Nepalese Journal of Biosciences **3(1): 18-25 (2013)** https://doi.org/10.3126/njbs.v3i1.41422

Phytoplankton status of Mahakali River, Nepal

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Abstract

Distribution of phytoplankton in Mahakali river was studied during 2003-2005. During the investigation a total of 31 genera belonging to 5 classes were identified. Chlorophyceae was dominant being represented by 15 genera, followed by Bacillariophyceae (9 genera), Cyanophyceae (5 genera), and 1 genus each of Dinophyceae and Xanthophyceae. The peak of Chlorophyceae was obtained in the month of April (465 units/l) during first year while in second year it was observed in the month of February (505 units/l). The maximum of Cyanophyceae was observed in the month of May (460 units/l) and March (216 units/l) during first and second year, respectively. Bacillariophyceae showed its maximum contribution during May (622 units/l) in first year and in March (600 units/l) in second year. The maximum density of phytoplankton was found during pre monsoon and minimum in early period of post monsoon (Sep.) and late period of monsoon. The density of phytoplankton increased from post monsoon (Oct.), whereas in rainy season, it was least due to dilution factor.

***Key words*:** Diatoms, chlorophyceae, cyanophyceae, *Microcystis*, monsoon.

Introduction

Phytoplankton forms the base of food chain in most of the aquatic ecosystems, thus playing a vital role in fisheries. The productivity of a water body is characterized by the presence of living organisms in the natural environment. Among the biotic components of an aquatic ecosystem, phytoplankton community plays a significant role in the productivity of the water body. Some of the prominent contributions on the various aspects of phytoplankton community analysis in freshwater bodies have been made by George (1966), Sarkar and Rai (1964), Munawar (1972), Abbas (1979), Sharma *et al.* (1982), Singh and Sharma (1998), Murugesan *et al.* (2003), Srivastava and Prakash (2003), Shrivastava (2005), Gurung *et al.* (2006), Tiwari and Chauhan (2006), Veereshkumar and Homani (2006), Tiwari and Shukla (2007), Sinthikumar and Sivakumar (2008), Singh and Singh (2008), Mukherjee *et al.* (2010), Kushwaha (2012). But the information regarding plankton of Mahakali river is very limited.

Study Site

The present study was conducted at the Chandani and Dodhara (Fig. 1), the V.D.C of Kanchanpur district near the bank of Mahakali river. The study area lies between longitude 80°25'E and latitude 28°35'N. It is situated at 176 m altitude. In the present study 12 Km of the river was investigated. Four sampling stations were selected for collection of water samples. Water samples from all the four stations were collected from three different depths.

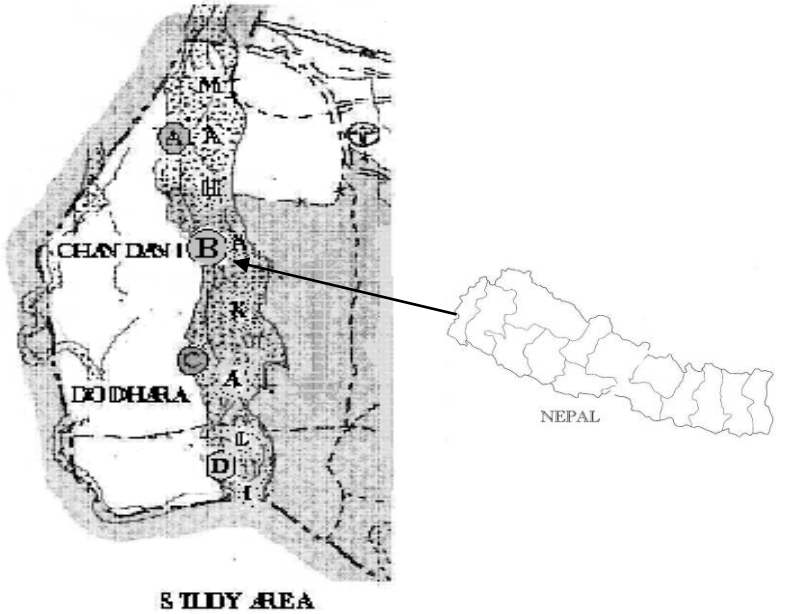

Figure 1. Chandani and Dodhara study area.

