Nature Conservation & Health Care Council
Biratnagar, Nepal

Our Nature
Journal homepage: http://nepjol.info/index.php/ON

ISSN: 1991-2951 (Print)
ISSN: 2091-2781 (Online)

Biomass composition of phytoplanktons in Mahakali River, Nepal

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Abstract
Phytoplankton biomass composition of Mahakali River has been studied. Samples were collected twice a month at an interval of 15 days for two years from September, 2003 to August, 2005. It was observed that the average annual biomass of phytoplankton community was 10.494 mg/m^3 during the first year and 8.057 mg/m^3 in the second year of the study. The peak of biomass was obtained in the month of May (15.276mg/m^3) and March (11.183mg/$m^{3)}$ during the first and second year, respectively. The lowest values of biomass were recorded in the month of September (0.989mg/$m^{3)}$ and August (0.842mg/$m^{3)}$ during the respective years.

***Key words*:** Algae community, Annual biomass, *Microcystis*, *Spirogyra*

DOI: http://dx.doi.org/10.3126/on.v14i1.16450

Manuscript details: Received: 28.06.2016 / Accepted: 23.11.2016

Citation: Mahaseth, V.K. 2016. Biomass composition of phytoplanktons in Mahakali River, Nepal. *Our Nature 14(1)*: 115-123. DOI: http://dx.doi.org/10.3126/on.v14i1.16450

Introduction
Phytoplankton, the minute chlorophyll bearing organisms, constitutes the most important component of the plankton and account for almost all the primary production in the water body. The growth of fish depends on the natural food available in the river. Generally, the fish grow well and remain healthy, if sufficient natural food is available. Plankton forms the base of food chain in most of the aquatic ecosystem, 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, plankton community plays a significant role in the productivity and the trophic balance of the system.

Indigenous plankton populations can be seen in large rivers, their density being lesser in rivers with high water current (Dobriyal *et al.* 1993). Plankton constitutes the major source of energy in the food web of aquatic systems. Their population fluctuates, depending on the hydrological regime and saprobiotic condition of the water. Because of their short life cycles, plankton responds quickly to environmental changes. Water temperature, light intensity, velocity and discharge of water, turbidity and alkalinity have widely been reported to affect plankton density in flowing waters (Bisht, 1993; Khanna *et al.* 1993). Planktonic fauna was abundant during the post-monsoon period, when the water temperature was moderate to low, current strength was feeble and the water was calm without turbidity. Plankton density was low during the rains, which may be due to high current and turbidity. The year round study by Srivastava and Singh (1995) in Ganga River revealed that during monsoon season, plankton abundance was almost negligible because of very fast water current, massive inflow of pollutants and heavy silt load.

Plankton is heterogeneous assemblage of microscopic organisms occurring in natural waters and floating by the wave action and movement of water. Plankton community is practically non-existent in the Mountain Rivers. Phytoplankton organisms are sensitive to velocity of flow in the rivers, the rapid current and mechanical stress inhibit the development of new plankton and suppress any existing organisms discharged from associated lentic waters.

Plankton, particularly phytoplankton, has been used as indicators of water quality. Some species flourish in highly eutrophic waters while others are very sensitive to organic and/or chemical wastes. Some of the prominent contributions on the various aspects of phytoplankton community analysis in freshwater bodies have been made by Singh (1965), Sharma (1980), Sharma *et al.* (1982), Srivastava and Prakash (2003), Sushama *et al.* (2005), Shrivastava (2005), Wetz *et al.* (2011), Peieris *et al.* (2012), Jabde and Rokade (2014), Putland *et al.* (2014) and Sharma (2016). But the information regarding plankton of Mahakali River is very limited.

The study of plankton is very important in development of riverine fisheries. Riverine ecosystems are integral and important component of freshwater ecosystem, of which mountain stream ecosystem is unique as well as distinct in all aspects.

Materials and methods

Mahakali river originates from Indo-Nepalese glaciers, Milan glacier of India and Lipu-lekh of Nepal. The river leaves the mountains near Tanakpur and then known as Sarada in India. Later, it reaches Sharada barrage, where it is considerably wider. Mahakali then enters into Nepal at Chandani and flows through Nepal upto Dodhara, after which it enters Indian Territory, finally confluence with the Ghaghara.

The present study was conducted in the Mahakali river (80°25'E, 28°35'N) at Chandani and Dodhara V.D.C. (Village Development Committee), Kanchanpur district. Four stations (A, B, C and D) were selected. First station 'A' is an upper station, which is near at Purnagiri temple of Syavle Bajar. Second station 'B' is 4 km from station A. Third station 'C', which is 4 km from station B. Fourth station 'D' is a lower station, which is 4 km from station C.

