of Kayamkulam lake and the adjoining Ayirumthengu mangrove waters (between 9°2'and 9°12'N latitude and 76°26' and 76°32'E longitude) in Kerala was studied for a period of one year. All the physic- chemical characteristics and biological parameters analysed reported significant temporal variations. Salinity variations were more conspicuous than the variations in other parameters. Nutrients (NO_3-N, NO_2-N and PO_4-P) values in general were higher in the mangrove water than in the lake water. The sediments were silty sand and clayey sand with good amount of organic matter. Diatoms contributed more than 50% of the phytoplanktons and copepods dominated the zooplanktons (>40%). Benthic density (annual mean) was 1796 m^{-2} in the lake bottom and 3210 m^{-2} in the mangrove environment.

Keywords: Water quality; Sediment quality; Plankton; Benthos; Backwater; Mangrove environments

Introduction

Kerala is a state gifted with notable physical feature of brackish water areas adjoining to the sea. The backwaters of Kerala, sprawling in the entire coastal length of the state play a significant role in the socio-economic development of the state especially in the light of potentials for development of commercial fisheries and aquaculture. Mangrove constitutes one of the most productive zones of brackish water fishery development. Biologically and economically, one of the most important aspects of man-mangrove interaction is the mangrove dependant or associated capture and captive fisheries and aquaculture. The detritus food web that develops in mangrove ecosystems provides rich food for several species of edible fin fishes and shell fishes.

Kayamkulam lake, a narrow stretch of brackish water lying between 9°2'and 9°12'N latitude and 76°26' and 76°32'E longitude on the southwest coast of India is one of the best developed and little explored estuarine habitat in Kerala which offers great scope for aquaculture operations. During flood season freshwater canals empty water from the Pampa and Achankoil rivers in to the lake. The influence of tidal movements from the Arabian Sea in to the lake through the Kayamkulam bar mouth is felt in almost all parts of the lake. Ayirumthengu mangrove area is situated at the low-lying region on the southern portion of Kayamkulam Lake. The mangrove region is richly vegetated mainly with *Rhizophora* sp., *Avecennia* sp. and *Acanthus* sp.

Physico-chemical characteristics soil and water basically determines the potentiality of an aquatic habitat in terms of aquaculture production. Proper understanding of these characteristics is the prime requisite to achieve success in aquaculture programmes. Considering the biological and economic importance of estuarine habitats and the mangrove dependant or associated fisheries and aquaculture the present investigation depicts a comprehensive account on water quality, soil condition, plankton and benthic faunal components of Kayamkulam Lake and the Ayirumthengu mangrove habitat.

Materials and Methods

The water and sediment samples were collected from two selected stations, one in Kayamkulam lake (station I), about 1 km away from the Kayamkulam bar mouth and the other in Ayirumthengu mangrove (station II). Collections were made out for a period of one year at monthly intervals from January to December 2010. The hydrographical parameters studied were water depth, temperature, pH, dissolved oxygen, salinity, nitrate-nitrogen, nitrite-nitrogen and phosphate-phosphorus which were analysed following the standard procedures of Strickland and Parsons [1], Grasshoff et al. [2] and APHA [3]. Core samples of sediment were used for the observations on temperature, organic carbon [4], texture [5] and benthos [6]. Plankton samples were subjected to both quantitative and qualitative estimations following Gopinathan [7] and Santhanam et al. [8].

Results, Discussion and Conclusion

Water quality

Surface water temperature generally follows the trend of atmospheric temperature. Lower temperature was recorded during the monsoon and early post monsoon period. Mean as well as range of variation in temperature was higher in the mangrove waters (Table 1). The depth of the water column was from 126-266.3 cm at station I and from 70-118 cm at station II. The depth profile of the stations reveals that the lake is a shallow biotope suitable for aquaculture activities. Studies conducted in Kerala estuaries have shown that most of the estuarine water bodies of the state are shallow varying in depth below 3 meters [9-12]. The successive accumulation of organic matter and silt deposition can be cited as a reason for the low water depth in the mangrove area.

pH values varied from 6.56 to 9.16 at station I and from 6.1 to 10.1 at station II. Such alkaline waters are favourable for the healthy existence of aquatic organisms. High pH at both the stations could be due to the influx of sea water. Fluctuations in DO content, CO_2 content,

