

Diversity of Phytoplanktons in Narmada River, Jabalpur Region (M.P) India

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Abstract: *The aim of the present study is to find out the seasonal diversity of Phytoplanktons in the year October 2010 to september 2011. The studies are carried out in 5 different sampling stations in Jabalpur(M.P)India and months are categorized as October-January as winter, February-May as summer, June-September as rainy. A total of 19 genera belonging to four different groups (Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae) were recorded during the study period. The Planktons were collected, counted and identified by using the methods suggested by APHA and Prescott[1]. From the recorded data, quantitatively and qualitatively, Chlorophyceae is the most dominant group followed by Bacillariophyceae as the second dominant group and Cyanophyceae and Euglenophyceae as third and fourth respectively.*

Keywords: Phytoplankton Diversity, Narmada River, Jabalpur region, Madhya – Pradesh

1. Introduction

Rivers are the main source of drinking water, besides their usage in agriculture, washing etc. Water pollution in India has come to a critical point. Domestic waste, industrial waste and other household wastes are directly discharged into the river. Major constituents of aquatic organisms is the plankton- Zooplankton and Phytoplankton. Plankton population is greatly affected by physical and chemical properties of water, Sharma and Diwan[2]. Rivers play a major role in assimilating or carrying industrial and municipal waste water, manure discharge and run off which are responsible for river pollution, Toman et al.,[3]. Many co-workers have connected their studies on ecology of Phytoplankton and important work in this field is investigated by Goel et al.,[4] Ramkrishna et al.,[5] Fouzia Ishaq et al.,[6]. The Narmada is the fifth longest river in India and largest west flowing river of Indian peninsula originating from Maikal ranges at Amarkantak in Madhya-Pradesh at an elevation of 900 meter. It flows over a length of 1312 km before draining in to the Gulf of Cambay, 50 km west of Bharuch. The river is also known as “Life line of Madhya –Pradesh”. It runs about 160 kms in Madhya –

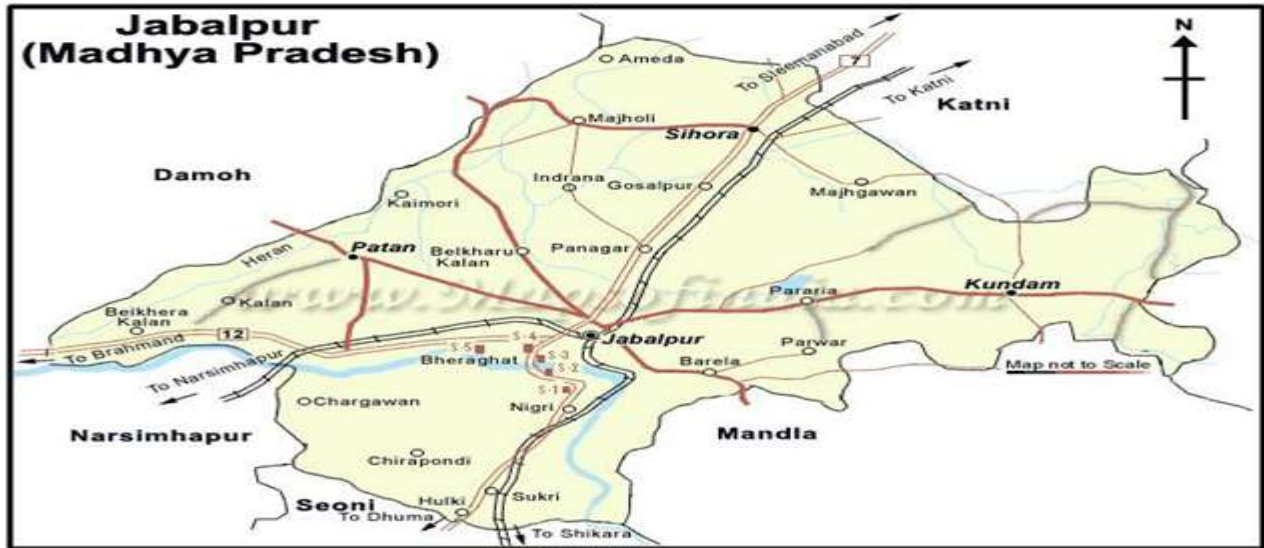
Pradesh. Jabalpur city is also called Mahakoushal and is situated almost in the centre of

India (between the coordinates of 23 10' Latitude and 79 57'E longitude with a general elevation of about 393 meters above MSL.)

2. Materials and Methods

2.1 Study Area

The present studies are carried out from October 2010 to September 2011 in 5 different sampling stations of river Narmada at Jabalpur region(M.P), India, namely (S-1) Lamhetaghat (16 km away from the city headquarters, (S-2) Laxminarayanghat (17^{1/2} km away from the city headquarters), (S-3) Gograghat (19 km away from the city headquarters), (S-4) Saraswatighat (20 km away from the city headquarters) and the last one (S-5) Bhedaghat (21 km away from the city headquarters). These all sampling sites are situated at the bank of river Narmada and are surrounded by large number of small villages. Hence, dumping wastes and ritual performances can be seen here frequently.



Map 1: Jabalpur region showing sampling stations



Map 2: Close view of sampling stations

- S-1 LAMHETAGHAT
- S-2 LAXMI NARAYAN GHAT
- S-3 GOGRAGHAT
- S-4 SARASWATI GHAT
- S-5 BHEDAGHAT

Photographs



(A) STATION -1: LAMHETAGHATGHAT



(B) STATION-2: LAXMI NARAYAN GHAT



(C) STATION-3: GOGRAGHAT



(D) STATION-4: SARASWATI GHAT



(E) STATION-5: BHEDAGHAT



(F) SAMPLE COLLECTION (GOGRAGHAT)

2.2 Sample Collection and Analysis

Phytoplanktons were collected from all the sampling stations (S-1, S-2, S-3, S-4, S-5) of river Narmada for qualitative and quantitative analysis. For this methods, plankton net was used as planktonic sampling device. The plankton net is cone shaped having a circular metal ring at one end and collecting graduated tube on the other end. For qualitative and quantitative analysis of planktons, 50 lit. of water sample was pass out from the plankton net and filter is collected in the graduated tube attached to the lower end of plankton net. Filter is than collected in 25 ml of vial and kept for sedimentation by the addition of lugol's iodine for phytoplanktons and preserved with 5% formaldehyde solution. The supernatant liquid is taken out with the help of pipette without disturbing the setteled planktons and the remaining sample is further concentrated upto 5 ml depending upon the number of planktons present. For qualitative and quantitative analysis of planktons ,Drop count method is preferred. This method involves plankton enumeration in one drop of concentrated sample taken on aside with coverslip using standard caliberated dropper. This slide is then put under the inverted research microscope (Leincamake DMIL) with 10×10 magnification. Planktons are counted specieswise identification of plankton was done by using standard literature of Needham and Needham [7] and Adoni et, al., [8]. Keeping in view, everyday the water quality is changing, which in turn changes the abundance and succession of phytoplanktons in a set of samples collected from 5 ghats of river Narmada, Jabalpur region(M.P)India.