Materials and Methods

The samples for the qualitative and quantitative estimation of phytoplankton were collected from the different stations of the study area, during an interval of 15 days at 8.30 to 9.30 a.m. and all the samples were mixed together and formed compound sample for study. For the qualitative estimations, known volume of surface water was filtered through Whatman No.44 filter paper on the same day of collection. The filter paper was washed thoroughly with a wash bottle and the plankton was collected in a tube, which was later centrifuged, and the sample was concentrated up to 5 ml.

Census of phytoplankton population was done with an improved bright line haemocytometer. Phytoplankton population was counted in all the 9 chambers of the haemocytometer. The calculation of the phytoplankton density was done by the following way.

The haemocytometer slide is divided into two separate fields. Each field is a grid measuring 3x3mm. Since, there is 1/10 mm space between the cover slip and the slide, so the volume contained over the grid is 3 mm x 3 mm x 0.1mm = 0.9 mm^3.

$$\text{Thus No. of cells/ l} = \frac{\text{No. of cells}}{0.9\ mm^3} \times \frac{1000\ mm^3}{1 cm^3} \times \frac{1000\ cm^3}{1\ l}$$

The final values were obtained by dividing the above values by the concentration factor of the initial sample. The phytoplankton were identified by the help of Edmondson (1959) and Fitter and Manuel (1986).

Results and Discussion

Phytoplankton of the river system consisted of 31 genera belonging to three major classes, Chlorophyceae, Cyanophyceae and Bacillariophyceae. On the quality basis Chlorophyceae was dominant being represented by 15 genera, followed Bacillariophyceae (9 genera), Cyanophyceae (5 genera), 1 genus each of Dinophyceae and Xanthophyceae (Table 1).

Table 1. List of phytoplankton species collected from Mahakali river during 2003 - 2005.

SN	Phytoplanktons				
	Chlorophyceae	**Bacillariophyceae**	**Cyanophyceae**	**Dinophyceae**	**Xanthophyceae**
1	*Chlorella* Sp	*Navicula* Sp.	*Microcystis* Sp.	*Ceratium* Sp.	*Tribonema* Sp.
2	*Chlamydomonas* Sp.	*Diatoma* Sp.	*Spirulina* Sp.		
3	*Spirogyra* Sp	*Synedra* Sp.	*Gomphosphaeria* Sp.		
4	*Cladophora* Sp	*Cymbella* Sp.	*Oscillatoria* Sp.		
5	*Coelestrum* Sp.	*Gomphonema* Sp.	*Merismopedia* Sp.		
6	*Gonatozygon* Sp.	*Fragilaria* Sp.			
7	*Scenedesmus* Sp.	*Gyrosigma* Sp.			
8	*Ankistrodesmus* Sp.	*Asterionella* Sp.			
9	*Mougeotia* Sp.	*Tabellaria* Sp.			
10	*Pediastrum* Sp.				
11	*Closteridium* Sp.				
12	*Closterium* Sp.				
13	*Actinastrum* Sp.				
14	*Desmidium* Sp.				
15	*Cosmarium* Sp.				
	15	9	5	1	1

Total number of genera: 31.

Chlorophyceae was the dominant group due to the presence of *Chlorella* almost throughout the year. *Chlamydomonas* and *Spirogyra* were two other dominant members of Chlorophyceae (Tables 2 & 3). Bacillariophyceae was the second dominant group. *Diatoma* was mainly responsible for the dominance of this group which was abundant throughout the year (Tables 2 & 3). Cyanophyceae was the third dominant phytoplankton group. The dominant member of Cyanophyceae was *Microcystis* which was found throughout the year, followed by *Spirulina* (Tables 2 & 3). The density of phytoplankton ranged between 73 – 1566 units/l, minimum value being observed in monsoon and maximum in pre-monsoon (summer) (Tables 2 & 3).

