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PLANKTONIC DIVERSITY OF RIVER GANGA FROM DEVPRAYAG TO HARIDWAR, UTTARAKHAND (INDIA)

Deepmala Kaushik[1], Pratibha Giri[1] ,Sushil Bhadula[2]

[1]Department of Zoology, Hari Om Saraswati P.G. College, Dhanuari, Haridwar, Uttarakhand
[2]Department of Zoology, Dr. S.N.N. Government Degree College, Pauri Garhwal, Uttarakhand

ABSTRACT :

This research paper is emphasized on plankton diversity of Ganga River from Devprayag to Haridwar. Water of River Ganga analyzed for planktonic variety at four sampling points along the Ganga River, which stretches 120 kilometers from Devprayag to Haridwar. The investigation conducted for one year from January, 2024 to December, 2024. The study was conducted at four sites: namely, Devprayag, Rishikesh, Haridwar and Pul Jatwada. In the current study of the river Ganga, among the zooplankton, Protozoa, Rotifera, Cladocera, and Copepod represent the predominant component. During the study period, diatoms predominated, with the least amount of blue green algae recorded. Plankton diversity was highest throughout the winter and lowest during the monsoon season. It was also found that most of the plankton diversity was recorded at Site-I i.e. Devprayag and least diversity was recorded at Site-IV i.e. Pul Jatwada. During our observation Bacillariophyceae (61%) followed by chlorophyceae (35%) and Cyanophyceae (4%). In zooplankton, Rotifera (44%) was most dominant followed by protozoa (36%) , Cladocera (16%) and Copepoda (4%).

Key words: Phytoplankton, Zooplankton, Haridwar, Devprayag, Rishikesh, seasonal variation

Introduction :

The River Ganga is India's largest river basin, accounting for 26.2% of the country's total geographic area. The plankton in a reservoir is an essential biological indicator for determining the water quality of aquatic ecosystem. Plankton are surface dwellers and categorized as phytoplankton and zooplankton. Phytoplankton are crucial primary producers and the foundation of the food chain in open water. They are primary producers in any aquatic ecosystem and make their own food with the help of photosynthesis. Besides this, some species can be used as water quality indicators. Phytoplankton studies are useful for monitoring the physicochemical and biological properties of water in any aquatic ecosystem. Phytoplankton is increasingly being utilized to monitor the ecological quality and health of the aquatic environment, as well as to assess the efficacy of management or restoration programs or regulatory activities.

Fresh water constitutes of rivers, streams, lakes, wetlands, ponds, and reservoirs. These freshwater bodies directly contribute to the development of human civilization. Freshwater resources are deteriorating at an alarming rate, and water quality is increasingly a global issue. Freshwater communities, including phytoplankton, zooplankton, macrophytes, and macro-invertebrates, are susceptible to environmental conditions. Different species of plankton vary with the seasons due to changes in water. The phytoplankton population exhibits significant diversity with seasonal fluctuations, indicating diversity in ecological niches. The zooplankton at the secondary level of the food chain play an important part in the conversion of food energy generated by phytoplankton to the higher trophic level. Both phytoplankton and zooplankton supports the economically important fish populations. The plankton diversity is ecologically important, therefore this study has been taken in to account to identify the plankton from Ganga River ecosystem at different stretches.

Material and Methods :

Samples for the plankton study were collected from four sampling sites along the Ganga River between January, 2024 and December 2024. For qualitative examination, plankton samples were obtained using conventional plankton net. Plankton species were identified using standard methods **Edmondson (1992**).

Study Site

To assess phytoplankton diversity and abundance, samples were collected seasonally during the study period, from January 2024 to December 2024 at four spots: **Devprayag, Rishikesh, Haridwar and Pul Jatwada** within a stretch of 120 km in the Ganga River.

RESULTS AND DISCUSSION :

The obtained plankton forms were divided into two groups: phytoplankton and zooplankton. Phytoplankton constitutes of three family viz. Bacillariophyceae, Chlorophyceae, and Cyanophyceae, while zooplankton constitutes of Rotifera, protozoa, cladocera and copepoda. In Phytoplankton, bacillariophyceae being the most diverse, consisting of 35 genera. Chlorophyceae has 20 genera, while Cyanophyceae has only 02 genera. A total of 25 genera from four groupings have been recognized in Zooplankton category. Protozoa are made up of 09 genera, Rotifera have 11 genera, Cladocera have 04 genera, and Copepoda have 01 genera.