The study was carried out for a period of two years from September, 2003 to August, 2005. 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 on centrifuged, and the sample was concentrated up to 5 ml. The microscopic examination of the filtrate revealed that the loss due to filtration was minimal.

Census of phytoplankton population was done with an improved bright line Haem-ocytometer. Phytoplankton population was counted in all the 9 chambers of the Haemo-cytometer. A mean volume for each species was calculated by simulating to their geometric shapes that most closely resembled the algae, such as sphere, spheroid, cylinder etc (Vollenweider, 1969). Assuming the algal protoplasm having specific gravity 1.00 (Willen, 1959; Nauwerck, 1963), volume was converted into biomass.

Results and discussion

The studies on biomass of phytoplankton were recorded for two years (September 2003 to August 2005). The seasonal variation in the total biomass of the plankton is given in (Tabs. 1-2). During the investigation a total of 5 groups of phytoplankton were recorded, out of which, Cyanophyceae (51.072mg/m^3) was the most dominant followed by Chlorophyceae (13.048mg/m3) and Bacillariophyceae (6.872mg/m^3) during first year while in second year Cyanophyceae (36.328mg/m^3) was the most dominant followed by Bacillariophyceae (11.807 mg/m^3) and Chlorophyceae (10.666mg/m^3). The other two groups were insignificant in term of biomass (Tabs. 1-2, Fig. 1).

The peak of biomass was obtained in the month of May (15.276mg/m^3) during first year while in second year it was observed in the month of March (11.183mg/m^3) (Fig. 2). Chlorophyceae shared 18%, Cyanophyceae 67%, Bacillariophyceae 14%, Dinophyceae 1% and Xanthophyceae 0% to the total phytoplankton biomass on the two year mean basis (Fig. 3). In the present study, the peaks of phytoplankton biomass (March and May) were similar to those of phytoplankton density.

Important phytoplankton species in terms of biomass

The top five phytoplankton species which contributed about 2% of the total biomass based on two year mean value are considered as important phytoplankton species in terms of biomass. Seasonal variations in biomass of total species are given in tables 1 and 2.

Microcystis: It was the first important taxa in term of annual and two years mean basis both. It was observed throughout the year during whole study period. *Microcystis* shared 63.61% to the total phytoplankton biomass on the two years mean basis (Tab. 3). The biomass of *Microcystis* varied from 0.645-8.440mg/m^{3}and 0.352-6.154mg/m^3 during the first and second year, respectively (Tabs. 1-2). The peak of biomass was observed in the month of May and March during first and second year, respectively (Tabs. 1-2).

Spirogyra: In terms of biomass, *Spirogyra* ranked second on the two years mean basis. It shared 11.62% of the total phytoplankton

Table 1. Seasonal variation in biomass (mg/m^3) of phytoplankton in Mahakali river during 2003-04

