Planktonic Variations in Lotic Waters of River Saryu and Ganga at Saran District, Bihar, India

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Abstract

Plankton community is a heterogeneous group of plants and animals mainly comprising of Phytoplankton and Zooplankton respectively. Phytoplankton of river Saryu and Ganga was represented by three major groups Diatoms, Green Algae and Blue Green Algae of class Bacillariophyceae, Chlorophyceae and Cyanophyceae respectively. The total phytoplankton density showed a bimodal pattern of fluctuation in both the rivers. The first maxima of higher magnitude was observed during the January month of the winter season (6385 u/l) followed by second peak of lesser magnitude in the summer month of May in Saryu river (5582 u/l). In Ganga river first maxima of phytoplankton density was recorded in January (7060 u/l) followed by April (6525 u/l). Bacillariophyceae was the dominant group in both the rivers and throughout the study period. All the peaks of total phytoplankton density were dominated by diatoms. Zooplankton of both the rivers was chiefly represented by the four major groups viz. Protozoa, Rotifera, Cladocera, and Copepoda. Zooplankton density exhibited bimodal maxima during the study period at both the rivers. First peak of higher value 65 u/l was recorded in the month of January followed by a second peak of lesser magnitude in the month of April 50 u/l. Similarly in Ganga first peak of 71 u/l was recorded in January and second peak of lesser magnitude 59 u/l was recorded in March.

KEYWORDS: Phytoplankton, Zooplankton, Bacillariophyceae, Chlorophycae, Cyanophyceae, Protozoa, Rotifera, Cladocera, Copepoda.

I. Introduction

The biological spectrum of river Ganga is multi dimensional and it is much richer than other lotic ecosystem in the country (Bilgrami and Mushi, 1985).[1] Plankton community is represented primarily by Phytoplankton and Zooplankton.[2,3] Phytoplankton are chiefly represented by algae such as green algae, blue green algae and diatoms.[4] Algae are the main primary producers and form the base of food chain in aquatic ecosystem. They are ubiquitous in flowing waters. Their distribution and periodicity largely depends upon environmental conditions.[5,6] The algae of Indian rivers have been studied by Roy and David (1966), Vass *et.al.*, (1977), Mishra and Yadav (1978), Siddiqui, (1980), Laal *et. al.* (1983), Singh *et. al.*, 1983, Bilgrami &Munshi, 1985, Srivastava and khare, 2009; Vasanthkumar and Vijaykumar, 2011; Agrahari and Kushwaha, 2012; Mishra and Khan, 2013; Negi and Rajput, 2013 etc.

Zooplankton are the integral part of the lotic community and contribute significantly to the biological productivity of the freshwater ecosystem (Makarewicz and Likens,1979). Zooplankton act as the primary consumer as well as secondary producer in the aquatic food chain.(7,8) The zooplankton of river Ganga is represented by the protozoans, rotifers, copepods and cladocerans (Bilgrami and Munshi,1985); Bhowmick (1968) and Verma (1981) have recorded seasonal variation and bimodal peak of zooplankton production. Numerical superiority of rotifers over the other groups of zooplankton have been reported in several freshwater ecosystem of our country (George, 1966, Arora, 1966, Vashisth and Sharma, 1975)

Investigations of freshwater plankton community structure have significant potential for assessing the health of aquatic ecosystem. Their dominance and seasonality are highly variable in different water bodies according to nutrient status, age, morphometry and other locational and environmental factors. Therefore changes in aquatic environment accompanying anthropogenic pollution are a cause of growing concern and require monitoring of surface waters and organisms inhabiting them (9,10). So the present study was carried out to understand the diversity and seasonal variation of planktons in Saryu and Ganga river in Saran district.

II. Materials & Methods

A. Study Site:

Physico-chemical analysis of lotic water of river Saryu (Site A) and Ganga (Site B) at Saran, Bihar, India was done for a period of 12 months from January to December 2010 including winter, summer and rainy seasons. Four sampling stations were selected and established, two each in river Saryu and Ganga respectively. For study, stretch of river Saryu and Ganga were undertaken which were quite virgin as well as almost unaffected by urbanization and anthropogenic activities to see the seasonal variation in the plankton.