The occurrence of Dinophyceae and Xanthophyceae were not remarkable. The phytoplankton taxa were most abundant in pre-monsoon and least in winter season. The density of the total phytoplankton ranged between 73 units/l (Sep.) to 1566 units/l (May) and 102 units/l (Aug.) to 1226 units/l (March) during the first and second year, respectively (Table 4).

Green algae (Chlorophyceae) were maximum, 465 units/l (April) and 505 units/l (February) during first and second year, respectively (Table 4). Cyanophyceae (Blue green algae) were maximum, 460 units/l in May and 216 units/l in March during first and second year, respectively (Table 4). Bacillariophyceae (Diatoms) were maximum, 622 units/l in May and 600 units/l in March during first and second year, respectively. Dinophyceae and Xanthophyceae were rare during the entire study period (Table 4). Chlorophyceae were minimum 40 units/l in September and 12 units/l in August during first and second year, respectively. Cyanophyceae were

minimum 11 units/l in September and 17 units/l in August during following years, while Bacillariophyceae were minimum 22 units/l and 50 units/l in September during both years.

Table 2. Quantitative analysis of phytoplankton of Mahakali river during 2003-2004

Phytoplankton	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
Chlorophyceae													
Chlorella Sp.	6	6	11	17	17	44	56	72	89	83	50	17	468
Chlamydomonas Sp.	11	6	17	33	39	50	-	94	122	-	-	-	372
Spirogyra Sp.	-	-	33	28	44	105	155	144	117	100	72	33	831
Cladophora Sp.	-	-	-	-	-	-	78	83	128	-	89	28	406
Coelestrum Sp.	-	-	-	-	-	-	-	-	-	17	-	-	17
Gonatozygon Sp.	-	28	-	-	-	-	-	72	-	39	-	28	167
Scenedesmus Sp.	6	-	-	-	-	-	-	-		-	17	-	23
Ankistrodesmus Sp.	-	-	-	-	-	-	-	-	-	-	-	17	17
Mougeotia Sp.	6	11	22	17	33	-	-	-	-	-	-	-	89
Pediastrum Sp.	11	11	17	-	22	-	-	-	-	-	-	-	61
Closteridium Sp.	-	-	-	-	-	-	-	-		-	-	-	-
Closterium Sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Actinastrum Sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Desmidium Sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Cosmarium Sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyanophyceae													
Microcystis Sp.	11	17	33	44	72	89	94	105	144	111	67	28	815
Spirulina Sp.	-	22	28	39	-	44	72	117	149	78	56	22	627
Gomphosphaeria Sp.	-	-	-	-	-	-	-	-	111	-	-	-	111
Oscillatoria Sp.	-	22	-	-	-	-	-	-	56	-	-	-	78
Merismopedia Sp.	-	-	-	-	-	-	-	-	-	-	-	11	11
Bacillariophyceae													
Navicula Sp.	-	-	-	-	-	-	-	22	-	-	-	-	22
Diatoma Sp.	22	28	39	56	72	78	100	178	222	155	56	28	1034
Synedra Sp.	-	-	33	44	50	72	94	111	144	105	28	17	698
Cymbella Sp.	-	-	-	-	-	-	-	56	-	-	-	-	56
Gomphonema Sp.	-	-	-	-	-	-	-	-	89	-	-	-	89
Fragilaria Sp.	-	-	-	-	-	-	28	-	78	39	-	-	145
Gyrosigma Sp.	-	-	-	-	-		17	-	89	-	22	-	128
Asterionella Sp.	-	-	-	-	-	-	-	-	-	-	-	-	
Tabellaria Sp.	-	-	-	17	-	-	-	-	-	-	-	-	17
Dinophyceae													
Ceratium Sp.	-	17	-	-	-	-	-	22	28	-	-	-	67
Xanthophyceae													
Tribonema Sp.	-	-	-	-	-	-	-	-	-	-	17	-	17
Total	73	168	233	295	349	482	694	1076	1566	727	474	229	6366

The number of genera varied throughout the year. The maximum number of genera (14) was recorded in May 2004 and the minimum (7) in Sep. 03, Feb. 04 and Jan. 05 during the entire study period (Table 5).