The Bacillariophyceae group is abundant in the river system, which are also known as diatoms. They were represented by 35 genera (Achnanthes, Achnanthidium, Amphipleura, Amphora, Bacillaria, Biddulphia, Brebissonia, Caloneis, Cocconeis, Cyclotella, Cymatopleura, Cymbella, Denticula, Diatoma, Diatomella, Encyonema, Epithelmia, Eunotia, Fragillaria, Fragilariforma, Frustulia, Gyrosigma, Melosira, Meridion, Navicula, Nedium, Nitzschia, Pinnularia These represented 61% of the entire population. **Bhadula and Joshi (2012)** reported the highest density in December, whereas numbers were low during the rainy season because to the rapid velocity of water. During the current investigation, Nitzschia species was the most dominant, while Diatoma species was the least dominant among the Bacillariophyceae group. The chlorophyceae group was the second most prominent group in the Ganga river, accounting for green algae. They were represented by 20 genera (Chlorella, Cladophora, Chlorococcus, Closterium, Cosmarium, Debarya, Desmidium, Hormidium, Hydrodictyon, Mesotaenium, Microspora, Micrasterias, Pediastrum, Rhizoclonium, Spirogyra, Stigeclonium, Tetradesmus, Ulothrix, Uronema, Zygnema), accounting for 35% of the total population. **Chakrabarty, et.al. (1980)** recorded greatest density throughout the winter and low numbers during the monsoon season. **Ariyadej, *et al.* (2004)** made similar observations, demonstrating that density and diversity were higher during the winter season than in the summer and monsoon. Cyanophyceae or blue green algae possess ability to grow in polluted waters hence called pollution tolerant group. In present study blue green algae contributed 4% of the total phytoplankton. Blue green algae were represented by 2 genera (Anabaena and Ocillotoria). Solar energy is stored in aquatic environments by phytoplanktonic species, which are producers that are consumed by zooplankton, which are main consumers, and secondary consumers are macro-invertebrates and planktivorous fish, which are consumed by fish **(Bhadula and Joshi, 2012)**.

Zooplankton Diversity

Protozoa made up the vast majority of zooplankton populations. During the current study, nine genera of protozoa (Arcella, Centrophyxis, Didinium, Difflugia, Loxodes, Paramecium, Stentor, Tetrahymina, and Volvox) were identified. The highest number of protozoans were reported from November to January, and the lowest from July to August. The lack of diversity during the rainy season could be attributed to excessive rains and floods, low water quality, and a scarcity of food. **Baghela (2006)** also described that zooplankton are mainly depend on population of phytoplankton and water quality of aquatic ecosystems. During our observation it was found that protozoa was second most group of zooplankton which constitutes 36% of total zooplankton population. **Das (2002)** also supports our results in terms of zooplankton.

Rotifera was most dominant group of Zooplankton which constitutes 44% of the total zooplankton population. The major portion of the zooplankton species were shared by Rotifers. The population of rotifers was maximum in December may be due to abundance in food. 11 genera of Rotifera (*Asplanchna, Brachionus, Dipleuchlanis, Filinia, Keratella, Lepidella, Monostyla, Notholca, Philodina, Polyarthra, Tricocera*) were recorded during the study period. This group dominated during winter months and considerably was very low in number during rainy months. The less diversity of this group was from July to September months due to rainfall and heavy floods, poor water quality and less food availability. **Canfield, *et.al.* (1996)** mentioned that the high number of Brachionus species indicates eutrophication in water body and this genus has ability to tolerate pollution but its only one species was found in all four sampling stations that indicate less pollution in river Ganga. **Chauhan (1993)** and **Sinha (1992)** also found similar type of patterns in zooplankton population in lotic ecosystems.

During the present investigation, 4 genera of Cladocera (Bosmia, Ceriodaphnia, Chydorus and Daphnia) were recorded from river Ganga at four sites. The Cladocera showed abundance from October to January. Similarly, **Alam and Khan (1998)** found maximum numbers of cladocerans from the months of October to January and least during monsoon months. **Joseph and Yamakanamardi (2011)** also reported similar observation when they studied the population of Zooplankton.