B. Sampling and Analysis

Plankton: The plankton were collected with the help of a plankton net made up of bolting silk (no 25) by the hauling method. The plankton from the shallower zone were collected by filtering water through plankton net with the help of a 1 liter capacity beaker as in these areas it was difficult to apply healing method. The volume of water filtered was calculated.

i. **Preservation:** The above collected sample was preserved in 5% formalin.
ii. **Qualitative Analysis**: The Qualitative Analysis of Plankton were done under a compound microscope with the help of available monograph and literature (Desi kachary, 1951,; Ward and Whipple, 1959; Needham and Needham, 1966; Smith, 1924; Torapi, 1980; Sehgal, 1983; Adoni *et. Al.* ,1985 and APHA, 1995)
iii. **Quantitative Analysis: -** Lackey Drop micro transects method subsequently modified by Edmonson, 1974 was used to enumerate plankton density quantitatively. This method involves the plankton

enumeration in one drop of the concentrated sample taken on a slide. The concentrated sample was shaken thoroughly and a drop of it was put quickly on a clear slide with the help of a dropper holding it vertically. The whole drop was covered carefully under the cover slip. The slide was kept under the microscope and one edge of the cover slip was focused. The phytoplankton and zooplankton were counted while moving the slide with the help of a movable stage to other edge. The slide was shifted to the next field and the above process was repeated on the path parallel to the earlier one in the reverse direction. Number of transects were counted. Five drops of concentrated sample was examined to get average plankton density.

Calculation :-

Organism / drop = [Area of cover slip/Area of transect] x Individual count recorded/ transect.

Where Area of cover slip $= \pi r^2$ (for round cover slip)

Area of transect was measured with the help of stage and ocular micrometer.

Total organism/ml = total no. of organism/ drop x No. of drops/ml.

Plankton Density (org/litre) = (a x v)/L

Where a= no. of organisms, v= vol. of concentrate, L= water filtered in litre.

III. Results and Discussion

Phytoplankton:

BACILLARIOPHYCEAE: - It was the dominant group of phytoplankton. Its density ranged between 845 & 5250 u/l in Sarayu river and between 1193 & 5750 u/l in Ganga river. Its abundance was 59.91 % to 84.33 % of the total phytoplankton density in Sarayu river and 60.8% to 91.22 % of the total phytoplankton density in Ganga river. Community structure of phytoplankton of both the rivers was mainly represented by *Synedra* sp., *Nitzschia* sp., *Melosiro* sp., *Fragilaria* sp., etc. The dominant and abundant diatoms were *Nitzschia* sp., *Synedra* sp., *Melosira* sp., in both the rivers. Diatom density was maximum during winters followed by summer and monsoon seasons during the study period.

CHLOROPHYCEAE:

It was the second dominant group of phytoplankton. Its density ranged between 121-1743 u/l and constituted 9.77 to 37.14 % of the total phytoplankton in the Sarayu river. Dominance of green algae was also recorded next to diatoms river Ganga where density ranged from nil to 1840 u/l and constituted 33,24 % of the total phytoplankton. Green algae were mainly represented by *Scenedesmus* sp., *Pediastrum* sp., *Coelestrum* sp., *Oedegonium* sp., *Spirogyra* sp., *Cosmasium* sp., in both the rivers.

CYANOPHYCEAE:

Cyanophyceae were poorly recorded in both the rivers. Its density was recorded between 60 u/l and 175 u/l. It constituted 1.64 to 6.91 % of the total phytoplankton in river Saryu. More or less similar condition was found in river Ganga were density ranged from 115 u/l to 415 u/l and comprised of 1.64 % to 17.06 % of total phytoplankton. In both the rivers abundant forms were *Nostoc* sp., *Aabaina* sp., *Oscillatoria* sp., and *Phormidium* sp.

The seasonal variation and density of phytoplankton of both the rivers are shown in Table 1 & 2 and Figure A & B.

