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Phytoplankton Density in Comparison with Monthly Variation of Hydro biological Parameters in Manakudy Estuary, South West Coast of India

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Abstract

Estuarine water quality and species composition of phytoplankton was studied from July 2011 to June 2012 at four locations in Manakudy estuary .Water temperature, pH, salinity, DO, BOD levels were detected. 57 species of the phytoplankton were identified from all the locations. Diatoms were the most diverse group with 33 species followed by the Green algae (12); the blue green algae (7) and din flagellates (5) species. The percentage distribution of Bacillariophyta (74.23%) in station 2 contributed more, among all the stations. during the study period. The observation from the study revealedi that phytoplankton density is not very good predictors for the changes in water quality in the study area.

Keywords: Manakudy estuary, physico-Chemical parameters, phytoplankton and species composition.

Introduction

Aquatic ecosystems are affected by several health stressors that significantly deplete biodiversity, the loss of biodiversity and its effects are predicted to be greater for aquatic ecosystems than for terrestrial ecosystems[1]. Estuaries are characterized by the gradient of salinity in a semi enclosed coastal system. It plays a fundamentally important role as nursery areas for many aquatic organisms[2]. To assess the potentialities of any aquatic system, the hydrobiological study are very essential. Physico-chemical variables which influence the distribution and abundance of plankton communities in estuaries[3, 4].

Phytoplankton is the important biological part in the energy transfer in food chain which transfers energy to the higher organisms[5,6]. The phytoplankton composition is affected by various environmental factors such as pH, temperature, salinity, turbidity, light and nutrients[7]. The density of phytoplankton often changes and each species appears to have its own peak period in different estuaries[8]. The nutrient loads also play a major role in ecological system of biological communities[9], associated mostly with eutrophication processes[10].

The aim of this paper is to show the species composition and distribution of phytoplankton in relation to physico-chemical parameters.

Material and Methods

Description of study area: Manakudy estuary is located in the southwest coast of Kanyakumari district, Tamilnadu. It is a large estuarine system, has a total area of about 150 ha , extending over 2 km and is located between $8^0$4' N latitude and $77^0$26' E longitude. The water samples were collected from four different points on the estuary every month respectively. It receives wastewater discharges from nearby coir-cottage industry, the agricultural runoff and human activities.

Collection of water sample: Monthly samplings were made between the time interval of 7 am and 9 am from July 2011-June 2012 throughout the year. Water samples were collected in a polythene can (2 litre) from a different depth of three spots in each stations

Physicochemical analysis: The physico - chemical parameters such as rainfall, water temperature, pH, salinity, DO and BOD was analysed. Rainfall data were obtained from Meteorological Department at Chennai. pH was measured by using a digital PH meter. Salinity is measured by salinity refractometer. Water temperature by thermometer. DO were estimated by the Wrinkler's titration method[11]. BOD was estimated by Wrinkler's method[12].

Phytoplankton analysis: Phytoplankton samples of Manakudy estuary were collected in polythene can (2litre) using a net mesh size (No.25). In each station three spots were randomly fixed. The collected phytoplankton samples are brought to a laboratory, then preserved in 4% formaldehyde and identified with suitable literatures[13-17]. The phytoplankton analysed were assigned to major groups viz. diatoms, green algae , blue green algae, and dinoflagellates. The numerical plankton counts were made by Haemocytometer counting with binocular microscope and the results are expressed in cells/ml.

Statistical analysis: All the values were computed, analysed and presented as mean ± standard deviation. The correlation coefficients (r) were calculated for phytoplankton density and physico - chemical parameters by using MS office - Excel, to understand their relationship.

Results and Discussion

The physical and chemical characters of water are considered as the important principles in the identification of the quality and type of the water for any aquatic system[18]. Rainfall is one of the main factors responsible for seasonal variation in hydrobiological parameters[19]. The total annual rainfall of (184.61mm) was recorded in the Manakudyestuary. The maximum rainfall was reported in the month of November (44mm), absence of rainfall occur during February, May (table 1). In the present study, peak values of rainfall were observed in monsoon season and the lower values were recorded during the pre and post monsoon seasons. It was also reported by earlier workers[20]. Statistical analysis of rainfall was negatively correlated with DO in all the study stations (table 3).