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Parameter	Station I			Station II		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Depth (cm)	126	266.3	161.5	70	118	93.8
Water temperature (°C)	26	31	28.5	25	31	29.4
pH	6.56	9.16	8.1	6.1	10.1	9.2
Salinity(ppt)	2.16	32.08	13.57	1.29	24.16	11.34
Dissolved oxygen (ml.l^{-1})	1.3	6.98	4.89	1.58	7.38	5.58
Nitrate- nitrogen (µmol. l^{-1})	1.29	5.48	2.25	3.28	6.06	4.54
Nitrate- nitrogen (µmol. l^{-1})	3.09	4.26	3.42	3.98	4.9	4.14
Phosphate-phosphorus (µmol. l^{-1})	0.43	2.16	1.79	2.2	5.58	2.58

Table 1: Water quality characteristics of Kayamkulam lake and Ayirumthengu mangrove area.

Parameter	Station I			Station II		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Temperature (°C)	27	29.2	28.4	28	30.5	28
Organic carbon (%)	0.23	1.66	0.76	1.07	2.64	1.85
Sand (%)	78.5	85.6	82.05	73.4	79.5	76.5
Silt (%)	7.41	11.86	9.63	11	15.88	13.44
Clay (%)	1.84	9.7	5.34	6.27	10.69	10.1

Table 2: Sediment characteristics of Kayamkulam lake and Ayirumthengu mangrove area.

salinity etc. can influence pH in inland saline waters. In the mangrove environment, the range of variation in pH was higher than that in the backwater. Extensive buffering capacity of the saline water allow only little pH changes to be pronounced normally [13], while in enclosed portions biological activity can cause considerable variations.

Salinity is the most important factor exercising a selective influence on the estuarine organisms [10]. Lower salinity is not found to be suitable for the culture of penaeid prawns and other brackish water fishes as it retards their growth and makes them less resistant to parasitic diseases. Though the range of salinity was wide (Table 1) salinity was evidently below 10 ppt during the flood period only. The lake is highly influenced by the influx of freshwater from the Pumpa and Achankoil rivers during the monsoon season and there is high influx of sea water from the Arabian Sea at other periods. Salinity fluctuation in the estuary varied seasonally depending up on the mixing of seawater and riverine fresh water in differing proportions

Dissolved oxygen did not vary much spatially but relatively higher values were observed at both the stations during the summer season. The amount of oxygen dissolved in natural waters is related to the physical, chemical and biological processes of the environment. Biochemical role involving photosynthesis, respiration and other oxidation – reduction processes such as decomposition of organic matter and recycling of minerals influence the rate of consumption and production of oxygen in tropical coastal ecosystems. The high photosynthetic activity leads to peak production of oxygen during February and March. Estuaries of Kerala generally have high concentration of DO and it serves as a major factor in maintaining the health of the estuarine tracts. The oxygen regime of the Kayamkulam Lake varies between 1.3 and 7.38 ml. l^{-1}. The DO values tend to be comparatively high in the mangrove waters and can be related to its local production through photosynthesis of rooted plants and phytoplankton.