During the present investigation, one genus was recorded. The maximum abundance of Copepods were reported in October and the minimum during July and September. The living copepods constitute an essential link in the aquatic food chain. Though they are not as important element in fish diet as the Cladoceran Species however they are in intermediate trophic level among bacteria, algae and protozoa on one hand and small and large plankton predators on the other **Carter, *et.al.*, (1980).** In our overall observation it was revealed that most of the plankton population was higher in site-I i.e. Devprayag and least population of plankton was observed at site-IV i.e. Pul Jatwada. It is certainly due to the higher pollution load in site-IV. There is urgent need of strict policy to minimize the pollution level specially at Haridwar and Pul Jatwada.

Table- 1:- Phytoplankton diversity & seasonal variation at the four sites in Ganga river during January, 2024 to December, 2024

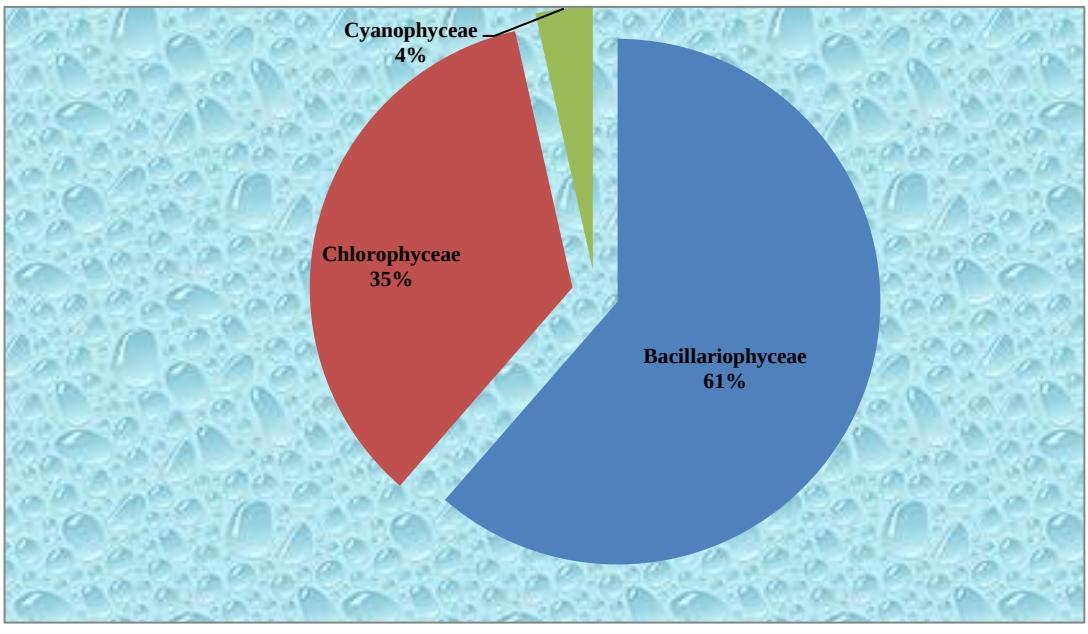
	WINTER				SUMMER				MONSOON			
Genera	**Devprayag**	**Rishikesh**	**Haridwar**	**Pul Jatwada**	**Devprayag**	**Rishikesh**	**Haridwar**	**Pul Jatwada**	**Devprayag**	**Rishikesh**	**Haridwar**	**Pul Jatwada**
Bacillariophyceae												
Achnanthes	+	+	+	-	+	+	+	+	-	+	-	-
Achnanthidium	+	+	+	-	+	+	+	-	-	+	-	-
Amphipleura	+	-	+	-	+	+	+	-	-	+	+	-