3. Results and Discussion

During the study period from October 2010 to September 2011, the phytoplankton species observed, belonging to 5 main groups. Total 19 species are observed out of which 05 species belong to Cyanophyceae, 08 species belong to Chlorophyceae, 04 species belong to Bacillariophyceae and 2 species of Euglenophyceae. Plankton species were collected from the surface(S) and bottom(B) of all prefix sampling stations(Table 1,2,3,4)

1. Chlorophyceae

Chlorophyceae is the first main dominant group of phytoplanktons. This group is represented by species *Ankistrodesmus*, *Chlorella*, *Eudorina*, *Pediastrum*, *Scendesmus*, *Spiroogyra*, *Ulothrix* and *Volvox*. During my study period in the year from October 2010 to September 2011, maximum density recorded for **Chlorophyceae** at different stations was observed as-

S-1	= S =	2525 nos/l,	B = 1951 nos/l
S-2	= S =	2523 nos/l,	B = 2030 nos/l
S-3	= S =	2473 nos/l,	B = 2002 nos/l
S-4	= S =	2478 nos/l,	B = 2111 nos/l
S-5	= S =	2280 nos/l,	B = 2034 nos/l

Chlorella species was dominant throughout the year with maximum range of 52 organism per litre in the month of March 2011 at station (S-2) on the surface while *Volvox* was observed to be maximum with lower range of 05 organisms per litre in the month of Oct. 2010 at S-4 in the bottom and absent at some places. Tripathi and Pandey [9] have reported a strong correlation between Chlorophyceae and various physico-chemicals parameters such as temperature turbidity, chloride, hardness etc.

2. Bacillariophyceae-

During my study period, **Bacillariophyceae** was the second dominant group. The group density observed for this group for the year 2010-11 was-

S-1	= S =	2523 nos/l,	B = 991 nos/l
S-2	= S =	2277 nos/l,	B = 1006nos/l
S-3	= S =	2320 nos/l,	B = 1002 nos/l
S-4	=S =	2205 nos/l,	B = 818 nos/l
S-5	= S =	2263 nos/l,	B = 984 nos/l

The number of species was maximum in summers and declined gradually during monsoon. Out of all the observed species *Diatoma* was dominating throughout the years with the maximum range of 84 organisms per litre in the month of Oct. 2010 at S-3 on the surface whereas *Nitzschia* was observed in lesser amount within the maximum range of 06 in the month of August 2011 at station S-5 at the bottom. *Nitzschia* was absent in some months. Venkatesh Warlu [10] expresses that increase in average number of **Bacillariophyceae** reflects bad water quality.

3. Cyanophyceae- The species observed in the group are – *Anabaena*, *Merismopedia*, *Microcystis*, *Oscillatoria*, *Nostoc*.

The maximum density recorded in year 2010-11 was-

S-1	= S =	1300 nos/l,	B = 1127 nos/l
S-2	= S =	1264 nos/l,	B = 1128 nos/l
S-3	= S =	1306 nos/l,	B = 1148 nos/l
S-4	= S =	1137 nos/l,	B = 1094 nos/l
S-5	= S =	1210 nos/l,	B = 940 nos/l

In the research period, *Anabaena* species was dominating with the maximum range of 34 organisms per litre in S-5(surface)in the month of April 2011 and in S-3(Surface)in the month of March 2011. *Nostoc* was observed in lesser amount and observed to be absent in many months. According to Kumar [11] excessive growth of certain algae like *Anabaena*, *Microcystis* is known to indicate nutrient enrichment in water.

4. Euglenophyceae- It forms a large and diverse group but few species are truly planktonic. During the study period, 02 species of Euglenophyceae were observed and identified. Maximum density in the first year Oct. 2010 to Sept. 2011 was observed as-

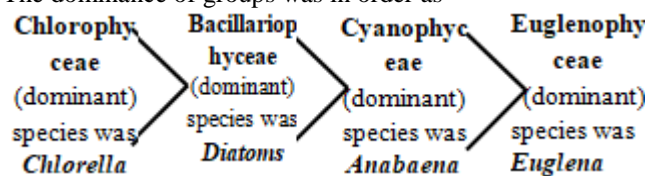
S-1	= S =	791 nos/l,	B = 569 nos/l
S-2	= S =	839 nos/l,	B = 521 nos/l
S-3	= S =	822 nos/l,	B = 498 nos/l
S-4	= S =	874 nos/l,	B = 519 nos/l
S-5	= S =	853 nos/l,	B = 528 nos/l

In **Euglenophyceae**, *Euglena* was found to be dominant with the maximum range of 64 organism per litre in the month of April 2011 at S-2 on the surface, *Phacus* was absent during some months and showed minimum range of 07 organisms per litre at S-5 in the bottom in the month of October 2010. Devidas et. al.,[12] observed Euglenoid species and Cyanophyceae species in the water bodies of Shimoga district, Karnataka.

From the data recorded in this research duration of October 2010 to September 2011, it is clear that the Chlorophyceae is the most dominating group with *chlorella* as the most

dominating species in river Narmada. The total plankton count/ml is minimum in rainy season whereas higher in summers. This data is further supported by taking a reference of data collected by Jyoti Sharma et. al., [13] Tayor and Deepti[14] also reported that phytoplankton grows and multiply best during months, when the temperature is high and having longer photoperiod. High summer growth of phytoplanktons may also be due to progressively increasing water temperature and nutrients in water that are responsible for high amount of phytoplankton growth during summer season. Similar studies are reported by Sudha Summarwar [15] and Manoj kumar and P.K Khare [16] they also observed highest planktonic concentration in summer whereas lower in rainy season (Graph 1, 2, 3, 4)

The dominance of groups was in order as-



4. Conclusion

Based on the present studies, the phytoplanktonic composition of the river Narmada at Jabalpur region in 5 different sampling stations indicated that change of seasons affect the phytoplankton abundance in selected stations. *Chlorophyceae* was observed to be the most dominating group followed by *Bacillariophyceae*, *Cyanophyceae* and lastly *Euglenophyceae*. Higher density of phytoplanktons is observed in summers whereas it was observed to be declined during the rainy season.