During the present study, the phytoplankton density varied from 73 units/l in September to 1566 units/l in May and 102 units/l in August to 1226 units/l in March during the first and second year of investigations, respectively. The maximum density of phytoplankton was found during pre-

monsoon (March and May) and lowest during monsoon (August) and post-monsoon (September). The density of phytoplankton increased from post-monsoon (October). Increase in phytoplankton population from post-monsoon (October) is a characteristic feature of other rivers.

Table 3. Quantitative analysis of phytoplankton of Mahakali river during 2004 - 2005

Phytoplankton	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Total**
Chlorophyceae													
Chlorella Sp.	17	33	50	72	83	105	144	-	111	61	33	6	715
Chlamydomonas Sp.	6	-	11	17	-	111	122	117	100	-	-	-	484
Spirogyra Sp.	-	-	50	67	94	122	144	105	28	-	-	-	610
Cladophora Sp.	-	-	-	-	-	-	-	-	-	44	28	-	72
Coelestrum Sp.	-	-	-	-	-	-	-	-	-	-	-	-	
Gonatozygon Sp.	-	33	-	-	-	56	-	-	-	39	17	6	151
Scenedesmus Sp.	22	-	-	-	-	-	-		-	-	-	-	22
Ankistrodesmus Sp.	-	-	-	-	-	-	-	-	-	-	-	-	
Mougeotia Sp.	28	33	-	-	94	111	-	-	-	-	-	-	266
Pediastrum Sp.	-	28	39	50	56	-	-	-	-	-	-	-	173
Closteridium Sp.	11	-	-	-	-	-	-	-	-	-	-	-	11
Closterium Sp.	6	-	-	-	-	-	-	-	-	-	-	-	6
Actinastrum Sp.	-	-	-	-	-	-	-	28	-	-	-	-	28
Desmidium Sp.	-	-	-	-	-	-	-	-	-	17	-	-	17
Cosmarium Sp.	-	-	-	-	-	-	-	-	33	-	-	-	33
Cyanophyceae													
Microcystis Sp.	22	17	28	44	61	78	105	94	78	56	22	6	611
Spirulina Sp.	-	28	33	50	-	89	111	-	-	44	17	11	383
Gomphosphaeria Sp.	-	-	-	-	-	-	-	-	-	-	-	-	
Oscillatoria Sp.	-	22	-	-	-	-	-	-	-	17	-	-	39
Merismopedia Sp.	-	-	-	-	-	-	-	-	-	-	-	-	
Bacillariophyceae													
Navicula Sp.	-	-	-	-	-	-	-	-	-	-	11	-	11
Diatoma Sp.	50	61	72	94	122	144	205	200	155	94	44	17	1258
Synedra Sp.	-	-	28	39	56	-	189	78	-	-	-	22	412
Cymbella Sp.	-	-	-	-	-	50	83	89	78	72	-	17	389
Gomphonema Sp.	-	-	-	-	-	-	-	-	-	-	28	-	28
Fragilaria Sp.	-	-	-	-	-	44	39	-	44	39	28	6	200
Gyrosigma Sp.	-	-	-	-	-	-	-	-	28	-	-	-	28
Asterionella Sp.	-	-	-	33	-	28	56	61	67	56	44	11	356
Tabellaria Sp.	-	-	-	-	-	-	28	-	-	-	17	-	45
Dinophyceae													
Ceratium Sp.	-	11	-	-	-	-	-	-	-	-	-	-	11
Xanthophyceae													
Tribonema Sp.	-	-	-	-	-	-	-	-	-	-	-	-	
Total	162	266	311	466	566	938	1226	772	722	539	289	102	6359

During monsoon (August) and post-monsoon (September) months, the density of phytoplankton was least due to dilution factor as a result of heavy precipitation in the catchment areas of river Mahakali. During monsoon months the river was heavily flooded and highly turbid with maximum velocity. Phytoplankton suspended in river water were dislodged and flushed out by the water current. This may be the reason for the poor representation of plankton group during

the monsoon. Similar observations have been made by Srivastava and Singh (1995) in the Ganga river.