Plankton	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	July.	Aug.	Total	Average
Chlorophyceae													**13.048**	
Chlorella	0.003	0.003	0.005	0.007	0.007	0.018	0.024	0.030	0.037	0.035	0.021	0.007	0.197	0.016
Chlamydomonas	0.267	0.015	0.041	0.080	0.095	0.121	-	0.228	0.296	-	-	-	1.143	0.142
Spirogyra	-	-	0.350	0.297	0.466	1.113	1.643	1.526	1.240	1.060	0.763	0.350	8.808	0.880
Cladophora	-	-	-	-	-	-	0.380	0.404	0.623	-	0.433	0.136	1.976	0.395
Coelestrum	-	-	-	-	-	-	-	-	-	0.035	-	-	0.035	0.035
Gonatozygon	-	0.051	-	-	-	-	-	0.132	-	0.072	-	0.052	0.307	0.076
Scenedesmus	0.001	-	-	-	-	-	-	-	-	-	0.003	-	0.004	0.002
Ankistrodesmus	-	-	-	-	-	-	-	-	-	-	-	0.021	0.021	0.021
Mougeotia	0.021	0.039	0.077	0.060	0.116	-	-	-	-	-	-	-	0.313	0.062
Pediastrum	0.044	0.044	0.068	-	0.088	-	-	-	-	-	-	-	0.244	0.061
Closteridium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Closterium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Actinastrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Desmidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cosmarium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyanophyceae													**51.072**	
Microcystis	0.645	0.996	1.934	2.579	4.220	5.217	5.510	6.154	8.440	6.506	3.927	1.641	47.769	3.980
Spirulina	-	0.017	0.021	0.029	-	0.033	0.054	0.088	0.112	0.059	0.042	0.017	0.472	0.047
Gomphosphaeria	-	-	-	-	-	-	-	-	2.220	-	-	-	2.220	2.220
Oscillatoria	-	0.129	-	-	-	-	-	-	0.328	-	-	-	0.457	0.228
Merismopedia	-	-	-	-	-	-	-	-	-	-	-	0.154	0.154	0.154
Bacillariophyceae													**6.872**	
Navicula	-	-	-	-	-	-	-	0.020	-	-	-	-	0.020	0.020
Diatoma	0.008	0.011	0.015	0.022	0.028	0.030	0.038	0.068	0.085	0.060	0.022	0.011	0.398	0.033
Synedra	-	-	0.191	0.255	0.290	0.418	0.645	0.644	0.835	0.609	0.162	0.099	4.148	0.414
Cymbella	-	-	-	-	-	-	-	0.893	-	-	-	-	0.893	0.893
Gomphonema	-	-	-	-	-	-	-	-	0.093	-	-	-	0.093	0.093
Fragillaria	-	-	-	-	-	-	0.213	-	0.593	0.296	-	-	1.102	0.367
Gyrosigma	-	-	-	-	-	-	0.026	-	0.134	-	0.033	-	0.193	0.064
Asterionella	-	-	-	0.025	-	-	-	-	-	-	-	-	0.025	0.025
Tabellaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dinophyceae													**0.575**	
Ceratium	-	0.146	-	-	-	-	-	0.189	0.240	-	-	-	0.575	0.191
Xanthophyceae													**0.075**	
Tribonema	-	-	-	-	-	-	-	-	-	-	0.075	-	0.075	0.075
Total	0.989	1.451	2.702	3.354	5.310	6.950	8.533	10.376	15.276	8.732	5.481	2.488	71.642	10.494

Table 2. Seasonal variation in biomass (mg/m^3) of phytoplankton in Mahakali river during 2004-05

Plankton	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	July.	Aug.	Total	Average
Chlorophyceae													**10.666**	
Chlorella	0.007	0.014	0.021	0.030	0.035	0.044	0.060	-	0.047	0.026	0.014	0.003	0.301	0.027
Chlamydomonas	0.0145	-	0.027	0.041	-	0.269	0.296	0.284	0.243	-	-	-	1.175	0.168
Spirogyra	-	-	0.530	0.710	0.996	1.293	1.526	1.113	0.297	-	-	-	6.465	0.924
Cladophora	-	-	-	-	-	-	-	-	-	0.214	0.136	-	0.350	0.175
Coelestrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gonatozygon	-	0.061	-	-	-	0.103	-	-	-	0.072	0.031	0.011	0.278	0.056
Scenedesmus	0.003	-	-	-	-	-	-	-	-	-	-	-	0.003	0.003
Ankistrodesmus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mougeotia	0.098	0.116	-	-	0.329	0.389	-	-	-	-	-	-	0.932	0.233
Pediastrum	-	0.112	0.566	0.200	0.224	-	-	-	-	-	-	-	1.102	0.275
Closteridium	0.001	-	-	-	-	-	-	-	-	-	-	-	0.001	0.001
Closterium	0.007	-	-	-	-	-	-	-	-	-	-	-	0.007	0.007
Actinastrum	-	-	-	-	-	-	-	0.017	-	-	-	-	0.017	0.017
Desmidium	-	-	-	-	-	-	-	-	-	0.015	-	-	0.015	0.015
Cosmarium	-	-	-	-	-	-	-	-	0.020	-	-	-	0.020	0.020
Cyanophyceae													**36.328**	
Microcystis	1.289	0.996	1.641	2.579	3.575	4.572	6.154	5.510	4.572	3.282	1.289	0.352	35.811	2.984
Spirulina	-	0.021	0.025	0.038	-	0.067	0.084	-	-	0.033	0.013	0.008	0.289	0.036
Gomphosphaeria	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oscillatoria	-	0.129	-	-	-	-	-	-	-	0.099	-	-	0.228	0.114
Merismopedia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bacillariophyceae													**11.807**	
Navicula	-	-	-	-	-	-	-	-	-	-	0.010	-	0.010	0.010
Diatoma	0.019	0.023	0.028	0.036	0.047	0.055	0.079	0.077	0.060	0.036	0.017	0.007	0.484	0.040
Synedra	-	-	0.162	0.226	0.332	-	1.096	0.452	-	-	-	0.128	2.396	0.399
Cymbella	-	-	-	-	-	0.798	1.323	1.420	1.244	1.148	-	0.271	6.204	1.034
Gomphonema	-	-	-	-	-	-	-	-	-	-	0.029	-	0.029	0.029
Fragillaria	-	-	-	-	-	0.334	0.296	-	0.334	0.296	0.213	0.046	1.519	0.253
Gyrosigma	-	-	-	-	-	-	-	-	0.042	-	-	-	0.042	0.042
Asterionella	-	-	-	0.049	-	0.341	0.082	0.090	0.098	0.082	0.065	0.016	0.823	0.103
Tabellaria	-	-	-	-	-	-	0.187	-	-	-	0.113	-	0.300	0.150
Dinophyceae													**0.942**	
Ceratium	-	0.942	-	-	-	-	-	-	-	-	-	-	0.942	0.942
Xanthophyceae													0.000	
Tribonema	-	-	-	-	-	-	-	-	-	-	-	-	0.000	
Total	1.439	2.414	3.000	3.909	5.538	8.265	11.183	8.963	6.957	5.303	1.930	0.842	59.743	8.057