5. Acknowledgement

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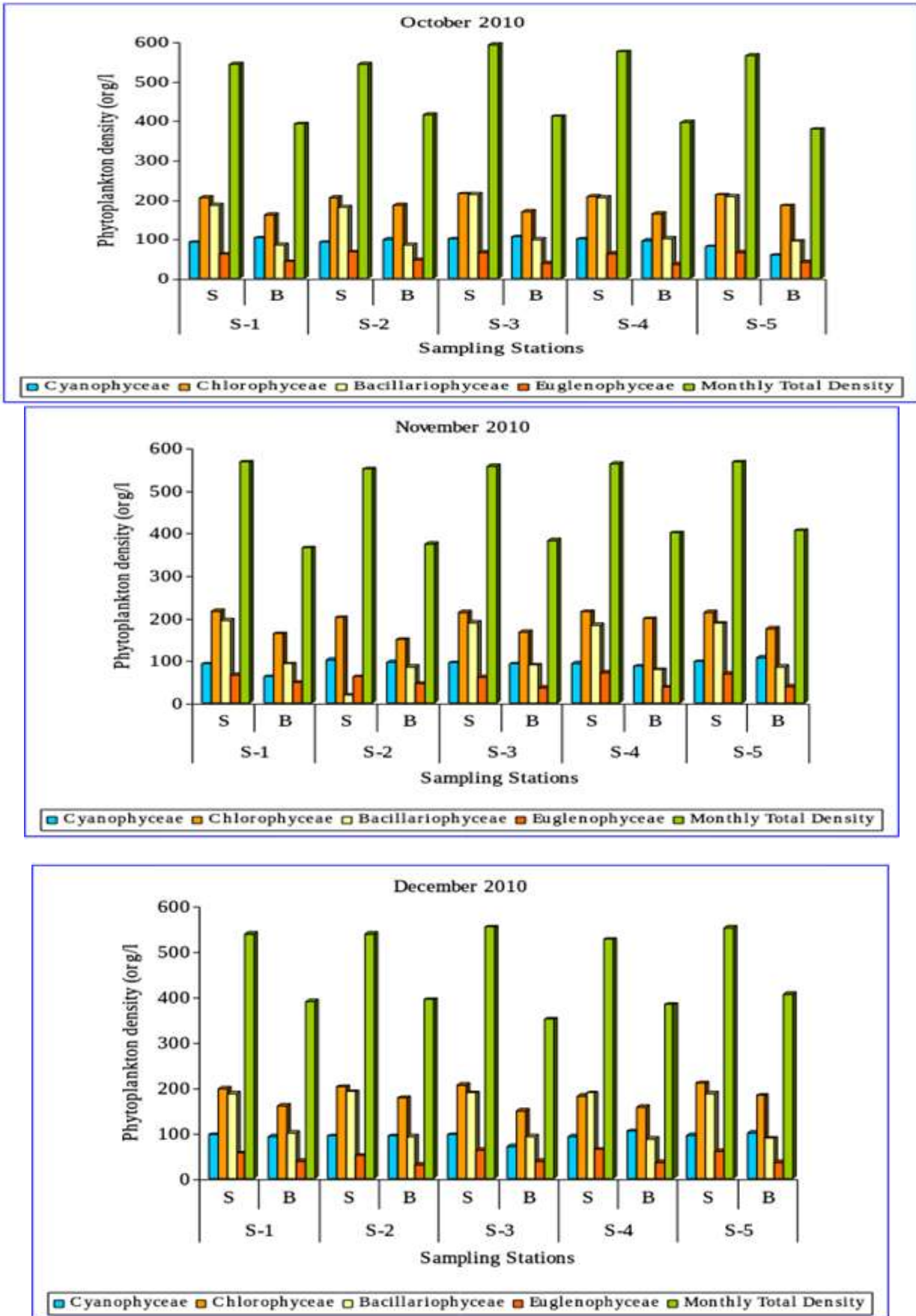
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Table 1: Seasonal variation in phytoplankton density (org/l) at 5 different sampling stations of river Narmada (Oct. 2010 to Dec. 2010)