Zooplankton:

Zooplankton of both the rivers was chiefly represented by the four major groups viz. Protozoa, Rotifera, Cladocera, and Copepoda. Zooplankton density exhibited bimodal maxima during the study period at both the rivers. First peak of higher value 65 u/l was recorded in the month of January followed by a second peak of lesser magnitude 50 u/l in the month of April. Similarly in Ganga, first peak of 71 u/l was recorded in January and second peak of lesser magnitude 59 u/l was recorded in March. The first peak was due to the rotifer abundance while other due to copepod abundance in both the rivers. The zooplankton density was maximum during winter (20 u/l to 65 u/l) while minimum during monsoon (06 u/l to 15 u/l). Almost same trend was recorded in Ganga where during winter maximum (25-71 u/l) density was recorded and minimum (09-17 u/l) density was recorded during monsoon season.

PROTOZOA:

Rhizopodans among protozoans were only recorded in both the rivers. The genus recorded were *Arcella vulgaris* and *Centropyxis aculeate*. Not a single representative could be detected during rainy seasons. They were recorded during winter and summer only. Protozoan community structure was poorly represented among zooplankton. Its density was between nil to 3 u/l and from nil to 4.61 % of the total zooplankton population and maximum density was 3 u/l was recorded in January month when it constituted 4.61 % of the total zooplankton population in Saryu river. Its density was only 21 u/l and formed 2.82 % of the total zooplankton population in January while in the month of May its density was 4 u/l and formed 12.12 % of the total zooplankton population.

ROTIFERA:

Rotifers form the main fraction of the zooplankton. They were represented by the maximum number of species and genera. Rotifers, the wheel animalculae were from the Brachionidae, Asplanchnidae, Synchaetidae and Testudinellidae. The *Brachionus, calyciflorus, Brachiorius falcatus, Brachiorus quadridentata, Brachiorus caudatus, Brachionus angularis, Brachiorus plicatlis, Keratalla tropica, Keratella serrulata, Keratella Cochlearis*. Asplanchridae, synchaitidae and Testudiinellidae were represented by single members each viz., *Asplanchna priodonta* , *Polyarthra vulgaries* and *Filinia longiseta* respectively.

Rotifer population ranged between nil to 84.62 % of the total zooplankton population whose density was in the range of nil to 55 u/l. Its density was in maximum range 8 to 55 u/l during winter followed by summer 16-28 u/l while in monsoon it was nil in Saryu. A similar trend was recorded in Ganga. Abundance was recorded between 10 to 85. 71 %. Density 2-60 u/l was recorded, maximum 16-60 u/l was recorded in winter followed by summer 12-40 u/l and in monsoon 0-9 u/l was recorded in river Ganga.

CLADOCERA:

Bosmina longirostris, Diaphanosoma excisum and Moina sp., dominated the cladoceran fauna. Its density varied between 2-10 u/l and comprised 7.14 – 77.77 % of total zooplankton population of Saryu river. Density was maximum in the month of May (10 u/l). Almost similar trend was observed in Ganga. Density varied between 2 and 10 u/l and comprised of 3.39% to 77.77 % of the zooplankton population of river Ganga . Its density was maximum in may that was 10u/l.

COPEPODA:

This was the second dominant group after rotifer. They were represented by *Mesocyclops leuckarti,Mesocyclops hyalinus, Diaptomus, Phyllodiaptomus annae, Cyclops* sp, *Nauplius larva* etc. Density ranged between 3 u/l to 13 u/l and 2 to 36 u/l in Saryu and Ganga respectively while they constituted 6.15 % to 66.66% and 2.82 % to 61.02 % of the total zooplankton in both the rivers respectively.

The seasonal variation and density of zooplanktons of both the rivers are shown in Table 3 & 4 and Figure C & D.