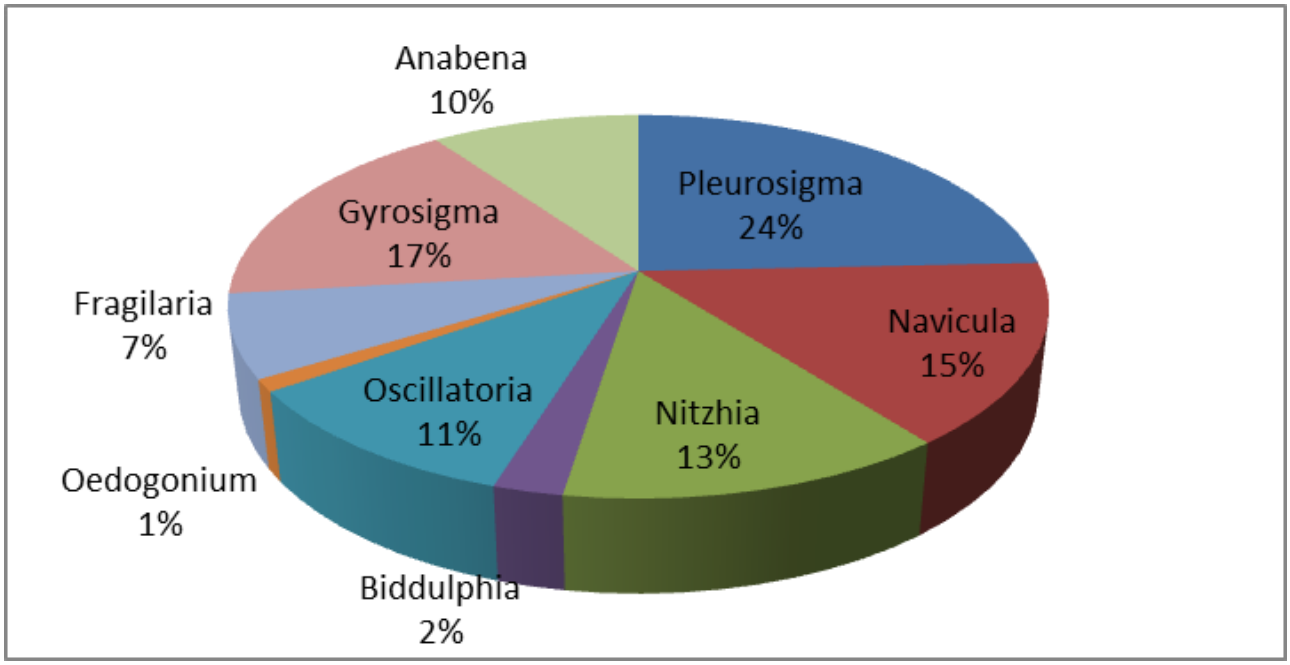
Data on nutrients collected from the Kayamkulam Lake and mangrove environment (Table 1) is encouraging. Estuaries of Kerala derive nutrients from the adjacent coastal waters and from river runoff and land drainage. The nitrate-nitrogen content varied between 1.29 and 5.48 µmol. l^{-1} at station I and between 3.28 and 6.06 µmol. l^{-1} at station II. Under the influence of edaphic factors, particularly during flood times nitrate content may be expected to increase significantly. Higher concentration of nitrates was recorded during November at station I (5.48 µmol. l^{-1}) and during December at station II (6.06 µmol. l^{-1}). The low values of the nutrient during the premonsoon period (Feb-May) could be attributed to its utilization by biological activity [14,15]. Nitrite- nitrogen, being a transitionary stage in the nitrogen cycle, shows fluctuations in its values. Comparatively higher values of nitrite at in the mangrove waters (Table 1) could be attributed to the accumulation of organic matter and its degradation processes [9,14]. The phosphate content of the two stations varied from 0.43 to 5.58 µmol. l^{-1}. In most of the water bodies assimilation by phytoplankton and bacteria leads to reduction in phosphate content. The low values of phosphate during early premonsoon months could be attributed to its utilization by phytoplanktons which were high in density during the period. The higher concentration of all the nutrients in the mangrove waters indicates the substantial nutrient input occurring from the decomposition of organic matter.