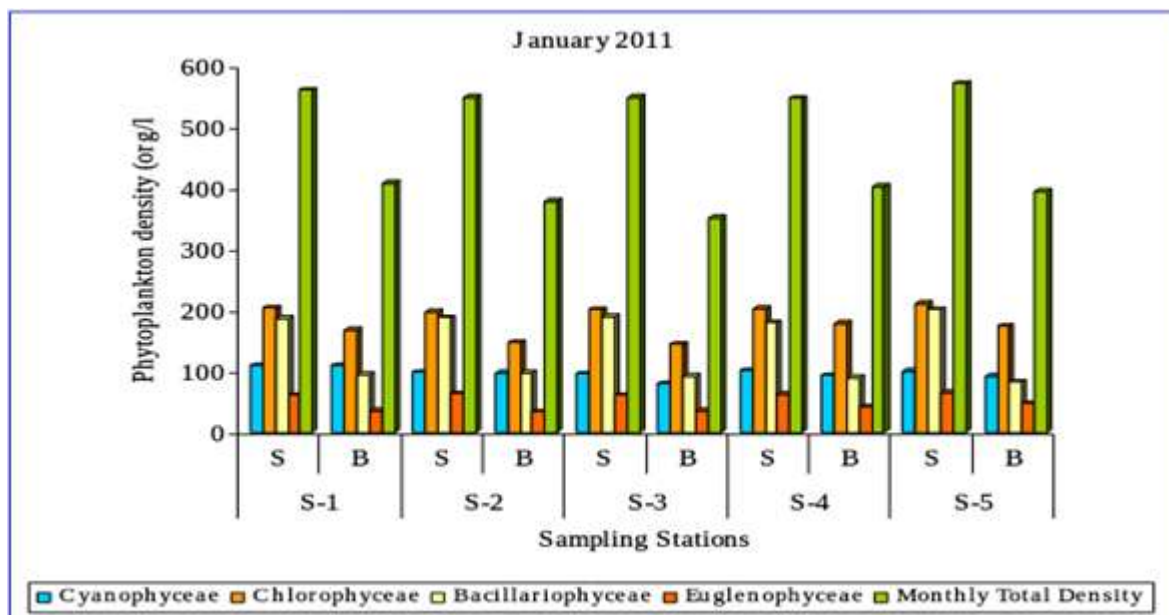
Phytoplankton Date	Oct. 2010										Nov. 2010										Dec. 2010									
	S-1		S-2		S-3		S-4		S-5		S-1		S-2		S-3		S-4		S-5		S-1		S-2		S-3		S-4		S-5	
	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th
Cyanophyceae	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B
<i>Anabaena</i>	22	20	22	21	22	21	23	23	20	15	18	10	20	22	19	21	22	23	20	21	18	20	20	12	18	23	20	18		
<i>Merismopedia</i>	19	24	19	20	18	20	20	15	18	10	17	14	18	10	18	20	17	20	19	23	19	17	21	18	22	20	20	22	19	23
<i>Microcystis</i>	20	22	17	20	19	20	19	17	15	7	20	12	24	22	20	20	19	22	21	20	20	18	17	18	18	15	19	21	18	21
<i>Oscillatoria</i>	19	23	18	20	21	23	18	20	16	12	19	10	22	20	17	10	17	21	18	21	18	16	20	22	17	14	17	18	21	20
<i>Nostoc</i>	12	14	15	17	20	21	20	20	12	15	18	15	17	22	19	20	18	-	19	20	19	20	18	16	19	10	18	20	17	18
Total	92	103	91	98	100	105	100	95	81	59	92	61	101	96	94	91	93	86	97	107	96	92	94	94	96	71	92	104	95	100
Chlorophyceae																														
<i>Ankistrodesmus</i>	28	26	29	30	29	20	27	20	29	28	28	22	25	20	27	20	27	23	29	28	26	22	25	22	28	22	30	24	30	31
<i>Chlorella</i>	38	28	39	23	37	32	36	28	37	32	37	28	32	22	36	24	38	28	37	32	32	24	30	28	35	22	34	28	37	32
<i>Eudorina</i>	29	24	24	20	27	22	25	20	26	24	26	18	29	21	25	23	26	28	28	23	27	20	28	25	24	20	20	18	28	25
<i>Pediastrum</i>	28	26	29	26	29	24	26	23	28	23	29	21	33	22	34	24	36	30	34	24	33	26	32	24	22	16	18	15	30	28
<i>Scendesmus</i>	26	20	25	20	28	23	30	25	29	22	24	19	20	15	20	23	22	20	25	22	26	20	23	20	29	21	24	18	24	23
<i>Spirogyra</i>	22	22	20	23	24	21	28	17	20	24	26	23	24	20	24	20	27	23	19	20	19	15	22	21	25	20	20	24	26	26
<i>Ulothrix</i>	25	23	27	20	25	17	27	26	27	23	27	18	25	21	29	23	28	32	27	18	25	20	28	25	28	18	25	22	24	20
<i>Volvox</i>	08	12	12	24	15	10	08	05	15	08	18	14	12	08	18	10	10	14	14	08	10	12	14	12	14	10	10	08	10	08
Total	204	161	205	186	214	169	207	164	211	184	215	163	200	149	213	167	214	198	213	198	159	202	177	205	149	181	157	209	183	
Bacillariophyceae																														
<i>Cyclotella</i>	49	24	50	28	27	30	56	35	54	28	50	24	47	28	55	24	54	24	50	24	55	28	56	32	50	28	52	24	49	20
<i>Diatoma</i>	45	22	62	26	84	26	70	24	76	30	75	26	72	26	73	26	62	26	74	26	65	30	68	26	76	36	70	22	77	30
<i>Navicula</i>	50	26	54	20	60	27	60	32	64	26	57	30	52	22	64	29	55	20	54	25	60	32	55	28	52	20	54	26	52	28
<i>Nitzschia</i>	12	12	14	10	12	15	18	10	14	10	12	12	10	08	07	10	12	08	09	10	07	10	12	06	10	08	12	14	09	10
Total	185	84	180	84	213	98	204	101	208	94	194	92	18	84	189	89	183	78	187	85	187	100	191	92	188	92	188	86	187	88
Euglenophyceae																														
<i>Englena</i>	38	28	34	20	46	24	43	21	40	24	40	34	45	25	43	21	47	27	46	24	40	24	32	20	43	21	47	20	42	20
<i>Phacus</i>	24	15	28	20	19	14	20	14	25	7	25	17	22	20	17	14	24	10	23	14	16	14	18	10	20	17	17	15	18	15
Total	62	43	67	46	65	38	63	35	65	41	65	48	61	45	60	35	71	37	69	38	56	38	50	30	63	38	64	35	60	35
Monthly Total Density	543	391	543	414	592	410	574	395	565	378	566	364	549	374	556	382	561	399	566	405	537	389	537	393	552	350	525	382	551	406