The surface water temperature (^{0}C) varied from 23.00-25.57, 22.53-27.63, 23.67-28.73 and 23.00-27.00 in ST-1, ST-2, ST-3 and ST-4 respectively (Table 1). The Maximum water temperature during march was due to high solar radiation and minimum recorded during August up to November was due to the strong land see breeze and precipitation . Rainfall brings the major change in the study station high value during summer could be attributed[21]. The temperature variation is one of the factors in the estuarine system, which may influence the physico-chemical characteristics[22]. The water temperature showed negative correlation with rainfall and positive correlation with PH in all the four stations.

Table-1
Average mean value of physico-chemical parameters during the months July'11 to June '12

Parameters		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Rainfall(mm)		14.87	12.47	4.93	34.65	44	23.93	19.60	0	13.0	7.83	0	9.33
Station 1	**WT**	21.43	21.47	23.00	24.57	24.40	23.43	23.30	26.40	26.00	25.50	25.57	23.53
	PH	7.26	7.14	7.33	7.77	7.17	7.48	7.20	7.16	7.40	7.61	7.52	6.84
	S	24.00	23.67	21.33	25.67	27.67	26.67	12.00	10.00	11.67	15.00	9.00	7.67
	DO	5.43	5.47	4.23	3.53	3.53	3.63	5.90	4.77	5.30	5.50	3.60	5.13
	BOD	4.07	3.23	2.53	1.57	4.70	0.57	0.70	2.13	2.70	1.90	0.63	2.77
Station 2	**WT**	25.00	22.53	26.00	23.00	25.53	23.67	23.63	27.50	27.63	26.63	25.57	24.00
	PH	7.12	7.28	6.93	7.19	7.14	6.50	6.58	7.24	7.42	7.77	6.57	6.84
	S	18.00	15.00	15.00	19.00	20.00	20.67	7.00	6.00	7.00	9.00	6.33	6.00
	DO	5.47	4.47	3.70	3.50	2.67	1.73	1.70	1.87	3.27	3.80	4.70	6.23
	BOD	3.20	2.43	0.57	1.77	5.30	0.57	3.70	2.90	3.53	2.83	2.60	3.67
Station 3	**WT**	24.60	24.33	24.70	25.30	24.53	23.67	23.67	27.67	28.53	28.73	25.70	24.00
	PH	7.62	7.03	6.50	7.63	7.57	6.83	6.83	7.24	7.49	7.46	6.74	7.02
	S	6.67	7.00	8.33	6.00	4.00	5.33	5.00	4.33	5.33	7.00	4.67	4.67
	DO	5.00	4.03	3.50	3.57	4.53	4.57	6.23	5.60	4.93	3.87	3.80	5.17
	BOD	3.57	2.53	1.03	1.47	2.00	1.93	3.73	2.53	2.73	0.73	0.63	2.83
Station 4	**WT**	23.00	24.00	24.30	24.27	23.50	23.00	23.57	26.50	25.53	27.00	25.60	26.57
	PH	7.29	6.96	7.13	7.23	7.21	6.82	7.25	7.70	7.25	7.34	7.03	7.19
	S	0.67	1.33	1.67	1.33	0.33	0.67	1.33	1.33	1.67	1.00	1.33	1.67
	DO	5.43	5.33	3.53	3.33	3.63	5.80	5.77	5.43	5.63	4.80	6.13	4.77
	BOD	1.73	2.47	0.73	0.67	1.60	3.67	0.53	0.63	0.60	2.00	2.73	2.50

WT-Water Temperature (˚C), S-Salinity (ppt), DO-Dissolved Oxygen (mg/l), BOD-Biological Oxygen Demand (mg/l).

The pH ranged between (6.84 -7.77, 6.50-7.77, 6.50-7.63 and 6.82-7.70) in the four study stations Station-1, Station-2, Station-3 and Station-4 respectively (table-1). The maximum value observed in April and minimum in December. The PH of river water entering estuaries is high during dry season and decreases markedly during monsoon[23]. The PH variation in different season depends on different factors such as reduction of salinity, temperature and decomposition of organic matter[24]. It shows positive correlation with water temperature of sampling stations (table-3).