Sedimentology

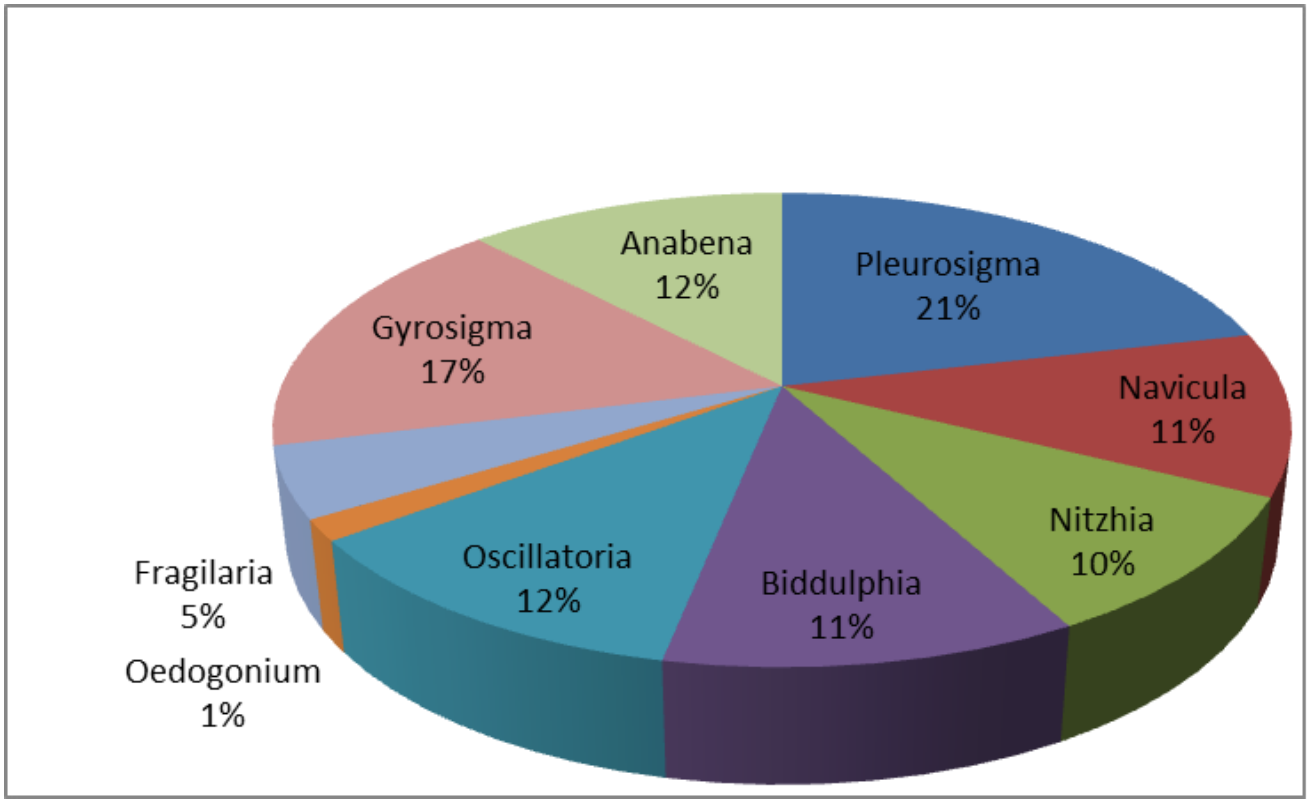
The substratum of the lake as a whole is sandy, but mixed with a considerable proportion of silt and clay. The proportion of silt and clay is higher in the sediments of mangrove area (Table 2) compared to that of lake outside the mangrove. Sediment temperature was found to be uniform with little variation among the two stations, with the mean values 28.4°C for station I and 28°C for station II. Organic matter in estuarine sediments is mainly due to plant and animal matter brought in from land and by deposition from the overlying water [16]. Organic content of estuarine sediments is also related to particle size. Mangroves play an important role in the formation of detritus while the higher proportion of sand in the substratum is not suitable for holding large amount of organic matter. Organic carbon percentages were higher in the mangrove area (mean 1.85%) together with higher proportion of fine particle in the substratum [16].

Plankton

The diatoms constituted the largest component of phytoplankton (Figure 1). The common phytoplanktons in the study area were *Pleurosigma* sp., *Navicula* sp., *Nitzhia* sp., *Biddulphia* sp. *Oscillatoria* sp., *Oedogonium* sp., *Fragilaria* sp., *Gyrosigma* sp. and *Anabena*. Salinity is the prime factor in phytoplankton distribution and abundance [17].