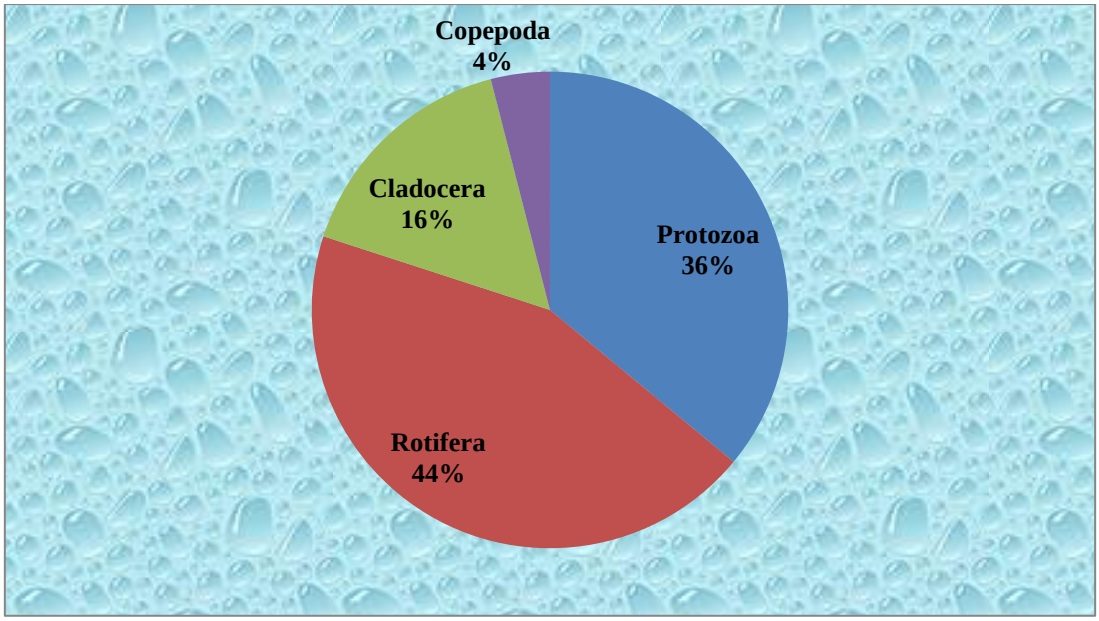
Amphora	+	+	+	-	+	+	+	-	+	+	+	+
Bacillaria	+	+	+	-	+	+	+	-	-	+	-	-
Biddulphia	+	-	-	-	+	+	+	-	+	+	-	+
Brebissonia	+	-	-	-	+	-	-	-	+	+	-	-
Caloneis	+	-	+	-	+	-	+	+	-	+	-	+
Cocconeis	+	-	-	+	+	+	+	+	+	+	-	+
Cyclotella	+	+	+	-	+	+	-	-	+	+	+	+
Cymatopleura	+	+	-	-	+	+	+	+	-	-	+	+
Cymbella	+	+	+	-	+	+	+	+	+	+	-	+
Denticula	+	-	+	-	+	+	+	+	-	-	+	-
Diatoma	+	+	+	+	+	+	+	+	+	+	-	+
Diatomella	+	-	-	+	-	+	-	-	-	-	+	-
Encyonema	+	+	+	+	+	+	+	+	-	-	-	-
Epithelmia	+	-	+	+	+	-	+	+	+	-	-	-
Eunotia	+	-	-	+	-	+	-	-	-	-	-	-
Fragillaria	+	-	+	+	-	+	+	+	-	-	+	+
Fragilariforma	+	+	+	-	+	+	-	-	+	-	-	-
Frustulia	+	+	-	-	+	+	-	-	-	-	-	-
Gomphoneis	+	+	+	+	+	+	+	+	+	+	-	+
Gyrosigma	+	+	+	+	+	+	-	-	+	-	-	-
Melosira	+	+	-	-	+	+	-	-	-	-	-	-
Meridion	-	-	-	+	-	+	+	+	-	-	-	-
Navicula	+	+	+	+	+	+	+	+	+	+	+	+
Nedium	+	-	-	-	-	+	+	+	-	-	-	+
Nitzschia	+	-	-	-	+	+	+	+	-	-	+	-
Pinnularia	+	+	-	-	+	+	+	+	+	-	-	+
Rhoicosphenia	+	+	+	+	+	+	-	-	+	+	+	+
Rhopalodia	+	+	+	-	+	+	-	-	-	+	+	-
Rhicosphenia	+	+	+	+	+	+	+	+	-	-	-	-
Surrirella	+	+	+	+	+	+	-	-	+	-	-	-
Synedra	+	+	-	-	+	+	-	-	-	+	+	+
Tabellaria	+	+	+	+	+	+	+	+	+	+	+	+
Chlorophyceae												
Chlorella	+	-	-	-	+	-	+	+	+	-	-	+
Cladophora	+	-	-	-	+	+	-	-	+	-	-	-
Chlorococcus	+	+	+	-	+	+	-	-	+	-	-	-
Closterium	+	+	-	-	+	+	-	-	-	-	-	-
Cosmarium	+	+	+	-	+	+	-	-	+	-	-	-
Debarya	+	+	-	-	+	+	-	-	-	-	-	+
Desmidium	+	+	+	+	+	+	-	-	+	-	-	-
Hormidium	+	+	-	-	+	+	-	-	-	-	-	+
Hydrodictyon	+	+	+	+	+	+	-	-	+			
Mesotaenium	+	+	-	-	+	+	-	-	-	-	-	+
Microspora	+	-	-	+	+	-	-	+	+	-	-	-
Micrasterias	+	+	+	+	+	+	-	-	+	-	-	-
Pediastrum	+	+	-	-	+	+	-	-	-	-	-	+
Rhizocloniu m	+	-	-	+	+	-	-	+	-	-	-	-
Spirogyra	+	+	+	+	+	+	+	+	-	-	-	+
Stigecloniu m	+	+	+	+	+	+	+	+	+	+	-	+
Tetradesmus	+	+	+	-	+	+	+	+	-	+	-	+
Ulothrix	+	+	+	-	+	+	+	-	+	-	-	-
Uronema	+	+	+	+	+	+	+	-	-	-	-	-
Zygnema	+	+	+	+	+	+	+	+	+	-	-	+
Cyanophyceae												
Anabaena	-	-	-	+	-	-	-	+	-	-	-	-
Ocillotoria	+	-	-	-	-	-	-	-	-	-	-	-