Salinity value varied in station 1(7–27ppt), station 2(6-20ppt), station 3(4-8ppt), and station 4(0-1ppt) (table-1). During November, it was minimum in station 4 and maximum in station 1. It is also observed that in manakudy estuary during this month, marine water influx was high in barmouth. Similar observations were noted in the Mahi estuary[25] and some Nigerian coastal waters[26]. The recorded high values of salinity could be attributed to the low amount of rainfall and higher rate of evaporation[27]. The inflow of freshwater from the land rainwater can change the salinity in the back waters, estuaries, backwaters and mangrove habitats. The salinity recorded a negative correlation with BOD in the four stations (table-3).

Dissolved oxygen (mg/l) content ranged from (3.53-5.47), (1.70-6.23), (3.80-6.23) and (3.33-6.13) in all the four stations ST-1, ST-2, ST-3 and ST-4respectively (table-1). The maximum value was observed in the month of December and minimum value in January. The higher wind velocity joint with heavy rainfall which results with freshwater mixing might be the higher DO value [28]. But the low level of DO recorded can be attributed to low density of aquatic plants and phytoplankton [29] or the sewage discharges gradually affecting the aquatic life[30]. The DO reported to have negative correlation with rainfall of the station (table-3).

The results showed that the BOD (mg/l) varied in st 1, st 2, st 3, st 4 as 0.57±4.07, 0.57±3.67, 0.63-3.57 and 0.60-3.67 (table-1). Maximum value recorded during November and the minimum level was observed in January. were due to The activity of micro-organisms and self purification of surface water system are major reason for the biological Oxygen demand (BOD) in all the stations [31]. The statistical analysis of BOD is positively correlation with DO of the stations (Table 3).

Phytoplankton species composition: A total of 57 taxa were identified from the manakudy estuary (table-2). These include 33 bacillariophyceae, 12 taxa belonging to chlorophyceae, 7 taxa cyanophyceae, 5 taxa dinophyceae (table-2). The percentage occurrence of different phytoplankton groups with respect to total phytoplankton at four stations of mankodi estuary throughout the year has been given in (figure-2). The dominant species recorded at different sampling stations belonged to the genera *Coscinodiscusexentricus, Coscinodiscusconcinniformis, Thalassionemasubtilis, Navicula sp., Lauderiaannulata ,Nitzchialongissima, Pseudo-nitzchiasp, Nitzchiasp, Aulacoseirasp, Scenedesmusquadricauda, Nannochloropsissalina, Chlorella sp, Anabaena sp, Oscillatoriasp, Oscillatorialutea*. The percentage contribution of each group of phytoplankton was in the following order like Diatoms > Green algae> Blue green algae > Dinoflagellates. In manakudy estuary , diatoms were dominant (44) and also constituted 74.3% in station 2 , minor percentage in station 3, Dinophyceae 0.56% (Fig 2). Diatoms were the dominant group in the phytoplankton community in the four sampling stations of Bahía Blanca Estuary[32].

Table-3
Correlation coefficient values of physico-chemical parameters and phytoplankton density at the four stations of Manakudy estuary during July'11-June'12 station 1

	Rain fall	WT	pH	Salinity	DO	BOD	Phyto den
Rainfall	1						
WT	-0.17	1					
pH	0.15	0.34	1				
Salinity	0.69	-0.51	0.28	1			
DO	-0.39	-0.25	-0.40	-0.41	1		
BOD	0.28	-0.31	-0.46	0.35	0.14	1	
Phytoden	-0.01	0.21	0.04	-0.21	-0.55	-0.19	1

Station 2

	Rain fall	WT	pH	Salinity	DO	BOD	Phyto den
Rainfall	1						
WT	-0.41	1					
pH	-0.03	0.42	1				
Salinity	0.70	-0.43	-0.04	1			
DO	-0.30	-0.15	0.12	-0.12	1		
BOD	0.28	0.20	0.24	-0.28	0.10	1	
Phytoden	0.34	-0.46	-0.15	0.29	0.59	0.28	1

Station 3

	Rain fall	W. temp	pH	Salinity	DO	BOD	Phyto den
Rainfall	1						
WT	-0.38	1					
pH	0.46	0.41	1				
Salinity	-0.24	0.02	-0.16	1			
DO	-0.03	-0.10	0.05	-0.55	1		
BOD	0.13	-0.31	0.19	-0.25	0.83	1	
Phytoden	0.55	-0.46	0.08	-0.17	-0.33	-0.21	1