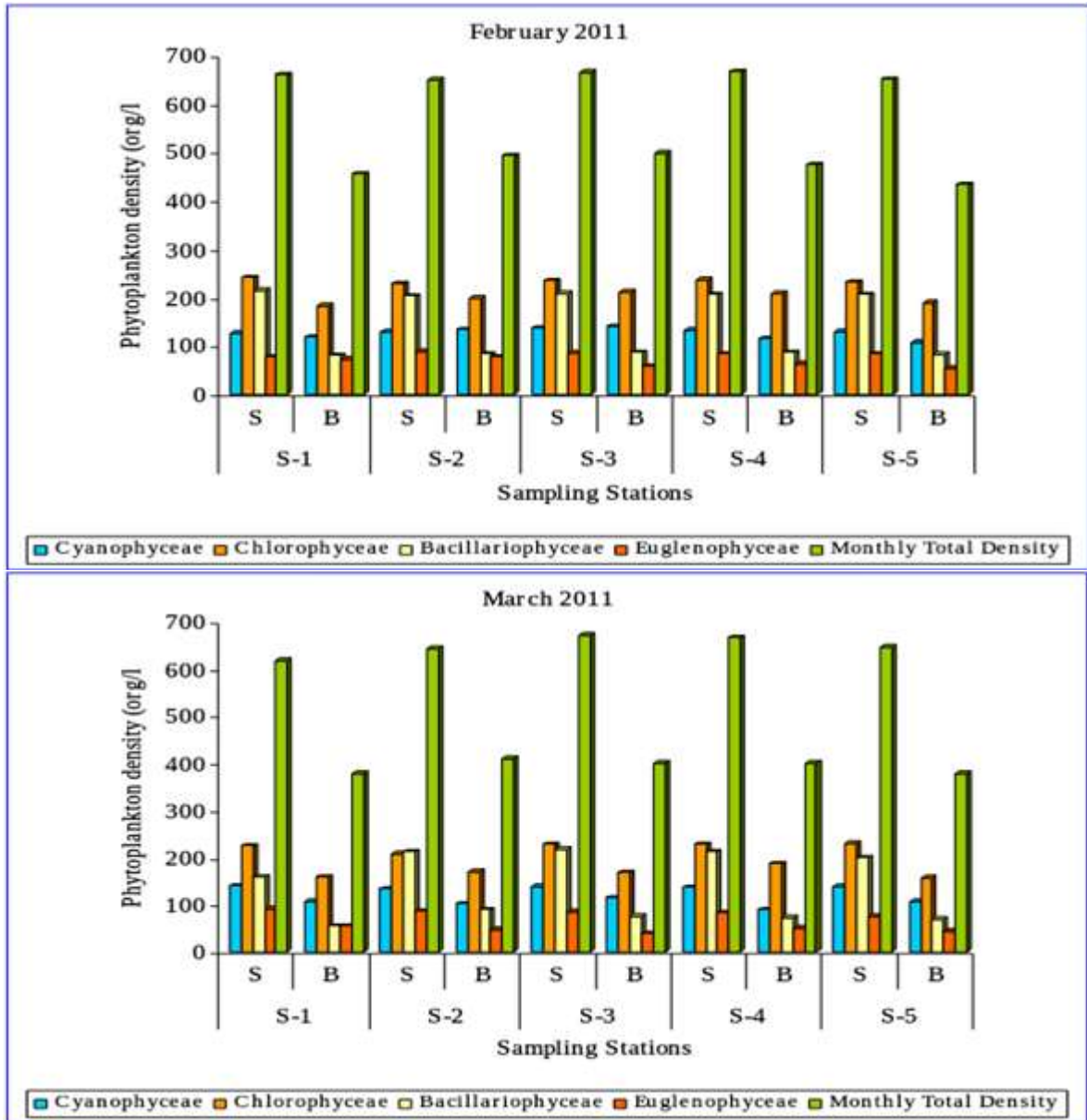


Graph 1(A, B, C): Graph showing seasonal variation in phytoplankton density (org/l) at 5 different sampling stations of river Narmada (Oct. 2010 to Dec. 2010)

Table 2: Seasonal variation in phytoplankton density (org/l) at 5 different sampling stations of river Narmada (Jan. 2011 to March 2011)

Phytoplankton Date	Jan. 2011					Feb. 2011					March 2011																			
	S-1		S-2		S-3		S-4		S-5		S-1		S-2		S-3		S-4		S-5											
	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th										
Cyanophyceae	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B								
<i>Anabaena</i>	20	21	20	15	20	12	23	15	20	22	28	32	29	22	32	24	32	28	29	24	30	20	32	24	34	28	32	18	30	24
<i>Merismopedia</i>	22	24	20	20	21	18	20	21	24	22	26	26	24	28	27	32	25	22	25	21	27	22	26	20	28	23	29	17	29	20
<i>Microcystis</i>	21	24	19	23	19	15	22	15	18	10	24	18	27	24	26	32	25	23	26	22	28	22	27	23	27	24	26	18	28	20
<i>Oscillatoria</i>	19	18	21	20	18	20	17	22	20	22	25	20	26	26	24	26	24	20	26	21	29	24	25	18	28	22	26	17	27	18
<i>Notoc</i>	21	23	19	20	18	15	19	20	18	16	23	22	24	34	28	26	27	22	23	20	26	20	24	18	22	18	25	20	25	21
Total	109	110	99	98	96	80	101	93	100	92	126	118	130	134	137	140	133	115	129	108	140	108	134	103	139	115	138	90	139	108
Chlorophyceae																														
<i>Ankistrodesmus</i>	28	23	28	22	28	22	25	22	28	24	36	24	37	32	32	28	34	30	33	30	34	28	30	27	37	20	32	28	34	23
<i>Chlorella</i>	36	28	35	21	34	28	38	32	34	28	44	28	46	36	44	30	46	34	44	20	43	22	52	32	46	24	48	26	45	28
<i>Eudorina</i>	26	25	27	18	26	18	27	24	26	22	29	24	28	26	28	24	27	24	27	24	27	20	26	20	25	20	28	24	25	20
<i>Pediastrum</i>	29	28	28	26	24	16	28	24	25	20	36	23	32	25	32	29	34	28	36	25	27	20	26	20	25	20	28	24	25	20
<i>Scendesmus</i>	24	18	18	15	26	18	25	20	27	21	28	20	28	22	24	28	23	21	24	28	25	21	28	20	26	23	28	26	26	15
<i>Spirogyra</i>	26	16	26	18	22	15	20	23	26	20	25	24	28	19	27	24	25	28	25	19	26	20	-	-	22	20	24	28	24	21
<i>Ulothrix</i>	25	20	24	20	28	18	25	20	27	22	29	28	31	28	32	29	30	28	28	24	26	18	26	28	28	18	25	20	26	18
<i>Volvox</i>	10	10	12	08	14	10	15	14	18	17	14	12	08	10	16	20	18	16	15	20	15	12	17	20	12	14	15	10	19	14
Total	204	168	198	148	202	145	203	179	211	174	241	183	228	198	235	212	237	209	232	190	226	159	209	170	229	169	229	188	231	157
Bacillariophyceae																														
<i>Cyclotella</i>	50	20	52	30	48	24	50	25	58	23	62	24	30	20	64	24	66	26	60	24	66	24	64	24	65	24	64	20	65	24
<i>Diatoma</i>	70	34	72	28	78	32	64	24	81	22	80	25	74	24	76	20	72	20	76	24	76	22	75	30	76	20	73	24	75	26
<i>Navicula</i>	59	29	54	32	55	21	54	26	54	25	56	22	54	20	52	23	54	24	58	20	-	-	60	26	60	22	62	21	60	20
<i>Nitzschia</i>	08	12	10	08	08	10	12	14	08	12	17	10	15	20	16	20	15	17	12	14	18	10	14	10	17	10	14	08	-	-
Total	187	95	188	98	189	92	180	89	201	82	215	81	203	84	208	87	207	87	206	82	160	56	213	90	218	76	213	73	200	70
Euglenophyceae																														
<i>Englena</i>	45	21	46	24	43	21	46	24	48	29	54	44	60	46	57	34	52	36	58	34	63	34	60	32	55	24	59	28	50	24
<i>Phacus</i>	16	14	18	10	18	14	17	18	17	18	24	29	28	32	28	25	32	28	26	20	28	22	27	15	30	16	28	22	26	20
Total	61	35	64	34	61	35	63	42	65	47	78	73	88	78	85	59	84	64	84	54	91	56	87	47	85	40	84	50	76	40
Monthly Total Density	561	408	549	378	548	352	547	403	571	395	660	455	649	494	665	498	666	475	651	434	617	379	643	410	671	400	667	401	646	379