Discussions

Phytoplankton: Phytoplankton showed a bimodal peak of production in both the rivers studied. The first peak in winter and another of lesser magnitude in summer were observed. High density of phytoplankton has been recorded by several workers during summer (Staker, 1976; Rai, 1978; Bhowmick & Singh, 1985; Khan et. al., 1998; Shrivastava and Khare, 2009) bimodal pattern of phytoplankton production has also been reported in winter and other in monsoon season (Mathew, 1969; Verma, 1981). The monsoon month invariably constituted the minima for the density and abundance of phytoplankton. The onset of rains and the monsoon storms added the mud, sand and other suspended particulars in the river water. This caused a sudden fall in the transparency value and rise in turbidity value. The fast current during the monsoon causes rapid erosion of the sandy river banks which further contributed to the lowering of transparency values. The suspended particles interfered with the photosynthetic activities of the phytoplankton and had a detrimental effect on the growth and density of phytoplankton. In addition to restricting penetration of light, high turbidity along with fast current also causes destruction of planktons. The winter season constituted the recovery period for the phytoplankton community after the catastrophic events that had taken place during the rainy season. During winter months the river water gradually got cleaned which led to the resumption of proper photosynthetic activities of the primary

producer, phytoplankton. So the secondary peak for the density and abundance of phytoplankton was observed during the winter season.

Diatoms were abundant throughout the study period. The winter months were marked with high diatom densities. It has been observed that low temperature is related to high diatoms number and vice versa (Roy, 1955; Venkateswaralu, 1969; Shrivastava & Khare, 2009). Similar results were observed during the present study as diatoms maxima were found to have correlation with temperature minima (Potter et. al. 1975). Temperature range of 18-26° C has been found as the preference temperature for the diatoms growth. Blue green algae were abundant during March to August in the temperature of 27-30 ^{o} C. Munawar 1974 recorded temperature range of 28-30 ^{o} C to be most suitable for Cyanophyceae growth. Green algae form the bulk of phytoplankton community during the summer season. Higher values of temperature, pH and low oxidizable organic matter are known to be favorable for the growth of Chlorohyceae (Genzalvez & Joshi, 1943; Dwivedi, et. al., 2005). It has been observed that temperature between 28°C and 35°C was most favorable for the development of *Scenedesmus* and *Pediastrum.* (Govindan and Sundereson, 1979).

ZOOPLANKTON:

The peak of zooplankton produced in January matched with the phytoplankton abundance of that time but the secondary peak of phytoplankton of April followed the zooplankton secondary peak of March. Wright (1965) has emphasized that the abundance of zooplankton is chiefly dependent upon the abundance of the primary producer, the phytoplankton.

There are controversies with regard to the influence of temperature on rotifer growth in freshwater ecosystem, which is quite different in case of individual species and also among the population of the same species (Hoffman, 1977). Low temperature favoring rotifer growth has been reported by Nayar, 1977; Radwan, 1980 while some researchers are not in agreement with the positive influence of temperature on rotifer abundance (Arora, 1966; Vashist and Sharma, 1977). The favourable temperature range of rotifer abundance seems to be 18-30 ^{o} C. Copepod population showed an irregular fluctuation trend. Most of the workers have reported bimodal distribution of Copepod (Singh and Sahai, 1978; Sharma and Saxena, 1983). Chaurasia (1985) disagrees with the permanent feature of bimodal distribution of copepod. Cladoceran population was comparatively poorer than two rotifer population. The cladoceran showed an irregular trend of fluctuation but maximum density was recorded in summer months. Density of Cladoceran is primarily determined by food supply (Wright, 1965) as Chlorophyceae was dominant during that period which also indicates food consumer relationship.

IV. Conclusions

Phytoplanktons of river Saryu were represented by three major groups viz: Diatoms, Green Algae and Blue Green Algae of class Bacillariophyceae, Chlorophyceae and Cyanophyceae respectively. Similar was the case of phytoplankton community structure of river Ganga. All the peaks of total phytoplankton density were dominated by diatoms. Zooplanktons of both the rivers were chiefly represented by the four major groups viz.

Protozoa, Rotifera, Cladocera and Copepoda. Zooplankton density exhibited bimodal maxima during the study period at both the rivers. First peak was recorded in the month of January followed by a second peak of lesser magnitude in the month of April. Similarly in Ganga first peak was recorded in January and second peak of lesser magnitude was observed in March. Present freshwater plankton community structure has significant potential for assessing the health of any aquatic ecosystem.