Station 4

	Rain fall	WT	pH	Salinity	DO	BOD	Phyto den
Rainfall	1						
WT	-0.60	1					
pH	-0.22	0.49	1				
Salinity	-0.59	0.51	0.12	1			
DO	-0.49	0.08	-0.10	0.04	1		
BOD	-0.04	-0.08	-0.68	-0.36	0.36	1	
Phytoden	-0.18	0.39	0.08	0.11	0.11	0.17	1

Table-2
List of phytoplankton species distribution recorded at Manakudy estuary during July 2011- June 2012 in the four stations

S. No	Taxonomic species	S-1	S-2	S-3	S-4
	Bacillariophyta (Diatoms)				
1	Coscinodiscusexcentricus* Ehrenberg	9	12	5	3
2.	Coscinodiscusconcinniformis*Simonsen	6	3	2	1
3	CyclotellamaneghinianaKutzing	1	1	0	0
4.	ThalassionemanitzschioidesGrunow and Hustedt	4	5	2	1
5.	Grammatophoraundulata	4	3	2	1
6.	Baxillariapaxillifer (O.F.Muller) Hendey	4	4	3	3
7	Chaetocerosaffinis Lauder	7	3	8	2
8.	Aulacoseirasp*Simonnsen	9	5	3	3
9.	Stephanodiscussp	3	2	2	10
10.	Synedrasp	7	6	6	7
11.	Nitzchiabicapitata*Cleve	2	2	5	1
12.	Naviculadistans*(W.Smith) Ralfs	3	2	1	1
13.	Navicularostellum*W.Smith	7	2	3	3
14.	Membraneis challenger Grunow	9	1	1	2
15.	Cymbellagracilis	7	1	5	3
16.	Cylindrothecaclosterium (Ehrenberg) Reimann and Lewin	3	0	2	2
17.	Thalassionemasubtilis*	4	22	3	9
18.	Fragillariasp	4	2	3	3
19.	Gyrosigmabalticum (Grunow) Cleve	1	1	2	4
20.	Guinardiasp	3	0	2	3
21.	Skeletonemacostatum (Greville) P.T.Cleve	1	2	2	2
22.	Rhaphoneisamphicerous (Ehrenberg)Ehrenberg	13	1	2	0
23	RhizosoleniacrassaSchimper in Karten	5	1	5	1
24.	Striatelladelicatula	5	0	9	0
25.	Lauderiaannulata* P.T.Cleve	0	17	5	8
26.	Nitzchialongissima*(Brebisson) Ralfs	1	5	2	8
27	Pseudo-nitzchiasubcurvata*(Hasle)G.Fryxell	5	3	5	2
28	Pseudo-nitzchiaturgidula (Hustedt) Hasle	3	0	5	2
29	Pseudo-nitzchiagraniivargraniiHasle	3	4	2	1
30	RhizosoleniafragillissimaBergon	4	0	1	0
31	Surirellasp	3	1	2	0
32	Asterionella japonica Cleve	3	4	1	1
33	Pleurosigmaangulatum (Quekett) W.Smith	3	2	1	1
	Chlorophyta (Green algae)				
34	Cosmariumsp	1	1	1	1
35	Closteriumsp	0	2	3	2
36	Dunaliellasalina	0	0	1	4
37	Chlorella marina	5	1	4	1
38	Chlorella vulgaris Beijerinck	3	1	5	2
39	Chlorella salina*	6	2	3	1
40	Pediastrumsp*	7	4	9	8
41	Spirogyra sp*	4	1	3	5
42	Scenedesmusdimorphis	1	0	6	8
43	Scenedesmusquadricauda*(Turp.)Breb.Var.WestiiG.M.Smith	2	1	7	4
44	Nannochloropsissalina*	5	1	6	2
45	Chlorococcumhumicola(Naegeli) Rabenhorst	1	1	3	2

Dinophyta (Dinoflagellate)					
46	Alexandriumsp	4	3	0	1
47	Akashiwosanguinea (Hiraska) G.Hansen	2	1	0	1
48	Prorocentrummicans Ehrenberg	3	1	1	4
49	Ceratinumfusus (Ehrenberg)Dujardin	2	0	0	1
50	Ceratinumlineatum (Ehrenberg) Cleve	2	0	0	0
Cyanophyta (Blue green algae)					
51	Anabaena nodularia	3	6	2	2
52	Anabaena sp*	7	2	5	7
53	Gleocapsasp	2	3	4	1
54	Nostocsp*	4	3	5	3
55	MicrocystisaeruginosaKutzing	0	0	0	3
56	Oscillatoriasp*	4	3	7	10
57	Oscillatorialutea* Agardh	4	2	3	6
	Total number of individual species	**218**	**156**	**180**	**167**

