*Int.J.Curr.Microbiol.App.Sci* (2020) *9*(11): 2662-2669

*International Journal of Current Microbiology and Applied Sciences*
***ISSN: 2319-7706* Volume 9 Number 11 (2020)**
Journal homepage: http://www.ijcmas.com

**Original Research Article** https://doi.org/10.20546/ijcmas.2020.911.323

# Qualitative and Quantitative Estimation of Phytoplankton and their Monsoon-Post Monsoon Fluctuations in Different Water Bodies, Tarai Region of Uttarakhand, India

**Ujjwala Upreti* and R. N. Ram**

*Department of Aquaculture, College of Fisheries, G.B.P.U.A & T., Pantnagar, India*
**Corresponding author*

**Keywords**

Phytoplankton, Tarai region, Fish pond, Beni River and physico-chemical parameters

**Article Info**

***Accepted:***
20 October 2020
***Available Online:***
10 November 2020

**A B S T R A C T**

A study was conducted on qualitative and quantitative analysis of phytoplankton to identify and estimate the abundance of phytoplankton in the Muddy pond, Stone pitched pond and Beni River. Analysis of phytoplankton samples recorded a total of 5 classes of phytoplankton viz.; Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceae and Fragilariophyceae. Out of 15 phytoplankton genera identified, 1 belong to Cyanophyceae, 5 to Chlorophyceae, 7 to Bacillariophyceae, 1 to Euglenophyceae and 1 to Euglenophyceae. Among the identified genera, *Gomphonema*, *Caloneis* and *Navicula*were found to be dominant genera. Total phytoplankton abundance was varied from 37632 cells/l to 40436 cells/l in the experimental ponds. Among all experimental ponds, Bascillariophyceae was found dominant. Second dominant group was Euglenophyceae observed in Stone pitched pond. Total phytoplankton densities were recorded 40436 cells/l, 34840 cells/l and 37620 cells/l in Muddy pond, Stone pitched pond and Beni River respectively. Management technique and water quality parameters were also studied during study period namely water temperature, Total dissolved solids (TDS), dissolve oxygen and pH. The present study reveals that phytoplankton species are variable among the different water bodies and their density is also variable. There is a certain decline in plankton density during monsoon which gradually increases post monsoon. The information provides for more research to match water quality and pond phytoplankton characteristics in earthen aquaculture systems with and without fish stocking.

## Introduction

Phytoplankton forms an intrinsic component of freshwater wetlands which significantly enriches the way towards succession and dynamics of zooplankton and fish. Community structure, dominance and seasonality of phytoplankton in tropical wetlands are rich in variety and are functions of nutrient status, water level, morphometry of the underlying substrate and other regional factors (Gopal and Zutshi, 1998; Zohary *et al*., 1998; Agostinho *et al.*, 2001).

Amicroscopic community of plants (phytoplankton), found usually free floating, swimming with little or no resistance to water currents, suspended in water, non-motile or insufficiently motile to beat transport by currents, are called "Plankton".

Phytoplankton (microscopic algae) usually occurs as unicellular, colonial or filamentous forms and is mostly photosynthetic and is gazed upon by the zooplankton and other organisms occurring in the same environment.

Phytoplanktons being the main producers of an aquatic ecosystem control the biological productivity. The variability of phytoplankton with the seasonal changes in aquatic environment is very much vital for the maintenance of water quality and sustainable aquaculture. Phytoplankton form the basis of food chain in open water resources, also acting as an indicator of the water quality. Due to the interdependence acting between the different entities of which systems are composed, these variations in the phytoplankton communities translate to variances in the trophic chain and the productivity of the lakes. Phytoplankton can be a dilemma in aquaculture. Properly managed populations are very often beneficial ("friend") to aquaculture production systems, but if inadequately managed, they will proliferate out of control and may have significant negative effects ("foe").Many species of phytoplankton that are propitious in shrimp and fish farming in terms of nutrition and removal of excessive nutrients (such as ammonium, nitrate and phosphate), are also responsible for a diel pH change which influences the dynamics of ammonia and hydrogen sulfide, both of which can be highly toxic to aquaculture species. Pond oxygen depletion at night is likely when excessive phytoplankton blooms occur, which in turn can affect and even kill cultured shrimp and fish, and phytoplankton groups like dinoflagellates can release toxins once they die and affect the health of shrimp and fish. Phytoplankton populations thus can perform the dual roles of friends or foes in aquaculture systems, depending on how adequately they are managed. The success of phytoplankton estimation and productivity would majorly depend upon the use of correct methodology which involves collections of samples, fixation, preservation, analysis and computation of data. The qualitative and quantitative ampleness of plankton and its relation to environmental condition has become a prerequisite for fish production.