V. Acknowledgements:
The Authors are thankful to JP University, Chapra for providing technical support. The Authors are also thankful to local community in supporting the research work.

TABLE: 1 - Standing Stock (u/l) and Percentage Composition (%) of Phytoplankton Community of River Sarayu. (Jan- Dec, 2010)

	Total Phytoplankton	**Bacillariophyceae**		**Chlorophyceae**		**Myxophyceae**	
Month	**Density (u/l)**	**Density (u/l)**	**Percentage(%)**	**Density (u/l)**	**Percentage(%)**	**Density (u/l)**	**Percentage(%)**
January	6385	5250	82.22	1030	16.13	105	1.64
Februry	3140	2084	67.37	940	29.94	115	3.66
March	4240	2540	59.91	1575	37.14	125	2.95
April	5035	3142	62.40	1743	31.28	150	2.98
May	5582	3850	68.97	1557	27.89	175	3.14
June	3840	2640	68.75	1040	27.08	160	4.17
July	1235	1032	83.36	121	9.77	85	6.8
August	1140	935	82.02	145	12.72	60	5.26
September	1085	845	77.88	165	15.21	75	6.91
October	1320	990	75	240	18.18	90	6.82
November	2840	2395	84.33	350	12.32	95	3.35
December	3785	3165	83.62	520	13.74	100	2.64

TABLE:2 - Standing Stock (u/l) and Percentage Composition (%) of Phytoplankton Community of River Ganga. (Jan- Dec, 2010)

	Total Phytoplankton	**Bacillariophyceae**		**Chlorophyceae**		**Myxophyceae**	
Month	**Density (u/l)**	**Density (u/l)**	**Percentage(%)**	**Density (u/l)**	**Percentage(%)**	**Density (u/l)**	**Percentage(%)**
January	7060	5750	81.44	1194	16.91	116	1.64
February	4460	3190	71.52	1145	25.67	125	2.80
March	5535	3365	60.79	1840	33.24	330	5.96
April	6525	4362	66.85	1837	28.15	326	4.99
May	5845	4087	69.80	1343	22.97	415	7.10

June	4200	3048	72.57	827	19.69	325	7.73
July	1590	1197	75.28	163	10.25	230	14.46
August	1535	1283	83.52	-	-	262	17.06
September	1305	1193	91.42	-	-	113	8.65
October	1720	1376	80	228	13.25	115	6.68
November	3340	2828	84.07	318	9.52	154	5.80
December	4230	3438	81.28	532	12.57	260	6.14

TABLE: 3 - Standing Stock (u/l) and Percentage Composition (%) of Zooplankton Community of River Saryu. (Jan- Dec, 2010)

	Total Zooplankton	**PROTOZOA**		**ROTIFERA**		**COPEPODA**		**CLADOCERA**	
Month	**Density (u/l)**	**Density (u/l)**	**Percentage(%)**	**Density (u/l)**	**Percentage (%)**	**Density (u/l)**	**Percentage(%)**	**Density (u/l)**	**Percentage(%)**
January	65	3	4.61	55	84.62	4	6.15	3	4.61
Februry	25	-	-	12	48	8	32	5	20
March	45	2	4.44	24	53.33	6	13.33	13	28.88
April	35	-	-	16	45.71	9	25.71	10	28.57
May	50	2	4	28	56	13	26	7	14
June	43	-	-	24	55.81	12	27.9	7	16.28
July	6	-	-	-	-	4	66.66	2	33.33
August	8	-	-	2	25	3	37.5	3	37.5
September	10	-	-	3	30	4	40	3	30
October	15	-	-	4	26.66	6	40	5	33.33
November	20	-	-	8	40	6	30	6	30
December	30	-	-	20	66.66	4	13.33	6	20

TABLE: 4 - Standing Stock (u/l) and Percentage Composition (%) of Zooplankton Community of River Ganga. (Jan- Dec, 2010)