*Dominated taxa throughout study stations

In the present investigation of manakudy estuary, diatoms were found to be dominant throughout the study period. Diatoms are cosmopolitically distributed and are considered to be of the opportunistic algal group in the sense that they are quite sensitive to minor change in environment [33]. Most diatoms were capable of surviving in the estuarine environment irrespective of the variable salinity[34] During the study period, it is observed that the chlorophyceae was dominant in the month of February (post-monsoon) in station 4. The chlorophyta were less tolerant of salinity and then restricted to the freshwater zone of the estuary[35].

The phytoplankton density (cells/l) in the manakudy estuary recorded higher level during June (35×10^5) in station-1, low level (2×10^5) recorded in April in station 2 (figure-1). Similar observations were earlier reported[36]. Phytoplankton and their growth depend on several environmental factors, which are variable in different seasons and regions[37].

Pollution causing species in Manakudy estuary were *Alexandriumsp, Microcystisaeruginosa, Oscillatorialutea*were observed. Plankton communities in the estuary can be served as an indicator for the change in ecosystems under the pollution stress. The statistical analysis of correlation coefficients in the present study revealed that phytoplankton shows positive and negative correlation with the physico-chemical parameters. In the station 1 (r= -0.01) recorded low value of negative correlation among phytoplankton with rainfall (table-3).

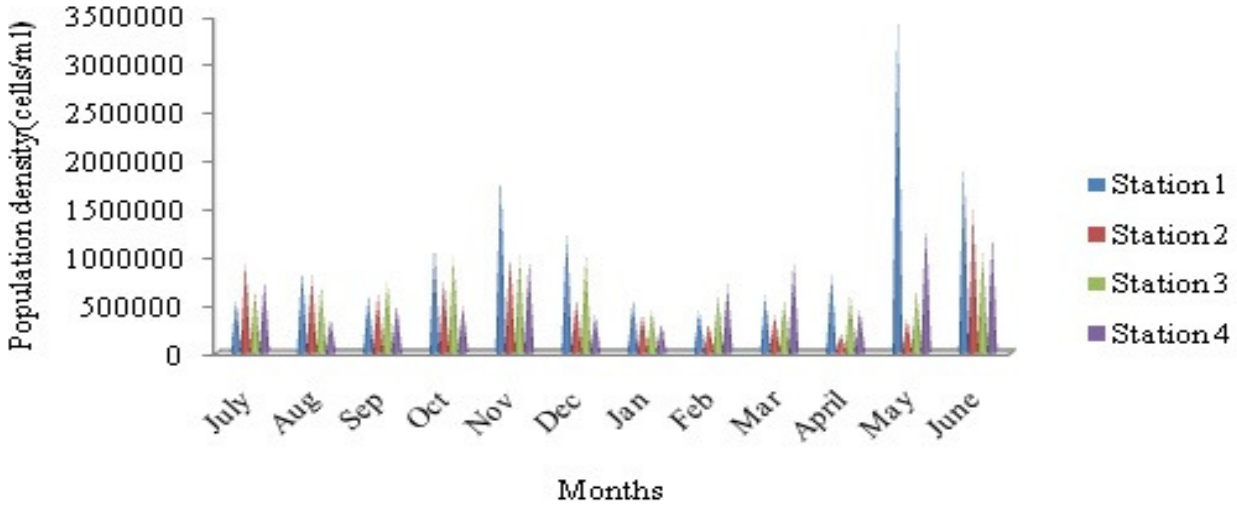

Figure-1
Population density (cells/ml) in the sampling stations of Manakudy estuary during July'11-June'12