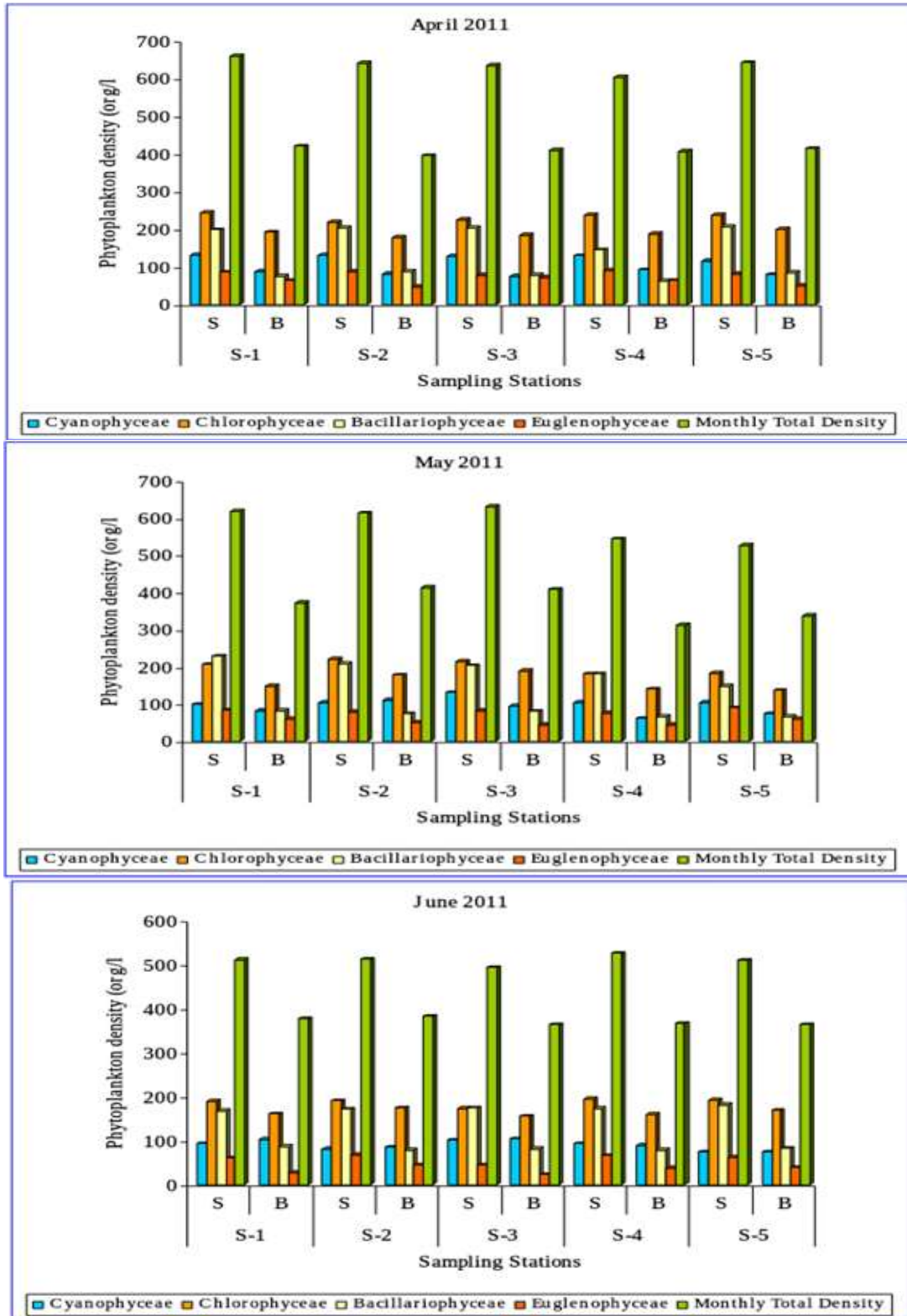


Graph 2(A,B,C): Graph showing seasonal variation in phytoplankton density (org/l) at 5 different sampling stations of river Narmada (Jan. 2011 to March. 2011)

Table 3: Seasonal variation in phytoplankton density (org/l) at 5 different sampling stations of river Narmada (April 2011 to June 2011)

Phytoplankton Date	April 2011										May 2011										June 2011													
	S-1		S-2		S-3		S-4		S-5		S-1		S-2		S-3		S-4		S-5		S-1		S-2		S-3		S-4		S-5					
	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th				
Cyanophyceae	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B
<i>Anabaena</i>	30	18	32	18	30	20	30	16	34	20	30	26	32	26	33	15	32	25	30	18	22	21	23	20	24	22	17	22	16	14				
<i>Merismopedia</i>	28	15	27	14	27	18	28	20	28	26	-	-	27	30	28	22	26	22	18	20	23	20	22	17	21	20	14	17	10					
<i>Microcystis</i>	26	18	24	18	23	21	24	16	29	16	25	20	26	15	26	20	-	-	-	-	18	20	18	21	18	22	18	16	14	16				
<i>Oscillatoria</i>	25	19	26	17	26	18	25	20	25	18	24	18	28	21	28	18	27	15	28	20	20	24	20	22	20	20	17	19	15	20				
<i>Nostoc</i>	23	18	22	15	22	16	23	20	-	-	20	18	18	19	22	20	20	-	21	18	14	15	-	-	22	19	21	18	11	14				
Total	132	88	131	82	128	75	130	92	116	80	99	82	105	111	131	95	105	62	105	74	94	103	81	85	101	104	93	89	74	74				
Chlorophyceae																																		
<i>Ankistrodesmus</i>	39	28	34	30	34	26	35	30	36	28	35	26	30	28	36	26	36	24	36	17	27	24	28	29	27	23	26	20	28	25				
<i>Chlorella</i>	47	32	43	28	42	30	46	28	46	36	47	24	48	26	47	36	44	28	28	20	36	27	32	22	38	31	35	24	36	31				
<i>Eudorina</i>	28	24	26	24	27	20	29	20	26	18	29	20	27	15	28	28	-	-	25	24	22	18	23	19	24	19	24	19	24	20				
<i>Pediastrum</i>	36	26	26	20	30	28	32	28	30	26	28	22	26	28	32	24	30	28	29	20	25	20	25	21	27	20	25	22	26	24				
<i>Scendesmus</i>	26	20	24	19	28	22	27	22	28	28	24	18	23	20	26	30	-	-	-	-	26	19	24	19	27	21	22	18	25	21				
<i>Spirogyra</i>	25	28	25	20	22	20	25	22	27	26	26	20	25	28	27	25	28	25	24	18	20	18	22	24	25	19	26	19	23	19				
<i>Ulothrix</i>	24	20	23	27	24	18	24	18	24	18	-	-	21	18	-	-	26	24	23	20	24	24	23	18	22	15	24	24	20	22				
<i>Volvox</i>	18	14	17	15	18	20	19	20	20	20	17	18	20	15	18	20	18	12	18	19	09	11	14	23	10	08	12	14	10	7				
Total	243	192	218	178	225	184	237	188	237	200	206	148	220	178	214	189	182	141	183	138	189	161	191	175	173	156	194	160	192	169				
Bacillariophyceae																																		
<i>Cyclotella</i>	60	20	62	20	63	24	62	24	62	22	69	20	67	22	62	20	60	20	62	24	52	24	50	20	52	24	52	24	54	22				