	Total Zooplankton	**PROTOZOA**		**ROTIFERA**		**COPEPODA**		**CLADOCERA**	
Month	**Density (u/l)**	**Density (u/l)**	**Percentage (%)**	**Density (u/l)**	**Percentage (%)**	**Density (u/l)**	**Percentage(%)**	**Density (u/l)**	**Percentage(%)**
January	71	2	2.82	60	84.5	2	2.82	7	9.86
February	32	-	-	16	50	9	28.12	7	28.88

March	59	-	-	21	35.59	36	61.02	2	3.34
April	45	-	-	20	44.44	18	40	7	15.56
May	33	4	12.12	12	36.36	7	21.21	10	30.3
June	30	-	-	12	40	13	43.33	5	16.66
July	9	-	-	-	-	2	22.22	7	77.77
August	14	-	-	2	14.29	5	35.71	7	50
September	15	-	-	2	13.33	9	60	4	26.66
October	17	-	-	2	11.76	13	76.47	2	11.76
November	25	-	-	12	48	11	44	2	8
December	28	-	-	24	85.71	2	7.14	2	7.14

Figure 1: Seasonal Variations in Phytoplankton Density (u/l) at Site A during Jan-Dec 2010.

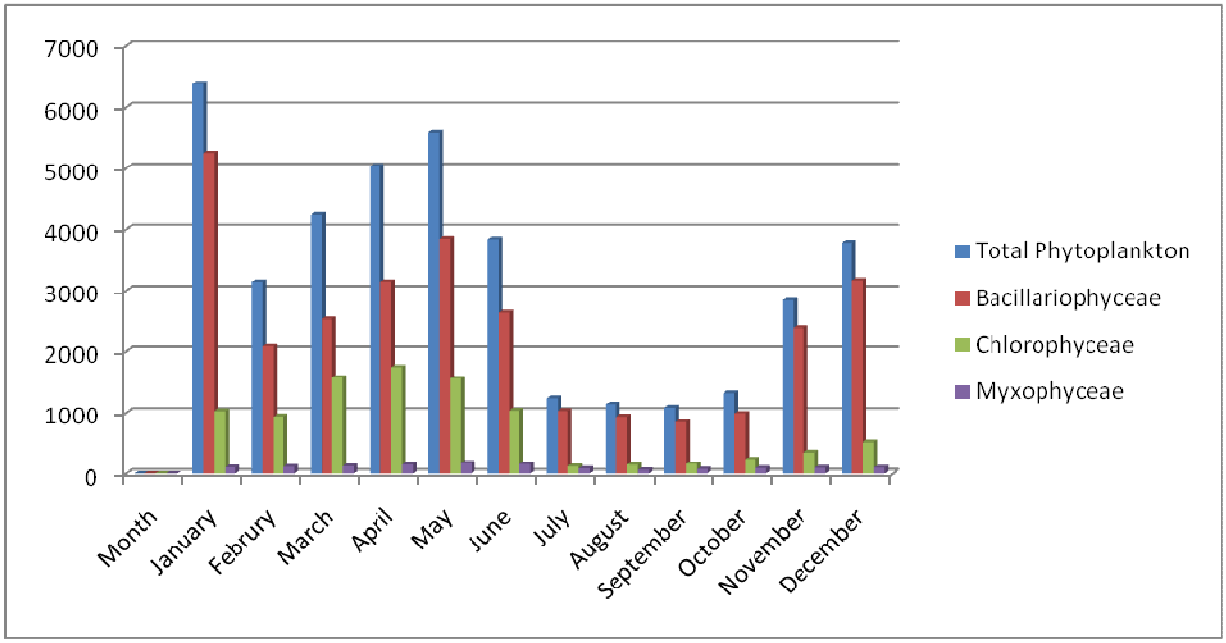


Fig: 2: Seasonal Variations in Phytoplankton Density (u/l) at Site B during Jan- Dec 2010.