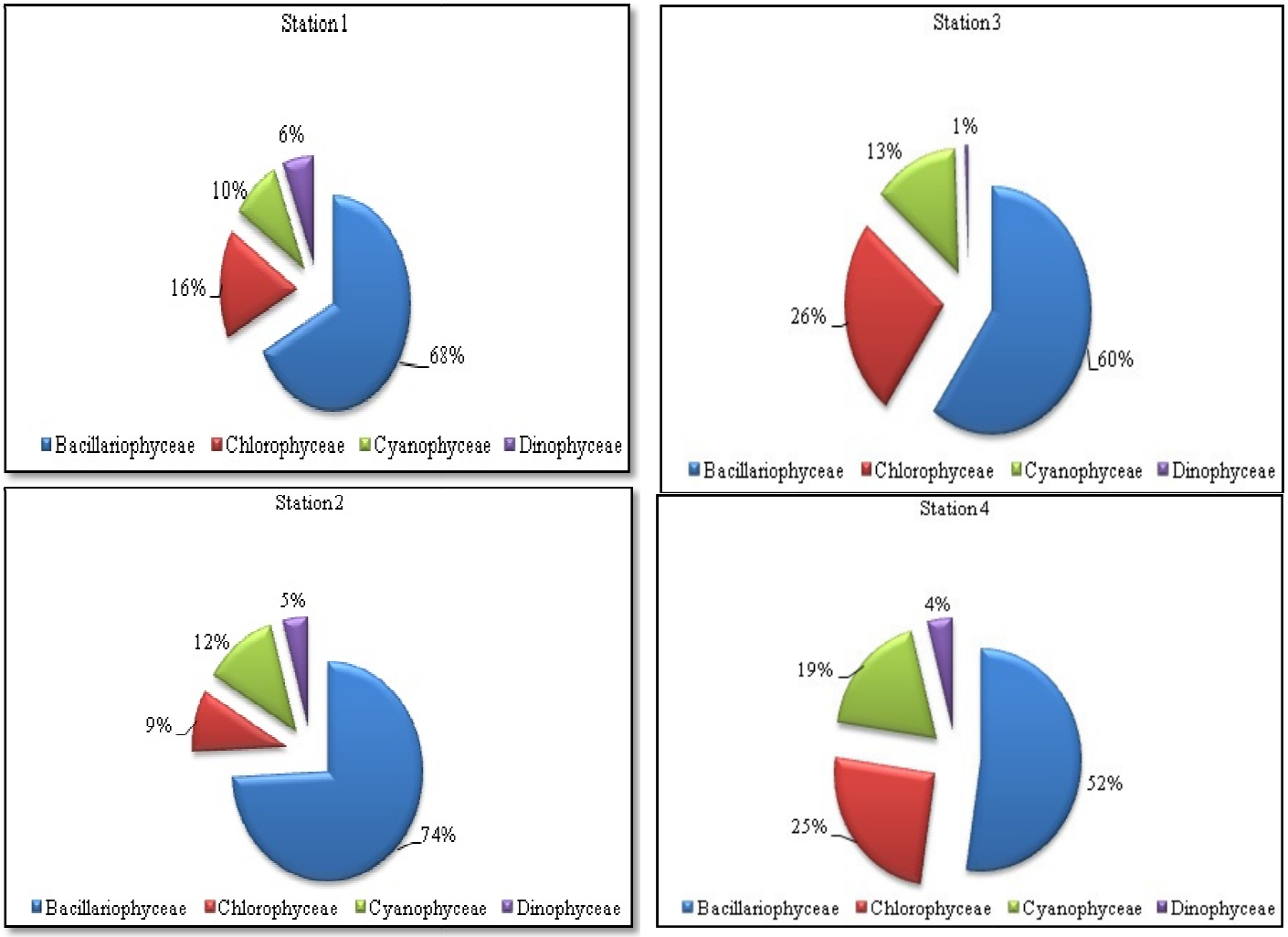

Figure2-

Percentage distribution of phytoplankton in the study sites of Manakudy estuary from July'11 to June'12

Conclusion

The present study of the manakudy estuary indicates that the salinity level is the main factor responsible for variation in the hydrobiology. In this estuarine ecosystem, the main cause of the adjoin and separation of sandbars in bar mouth is the major reason for the hydrobiologicalchanges. Diatoms were dominated throughout the study period. Rainfall, which have a direct effect on the density and distribution of phytoplankton species. Tidal action, affected the diversity indices too low level through the interchange of estuarine and marine communities and the favouring of distinct species in different sectors of the estuary. In the sampling stations, 15 species were present in all the months. It is evident that the Manakudy estuary has been polluted by domestic sewages, disposal of coconut husk retting factory and agricultural runoff.

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