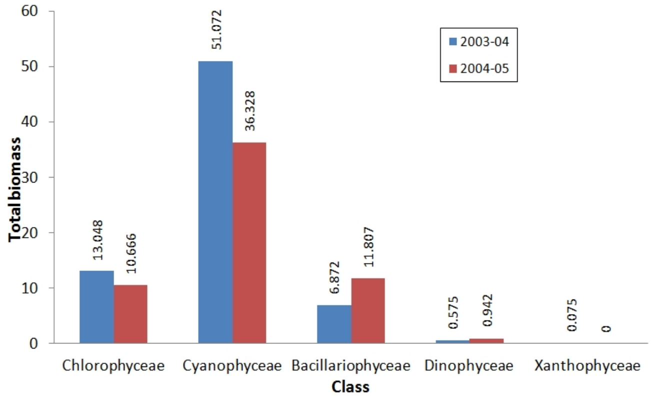

Figure 1. Class-wise biomass composition in Mahakali river.

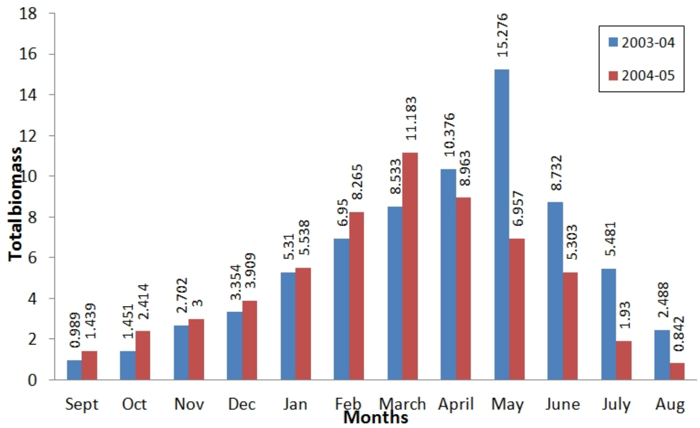

Figure 2. Monthly variation of biomass in Mahakali river

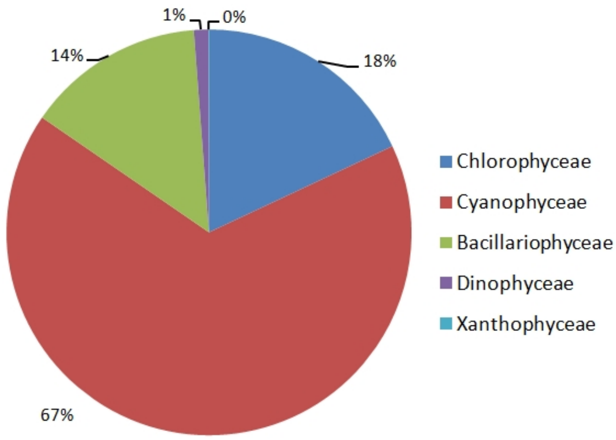

Figure 3. Percentage composition of biomass in Mahakali river

Table 3. Yearly biomass of phytoplankton mg/m^3

Phytoplankton	1st Year	2nd Years	Two Years Total	Percentage (%)	Rank
Chlorophyceae				**18.01**	
Chlorella	0.197	0.301	0.498	0.38	
Chlamydomonas	1.143	1.175	2.318	1.76	VII
Spirogyra	8.808	6.465	15.273	11.62	II
Cladophora	1.976	0.350	2.326	1.77	VI
Coelestrum	0.035	-	0.035	0.02	
Gonatozygon	0.307	0.278	0.585	0.45	
Scenedesmus	0.004	0.003	0.007	0.00	
Ankistrodesmus	0.021	-	0.021	0.01	
Mougeotia	0.313	0.932	1.245	0.95	
Pediastrum	0.244	1.102	1.346	1.02	X
Closteridium	-	0.001	0.001	0.00	
Closterium	-	0.007	0.007	0.00	
Actinastrum	-	0.017	0.017	0.01	
Desmidium	-	0.015	0.015	0.01	
Cosmarium	-	0.020	0.020	0.01	
Cyanophyceae				**66.52**	
Microcystis	47.769	35.811	83.580	63.61	I
Spirulina	0.472	0.289	0.761	0.58	
Gomphosphaeria	2.220	-	2.220	1.69	VIIl
Oscillatoria	0.457	0.228	0.685	0.52	
Merismopedia	0.154	-	0.154	0.11	
Bacillariophyceae				**14.21**	
Navicula	0.020	0.010	0.030	0.02	
Diatoma	0.398	0.484	0.882	0.67	
Synedra	4.148	2.396	6.544	4.98	IV
Cymbella	0.893	6.204	7.097	5.40	III
Gomphonema	0.093	0.029	0.122	0.09	
Fragilaria	1.102	1.519	2.621	1.99	V
Gyrosigma	0.193	0.042	0.235	0.18	
Asterionella	0.025	0.823	0.848	0.65	
Tabellaria	-	0.300	0.300	0.23	
Dinophyceae				**1.15**	
Ceratium	0.575	0.942	1.517	1.15	lX
Xanthophyceae				**0.05**	
Tribonema	0.075	-	0.075	0.05	

biomass on the two years mean basis (Tab. 3). The biomass of *Spirogyra* varied from 0-1.64 mg/m^3 and 0-1.52 mg/m^3 during first and second year, respectively (Tabs. 1-2). The peak of this alga was observed in the month of March in both years.

Cymbella: It ranked third and shared 5.40% of total phytoplankton biomass on the two years mean basis (Tab. 3). It was observed only in the month of April during first year while in several months in the second year. Its peak was noticed in the month of April.