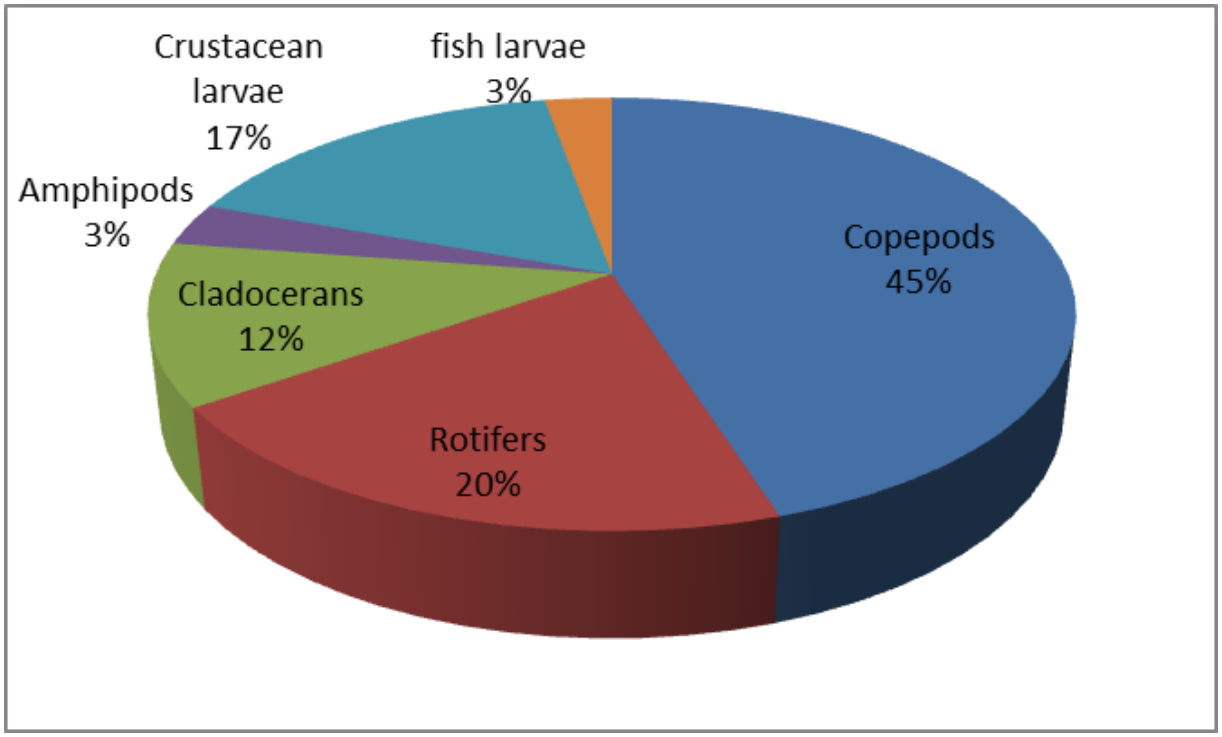


Station I

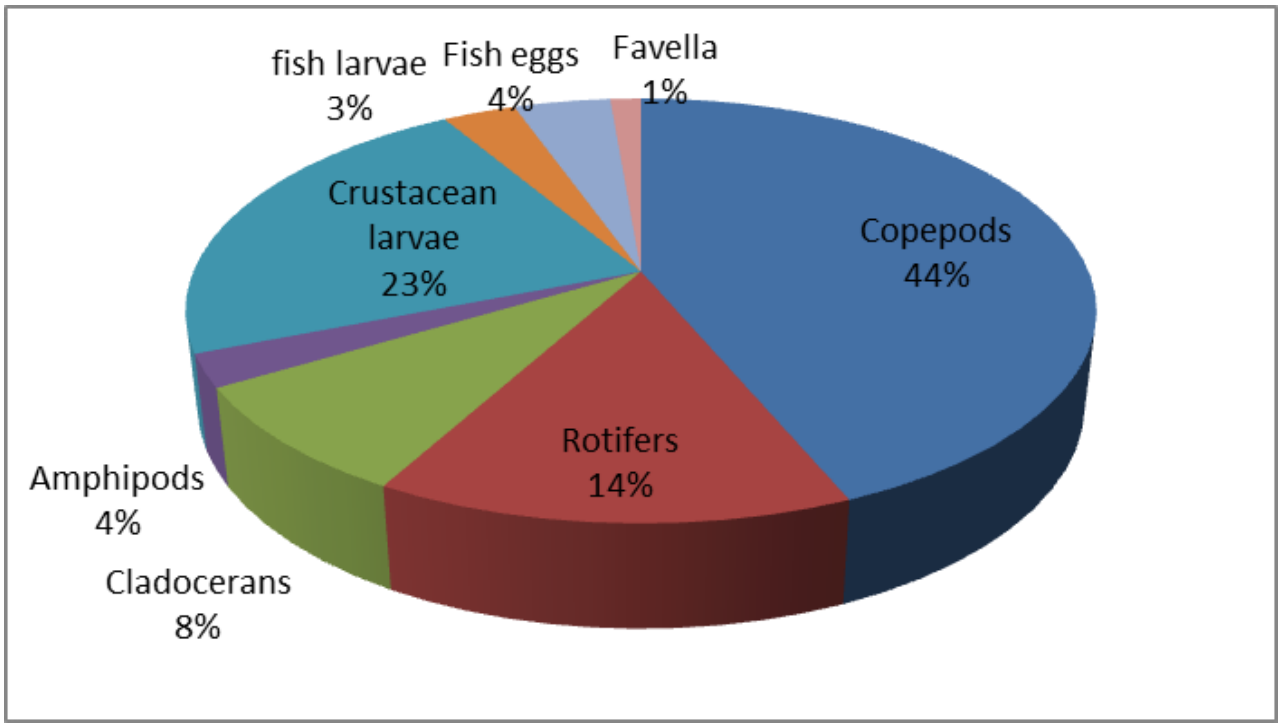


Station II

Figure 1: Distribution of phytoplankton (annual mean) in the Kayamkulam lake.