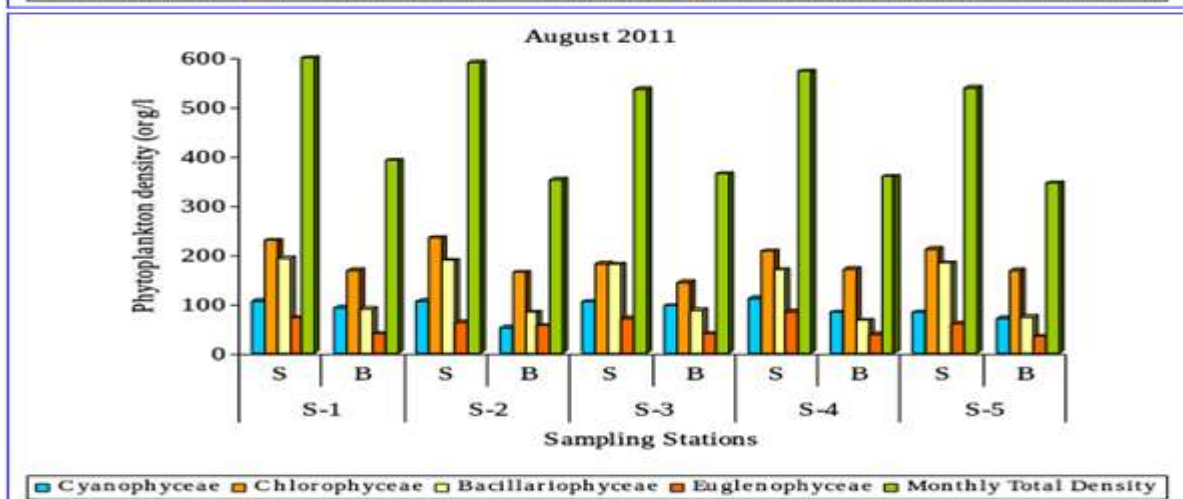
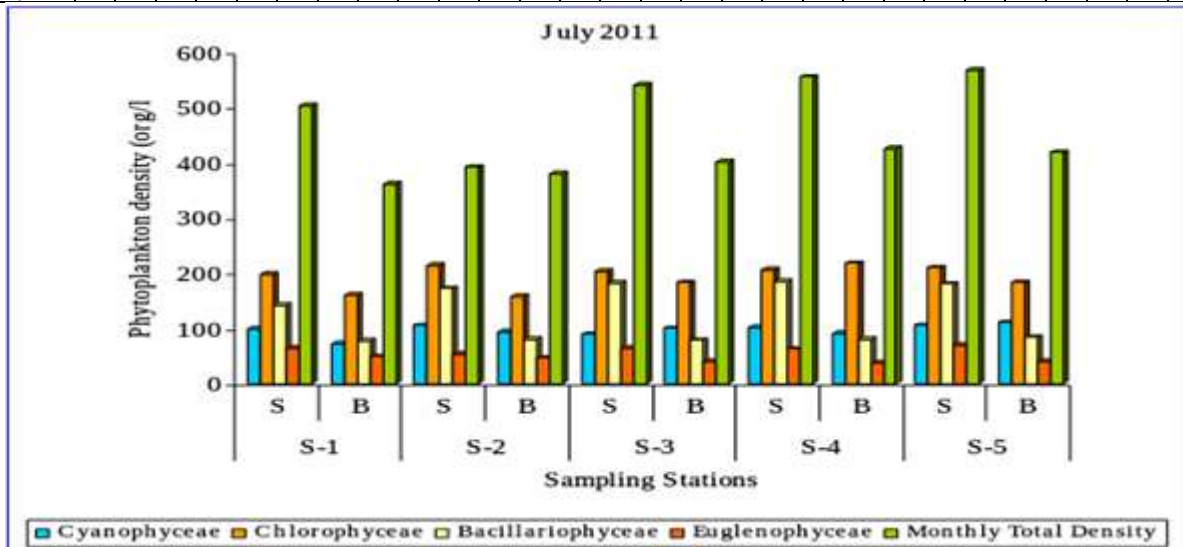
<i>Diatoma</i>	72	25	69	26	71	20	69	28	69	20	72	22	70	24	70	24	69	22	72	22	60	26	62	26	62	20	61	20	60	24
<i>Navicula</i>	54	23	56	24	59	26	-	-	58	27	66	24	62	20	56	22	52	24	-	-	49	25	50	24	50	25	50	26	51	26
<i>Nitzschia</i>	12	8	17	18	10	08	15	10	18	15	22	16	10	08	12	15	-	-	15	20	07	11	10	08	10	12	10	09	16	10
Total	198	76	204	88	203	78	146	62	207	84	229	82	209	74	203	81	181	66	149	66	167	86	172	78	174	81	173	79	181	82
Euglenophyceae																														
<i>Englena</i>	58	42	64	32	54	44	63	42	58	32	55	36	52	30	55	24	50	26	63	42	39	14	42	24	45	23	42	20	38	23
<i>Phacus</i>	28	22	24	15	24	28	27	22	24	18	29	24	27	20	28	20	26	18	27	18	22	13	26	21	-	-	24	18	24	16
Total	86	64	88	47	78	72	90	64	82	50	84	60	79	50	83	44	76	44	90	60	61	27	68	45	45	23	66	38	62	39
Monthly Total Density	659	420	641	395	635	409	603	406	642	414	618	372	613	413	631	409	544	313	527	338	511	377	512	383	493	364	526	366	509	364