Synedra: It ranked forth and contributed 4.98% of total phytoplankton biomass on the two years mean basis (Tab. 3). During first year, the biomass fluctuated from 0 - 0.835 mg/m^3 while 0 - 1.096 mg/m^3 in second year. Two peaks were observed, one in the month of May and another in the month of March during whole study period.

Fragilaria: It shared 1.99% and ranked fifth in the total phytoplankton biomass on the two years mean basis (Tab. 3). During the first year its biomass fluctuated from 0 - 0.593 mg/m^3 and 0-0.334 mg/m^3 in second year (Tabs. 1-2). The peak of biomass was observed in the month of May during both years of study. In the second year, another peak was also observed in the month of February.

During the present study, a total 31 phytoplankton were collected. The maximum number of phytoplankton genera was contributed by Chlorophyceae followed by Bacillariophycea, Cyanophyceae, Dinophyceae and Xanthophyceae (Tabs. 1-2). The phytoplankton community was mainly constituted by *Diatoma, Spirogyra, Microcystis, Chlorella, Synedra, Spirulina, Chlamydomonas, Chladophora, Cymbella* and *Asterionella.*

The maximum density of phytoplankton was found during pre-monsoon while minimum in early period of post monsoon (Sep.) and late period of monsoon. The density of phytoplankton increased from post-monsoon (Oct.). During rainy season, the density of phytoplankton was least due to dilution factor which flushed out along with water current. Srivastava and Singh (1995) have also reported that during rainy season, plankton abundance was almost negligible because of very fast water current in Ganga river. Shrivastava and Prakash (2003) observed winter and summer peak of phytoplankton in Mahanadi River while during the present observation only one peak in summer (pre-monsoon) was observed.

In the present study the peaks of phytoplankton biomass were observed at the same period (May and March) during pre-monsoon season. In the terms of biomass, *Microcystis* species was higher. The total two years biomass of phytoplankton varied from 0.001-83.580 mg/ m^3.

Acknowledgements

Thanks are due to the campus chief of S.N. Science Campus, Mahendranagar for providing the necessary facilities to the present work. The author is thankful also to Dr. (Mrs.) Manju Lata Bisht, Department of Zoology, D.S.B. Campus, Kumaun University, Nainital for her valuable guidance.

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