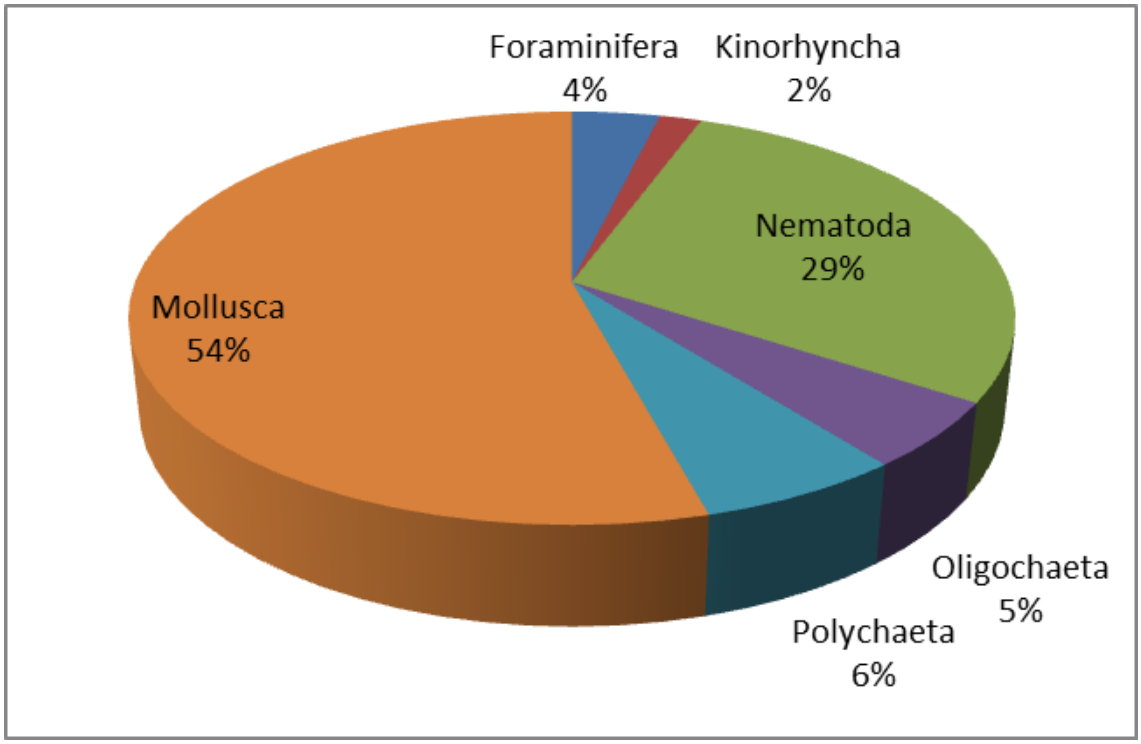


Station I

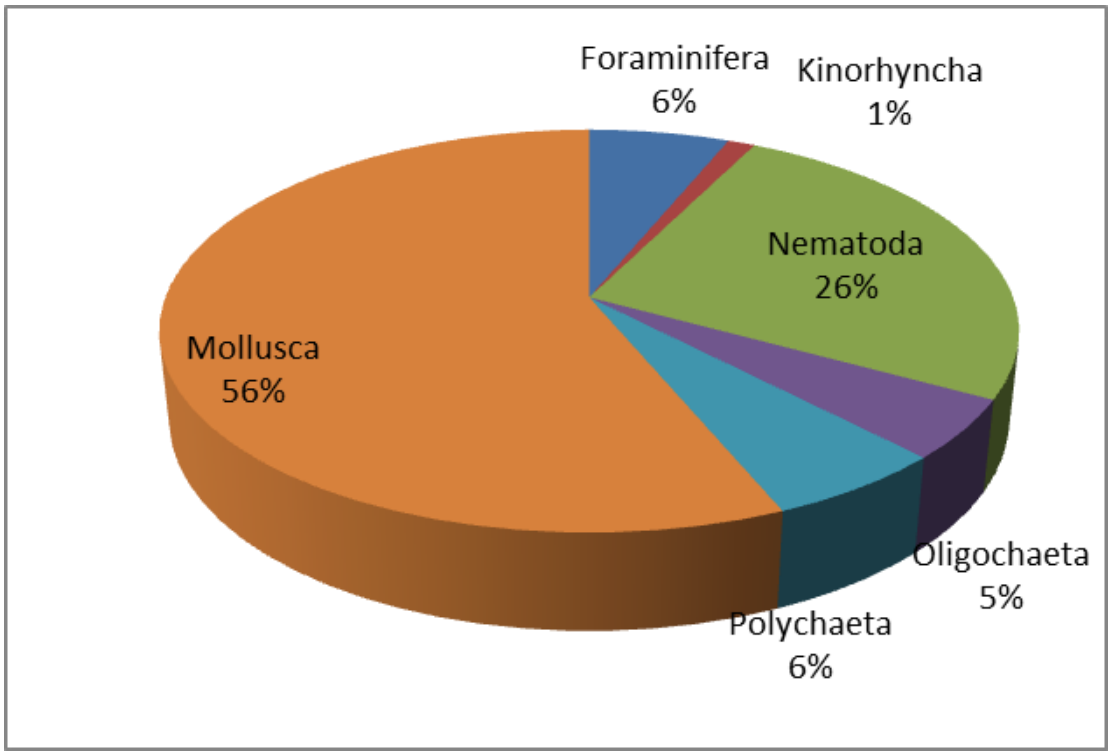


Station II

Figure 2: Distribution of zooplankton (annual mean) in the Kayamkulam lake.



Station I



Station II

Figure 3: Distribution of benthos (annual mean) in the Kayamkulam lake.

Phytoplankton density was at its peak when the salinity was high and rather stable during the premonsoon period. Temperature has been recognized as an important factor that influence the algal growth in coastal waters [18-20], the higher temperature is coincided with maximum density of phytoplankton. Phytoplakton density (mean) was higher at station I (2268 L^{-1}) compared to station II (1888 L^{-1}).

Among the zooplanktons copepod was the predominant item at both the stations contributing about 45.1% at station I and 43.7% at station II. Zooplankton community at station I showed 6 items and station II included 8 forms. Amphipods, cladocerans and rotifers were the other common zooplanktons in the estuary (Figure 2). The occurrence of larval forms of crustaceans in the mangrove area indicates the importance of mangrove swamps as nursery ground for crustaceans like prawns, crabs etc.

Benthos

The benthic fauna is of considerable importance in the coastal food chain due to its role in the recycling of materials and the flow of energy through the food chains. Nematodes, oligochaetes, polychaetes and molluscs were the common benthic fauna noticed in the estuary (Figure 3) and the range of variation in total density of benthos was between 316 at station I during July when the bottom sediment was most unstable and 3778 m^{-2} at station II during March when there was stable bottom conditions in the habitat. Quantitatively molluscs formed the predominant component of benthic fauna in the estuary contributing about 54.2% at station I and 56.3% at station II, the dominance of which can be attributed to the sandy nature of the substratum that favours diggers and burrowers and the low amount of silt and clay which is not favourable for tube dwellers such as polychaetes. Benthic density was maximum during the pre-monsoon period probably due to the stable salinity conditions. Higher amount of finer sediment particles and the high accumulation of organic matter in the mangrove sediments lead to the better abundance of benthic fauna.

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