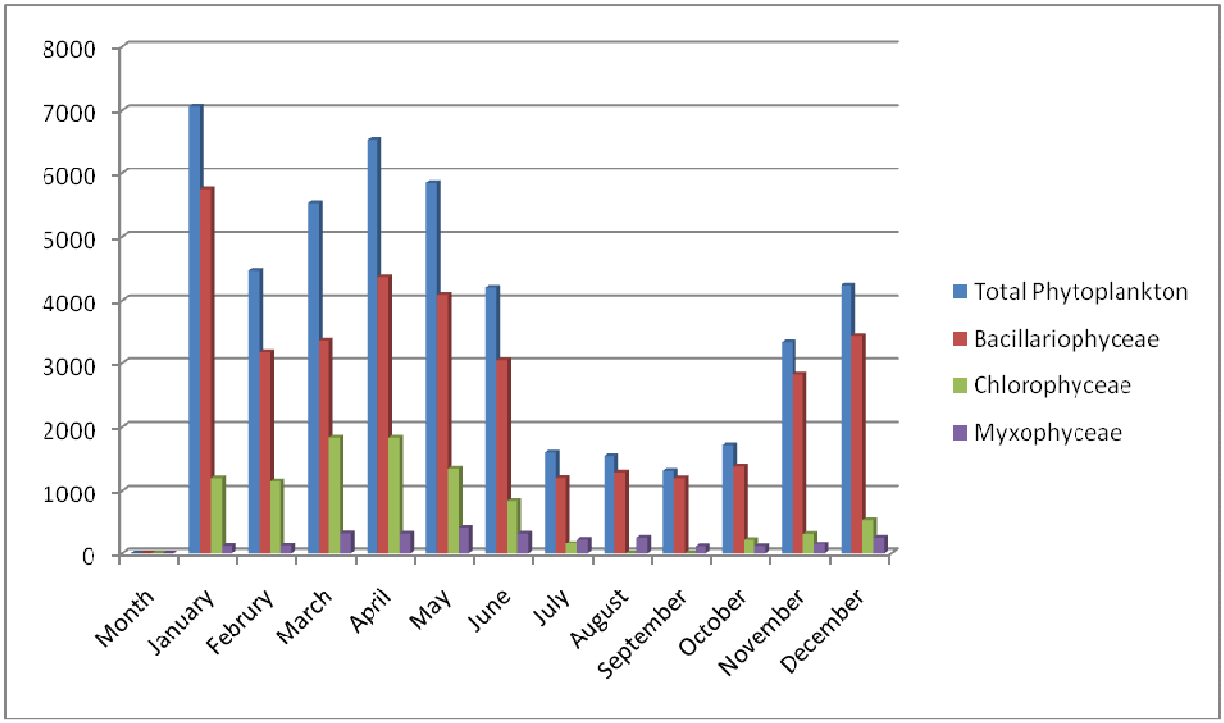


Figure 3: Seasonal Variations in Zooplankton Density (u/l) at Site A during Jan-Dec 2010.