Phytoplankton density, it's species composition and the dominance of certain species may vary from river to river, from location to location within the same river or even at the same location of a river from year to year. Sharma (1991) reported minimum density of plankton 20 units/l in August and 998 units/l in January from Bhagirathi river. Sehgal (1992) reported phytoplankton density between 13 to 11,643 units/l in 1985 and from 3 to 20,896 units/l in 1986 from the river Beas of Himachal Pradesh. Khanna *et al.* (1992) observed maximum number of Diatoms 4152 units/l in January and minimum 511.50 units/l in July from the Ganga river at Sapt Sarovar, Hardwar.

Table 4. Total estimated (units/l) composition of different classes of phytoplankton of Mahakali river during two years (2003-2005).

Month	Chloro	Cyno	Bacillario	Dino	Xantho	Total units/l
Sep.2003	40	11	22	-	-	73
Oct.	62	61	28	17	-	168
Nov.	100	61	72	-	-	233
Dec.	95	83	117	-	-	295
Jan.2004	155	72	122	-	-	349
Feb.	199	133	150	-	-	482
Mar.	289	166	239	-	-	694
Apr.	465	222	367	22	-	1076
May	456	460	622	28	-	1566
Jun.	239	189	299	-	-	727
Jul.	228	123	106	-	17	474
Aug.	123	61	45	-	-	229
Sep.	90	22	50	-	-	162
Oct.	127	67	61	11	-	266
Nov.	150	61	100	-	-	311
Dec.	206	94	166	-	-	466
Jan.2005	327	61	178	-	-	566
Feb.	505	167	266	-	-	938
Mar.	410	216	600	-	-	1226
Apr.	250	94	428	-	-	772
May	272	78	372	-	-	722
Jun.	161	117	261	-	-	539
Jul.	78	39	172	-	-	289
Aug.	12	17	73	-	-	102

The water temperature is one of the most important factor which influences the production of phytoplankton in a river system. Das and Srivastava (1959) pointed out the role of temperature as limiting factor for phytoplanktonic production. Khanna *et al.* (1993) and Joshi *et al.* (1996) are of the same view that the planktonic production is mainly influenced by temperature. During the present study, maximum phytoplankton was observed during summers (March and May).

Chlorophyceae was found to be in maximum number in April 2004 and February 2005 when the temperature increased. Abundance of Chlorophyceae genera is usually indicative of a better state

of water quality. The low incidence of *Pediastrum, Cymbella* and *Spirulina* and the dominance of Chlorophyceae indicated the less polluted nature of Mahakali river.

Table 5. Monthly changes in total species number in different groups of phytoplankton in Mahakali river during two years (2003-2005).

Month	Chloro	Cyano	Bacillario	Dino	Xantho	Total
Sep.2003	5	1	1	-	-	7
Oct.	5	3	1	1	-	10
Nov.	5	2	2	-	-	9
Dec.	4	2	3	-	-	9
Jan.2004	5	1	2	-	-	8
Feb.	3	2	2	-	-	7
Mar.	3	2	4	-	-	9
Apr.	5	2	4	1	-	12
May	4	4	5	1	-	14
Jun.	4	2	3	-	-	9
Jul.	4	2	3	-	1	10
Aug.	5	3	2	-	-	10
Sep.	6	1	1	-	-	8
Oct.	4	3	1	1	-	9
Nov.	4	2	2	-	-	8
Dec.	4	2	3	-	-	9
Jan.2005	4	1	2	-	-	7
Feb.	5	2	4	-	-	11
Mar.	3	2	6	-	-	11
Apr.	3	1	4	-	-	8
May	4	1	5	-	-	10
Jun.	4	3	4	-	-	11
Jul.	3	2	6	-	-	11
Aug.	2	2	5	-	-	9

Acknowledgement

The author is grateful to the Campus Chief, S.N. Science Campus, Mahendranagar, Kanchanpur, for laboratory facilities and constant encouragements.

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