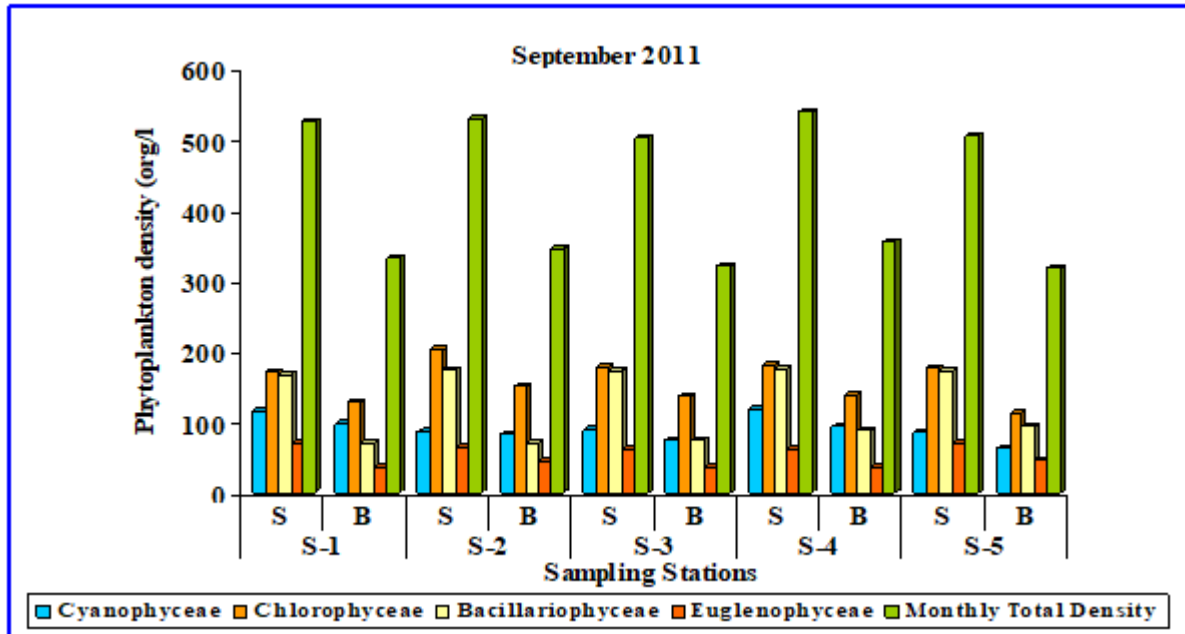


Graph 3(A, B, C): Graph showing seasonal variation in phytoplankton density (org/l) at 5 different sampling stations of river Narmada (April 2011 to June 2011)

Table 4: Seasonal variation in phytoplankton density (org/l) at 5 different sampling stations of river Narmada (July 2011 to September 2011)

Phytoplankton Date	July 2011															August 2011															September 2011														
	S-1			S-2			S-3			S-4			S-5			S-1			S-2			S-3			S-4			S-5																	
	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th	10 th	11 th	12 th	13 th	14 th																				
Cyanophyceae	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B																			
<i>Anabaena</i>	20	11	22	24	20	22	24	25	22	24	21	23	24	20	22	16	26	20	20	15	24	23	20	18	22	18	23	18	23	15															
<i>Merismopedia</i>	18	15	20	12	20	22	19	20	20	24	23	13	17	14	24	19	20	14	22	20	24	21	-	-	-	-	24	18	20	15															
<i>Microcystis</i>	22	13	26	24	22	23	21	23	23	21	20	17	24	17	20	22	24	22	-	-	27	18	26	24	27	24	28	24	-	-															
<i>Oscillatoria</i>	20	17	22	16	18	12	18	23	20	22	20	14	23	-	19	24	21	24	23	18	22	16	23	20	23	18	24	18	22	16															
<i>Nostoc</i>	19	16	16	18	20	21	19	-	21	20	21	25	17	-	19	15	20	18	18	18	19	20	18	20	18	14	20	16	20	18															
Total	99	72	106	94	90	100	102	91	106	111	105	92	105	51	104	96	111	83	83	71	116	98	87	82	90	74	119	94	85	64															
Chlorophyceae																																													
<i>Ankistrodesmus</i>	30	24	26	38	29	26	28	25	31	30	30	24	35	20	27	20	30	26	28	20	27	20	28	18	26	20	-	-	28	26															
<i>Chlorella</i>	36	28	38	26	37	25	35	30	38	35	36	28	37	24	36	28	38	28	34	26	35	28	1	26	35	24	36	23	35	26															
<i>Eudorina</i>	26	20	29	26	27	25	28	29	27	25	28	23	29	23	26	20	24	21	25	18	-	-	28	25	26	20	27	20	-	-															
<i>Pediastrum</i>	28	24	34	24	32	25	31	37	35	25	33	26	27	22	-	23	22	29	21	29	20	28	24	26	25	26	25	26	20	20															
<i>Scenedesmus</i>	24	20	23	17	22	24	19	22	20	19	31	20	31	20	28	22	26	18	26	20	23	17	25	21	24	18	30	20	23	18															
<i>Spirogyra</i>	21	24	27	21	20	22	22	24	21	20	24	15	30	21	25	18	27	20	22	21	20	18	22	19	25	20	2	18	24	18															
<i>Ulothrix</i>	24	20	26	22	27	24	29	35	28	20	27	17	30	23	25	20	29	28	28	21	23	15	25	20	-	-	18	20	24	18															
<i>Volvox</i>	09	-	12	10	10	12	14	16	10	09	20	15	15	10	16	15	10	8	19	20	15	10	12	10	14	10	16	12	17	14															
Total	198	161	215	158	204	183	206	218	210	183	229	168	234	163	181	143	207	171	211	167	172	128	203	150	178	136	181	138	177	114															
Bacillariophyceae																																													
<i>Cyclotella</i>	50	22	52	24	57	20	56	25	54	25	56	24	56	25	52	24	54	20	54	20	54	26	55	20	55	28	54	28	53	25															
<i>Diatoma</i>	62	20	60	25	63	24	62	24	65	26	64	26	66	22	63	20	65	22	64	22	62	25	60	26	64	25	60	26	62	28															
<i>Navicula</i>	48	24	49	22	52	23	52	22	52	22	52	25	53	26	50	22	50	24	53	25	51	20	52	24	54	22	50	24	46	26															
<i>Nitzschia</i>	10	12	12	10	10	12	15	09	10	12	20	15	13	10	15	20	-	-	12	06	-	-	8	10	-	-	12	10	12	14															
Total	142	78	173	81	182	79	185	80	181	85	192	90	188	83	180	86	169	66	183	73	167	71	175	70	173	75	176	88	173	93															
Euglenophyceae																																													
<i>Englena</i>	45	35	36	27	45	22	50	25	48	25	50	25	52	34	46	26	56	21	44	26	46	20	43	28	40	20	38	15	42	24															
<i>Phacus</i>	20	15	18	20	20	18	23	12	22	15	22	15	20	21	24	13	24	17	16	12	24	15	22	16	22	15	25	20	28	22															
Total	65	50	54	47	65	40	63	37	70	40	72	40	62	55	70	39	84	38	60	34	70	35	65	44	62	35	63	35	70	46															
Monthly Total Density	504	361	392	380	541	402	556	426	567	419	598	390	589	352	535	364	571	358	537	345	525	332	530	346	503	320	539	355	505	317															





Graph 4(A, B, C): Graph showing seasonal variation in phytoplankton density (org/l) at 5 different sampling stations of river Narmada (July 2011 to Sept. 2011)