The physico-chemical characteristics of water have certain impacts on the abundance, species composition, stability and productivity of the primitive populations of aquatic organisms. The quality and quantity of planktons vary in reference to depth, site, time and the season of the collection. They also differ according to biological and climatic factors (Sukumaran and Das, 2002).

Little or no studies on water quality and phytoplankton in culture ponds and Beni River in the Tarai region, Pantnagar Uttarakhand therefore, this research reports on qualitative and quantitative analysis of phytoplankton in culture ponds (muddy and stone pitched) and Beni River with some recommendations for further studies within the respective region.

## Materials and Methods

### Study area

Muddy pond (used for culture purpose by instructional farm of College of Fisheries, G.B.P.U.A.T.), stone pitched (pond with stone pitched dike, College of Fisheries G.B.P.U.A.T.) and Beni River located in Pantnagar, distt. U.S. Nagar, Uttarakhand, was chosen as experimental sites. The sampling was conducted over a 3-months period from August to October 2018 fortnightly. The muddy pond is regularly managed by fertilizer, cow dung, lime etc. and used for culture practices by the College of Fisheries, Gobind Ballabh Pant University of Agriculture and Technology, river is the open access without any management and the stone pitched being managed bi-monthly. The

present study is aimed at evaluating the variation during monsoon and post monsoon in the diversity and density of phytoplankton to cover the existing gap in the knowledge.

The biological methods used for assessing water quality include collection, counting and identification of aquatic organisms followed by processing and interpretation of data.

## Phytoplankton sampling and analysis

Phytoplankton samples were collected using plankton net by filtering 50 litres of water through it. The sieved residue, collected in the tube of 50ml capacity attached at the end of the net, was properly transferred to a well labelled vial and transported to the lab under dark conditions. The bottles were thoroughly cleaned and rinsed with distilled water prior to sampling. Sample was preserved by adding 1 ml of Lugols solution and 3 drops of 4% formalin (APHA 1998). Quantitative analysis of plankton was done by drop count method using Neubauer chamber. The results were recorded by counting the number of organisms per ml.

## Water quality analysis

Surface waters were collected twice a month during morning hours for estimating various physico-chemical parameters. Water temperature and pH were measured on site using mercury thermometer and pH strips respectively. D.O. bottles were used for collecting water and estimation was done by titration method. T.D.S. was measured using probe.

## Statistical analysis

The Graphs (Fig. 1) and tables (1–4) were represented in Microsoft excel. The R software and Microsoft Excel 2007 was used to plots graphs for dissemination of the results.

## Results and Discussion

### Qualitative and Quantitative status of phytoplankton community in experimental site

In the present study, 15 genera were identified in the two ponds and one river (Table 1). Maximum variety of the genera was found in the muddy pond (Table 2) during the sampling period. Phytoplankton constructs the base of aquatic food chain and any type of mutation in physical and chemical properties of water due to seasonal inconstancy and degree of pollution can be better assessed by their evaluation. Study and monitoring of phytoplankton are advantageous for control of biological conditions of water (Ariyadej *et al.*, 2004).Qualitative status of phytoplankton depends on the pond, type of water body (lotic or lentic), season, water quality parameters, management activities etc. In the course of study period 15 genera of phytoplankton population were spotted which fall into five major groups named Bacillariophyceae, Euglenophyceae, Chlorophyceae, Cyanophyceae and Fragilariophyceae. The maximum density is recorded in Muddy pond i.e. 40436no./l while the minimum in stone pitched pond i.e. 34840no./l, with Beni River showing a mediocre number of 37620/l. The phytoplankton population in nutrient rich waters is more diverse than those in nutrient deficient waters, Margalef (1964). Among muddy, stone pitched pond and Beni river phytoplankton density was higher in muddy pond throughout the three months. Phytoplankton density was higher in muddy pond, as it is used for culture pond and many fertilizers have been added in the pond, accompanied by the maximum diversity of 8 genera of the total phytoplankton community recorded during study period.

**Table.1** Generic status of phytoplankton with their different groups recorded from Muddy, Stone pitched pond and Beni River during the study period

| Group | Genus |
|---|---|
| **Chlorophyceae** | *Chlorella* |
| | *Senedesmus* |
| | *Spirogyra* |
| | *Pediastrum* |
| | *Ankistrodesmus* |
| **Bacillariophyceae** | *Navicula* |
| | *Nitzchia* |
| | *Melosira* |
| | *Diatoma* |
| | *Caloneis* |
| | *Gomphonema* |
| | *Tabellaria* |
| **Euglenophyceae** | *Euglena* |
| **Cyanophyceae** | *Microcystis* |
| **Fragilariophyceae** | *Synedra* |