Table- 2:- Zooplankton diversity & seasonal variation at the four sites in Ganga river during January, 2024 to December, 2024

	Winter				Summer				Monsoon			
Genera	**Devprayag**	**Rishikesh**	**Haridwar**	**Pul Jatwada**	**Devprayag**	**Rishikesh**	**Haridwar**	**Pul Jatwada**	**Devprayag**	**Rishikesh**	**Haridwar**	**Pul Jatwada**
	Protozoa											
Arcella	+	+	+	+	+	+	+	+	+	+	+	+
Centrophyxis	+	+	-	+	+	+	-	-	+	-	+	+
Didinium	+	-	-	-	+	+	-	-	+	+	-	-
Difflugia	+	+	+	-	+	+	+	-	+	+	+	+
Loxodes	+	+	+	-	+	+	+	-	+	+	-	-
Parameciu m	+	-	-	-	+	+	+	-	+	-	+	-
Stentor	+	-	-	-	+	-	-	+	+	+	-	-
Tetrahymina	+	+	+	+	+	+	+	+	+	+	+	-
Volvox	+	-	-	+	+	+	-	-	+	+	+	-
Rotifera												
Asplanchna	+	-	-	+	+	+	+	+	+	-	+	+
Brachionus	+	+	+	+	+	+	+	+	+	+	+	+
Dipleuchlanis	+	+	+	-	+	+	+	+	+	+	+	-
Filinia	+	-	+	-	+	+	-	+	-	+	+	-
Keratella	+	-	-	-	+	-	+	-	+	+	+	-
Lepidella	+	+	+	-	+	+	+	-	+	+	+	-
Monostyla	+	-	-	-	+	-	+	-	+	+	+	-
Notholca	+	+	+	+	+	+	+	-	+	+	+	+
Philodina	+	+	+	+	+	+	+	+	+	+	+	+
Polyarthra	+	-	-	+	+	+	-	-	+	+	+	-
Tricocera	+	-	-	+	+	+	+	+	+	+	+	+
Cladocera												
Bosmia	+	-	-	+	+	+	-	+	-	+	+	+
Ceriodaphnia	+	+	-	+	+	+	+	+	+	+	+	-
Chydorus	+	-	+	+	+	-	-	+	+	+	+	-
Daphnia	+	+	+	+	+	+	+	+	+	+	+	-
Copepoda												
Cyclops	+	-	-	+	+	-	+	+	+	+	+	+

Graph-1: Showing phytoplankton composition in Ganga River from Devprayag to Haridwar during the year 2024





Graph-1: Showing zooplankton composition in Ganga River from Devprayag to Haridwar during the year 2024

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