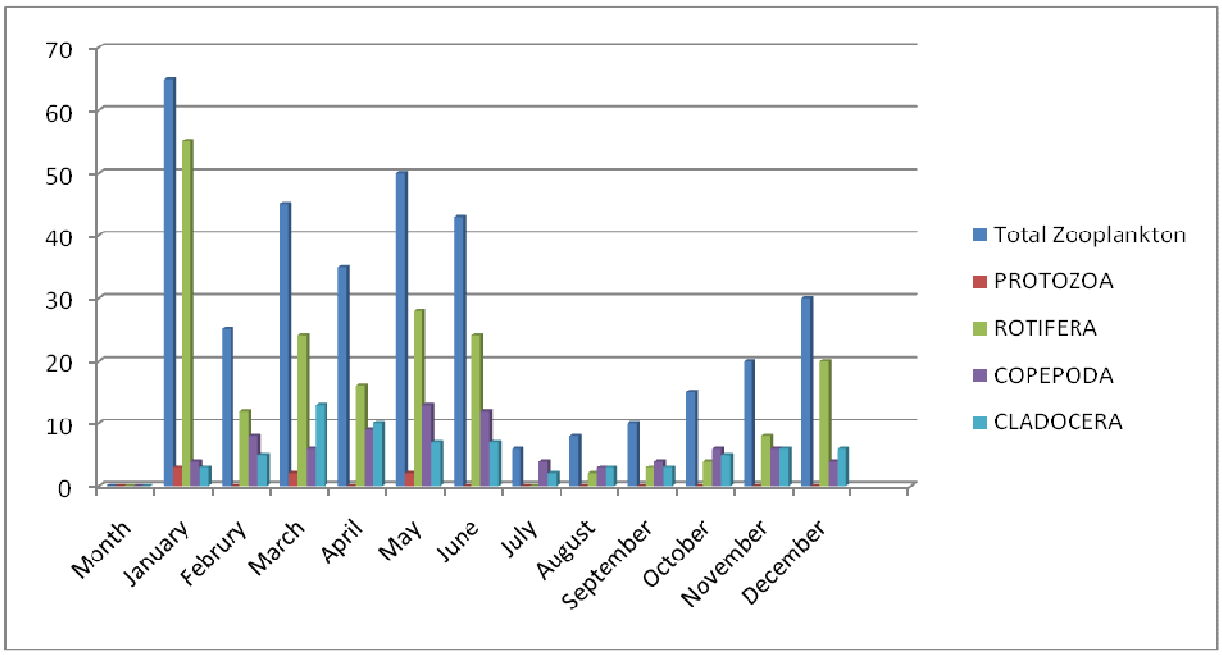
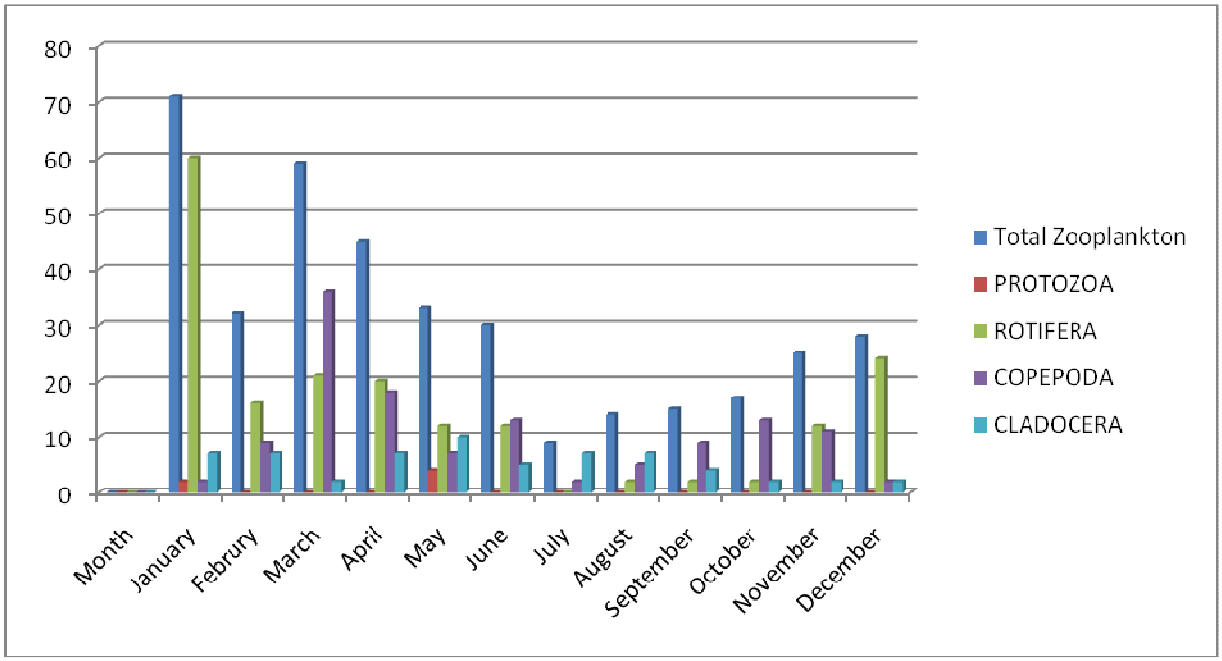


Fig 4: Seasonal Variations in Zooplankton Density (u/l) at Site B during Jan- Dec 2010.



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