**Table.2** Algae present in different water bodies during experimental period

| Algae | Muddy pond | Stone pitched | Beni River |
|---|---|---|---|
| **Chlorella** | + | - | - |
| **Senedesmus** | - | + | - |
| **Pediastrum** | + | ++ | - |
| **Euglena** | - | ++ | - |
| **Navicula** | + | - | ++ |
| **Synedra** | ++ | - | + |
| **Melosira** | - | + | - |
| **Nitzchia** | + | ++ | - |
| **Diatoma** | - | - | + |
| **Ankistrodesmus** | - | + | - |
| **Spirogyra** | - | - | ++ |
| **Gomphonema** | ++ | ++ | + |
| **Tabellaria** | - | - | ++ |
| **Microcystis** | + | - | - |
| **Caloneis** | ++ | - | ++ |

(+) = present
(++) = abundant
(-) = absent

**Table.3** Quantitative estimation of phytoplankton community in experimental sites

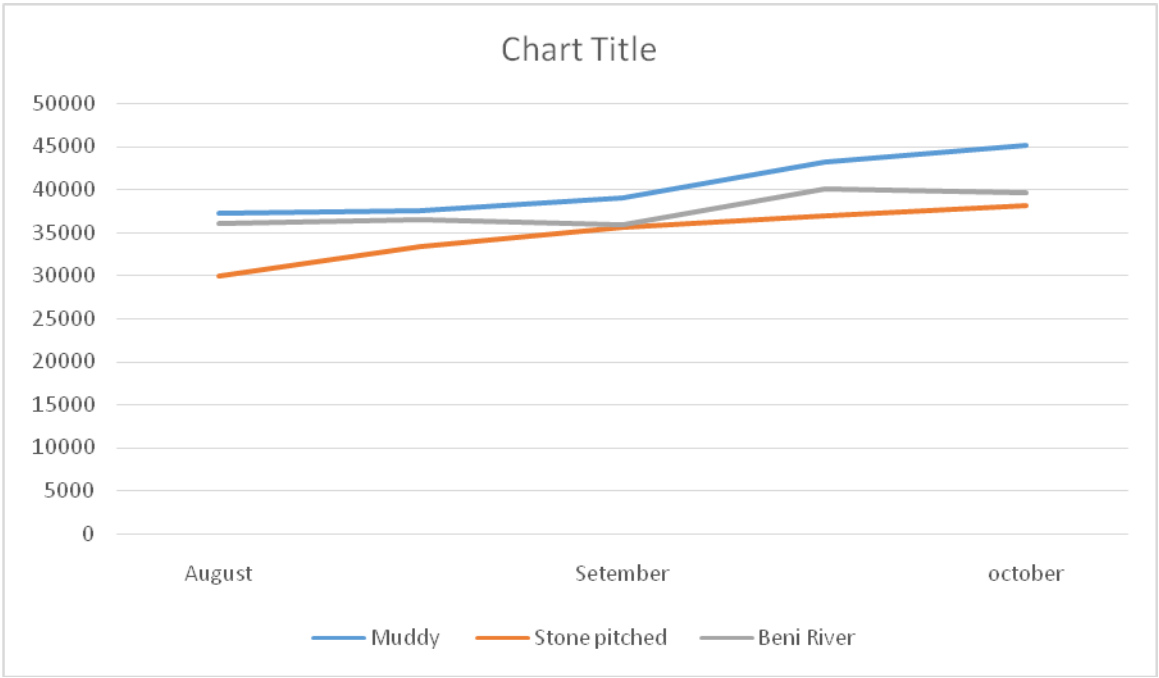
| Water bodies | Quantity (no./l) |
|---|---|
| **Muddy pond** | 40436 |
| **Stone pitched pond** | 34380 |
| **Beni River** | 37620 |
| **Mean** | 37632 |
| **Standard error** | 1615.43 |

Maximum – Muddy pond
Minimum – Stone pitched pond

**Table.4** Physico-chemical parameters with their mean values and standard error of different water bodies

| | Muddy pond | Stone pitched pond | Beni River | Mean | Standard error |
|---|---|---|---|---|---|
| **D.O. (mg/l)** | 5.6 | 5.56 | 6.12 | 5.76 | 0.18 |
| **pH** | 7.82 | 7.78 | 7.88 | 7.82 | 0.08 |
| **TDS(ppm)** | 242.8 | 228.6 | 263 | 244.8 | 9.98 |
| **Temperature($^0$C)** | 27.36 | 27.58 | 26.8 | 27.24 | 0.23 |

**Fig.1** Fortnightly fluctuations in quantity of phytoplankton



A clear perspective was seen in a study that abundance of blue green algae tends to increase as nutrient inputs in fertilizers or feeds increase, Claude E. Boyd (2017), however in the present study just a mere presence of blue green algae can be observed in the muddy pond. Bacillariophyceae group was found dominant in the Beni River because of lower pH in Muddy pond and Stone pitched pond. The acidic waters do not support an abundance of Bacillariophyceae, while in alkaline waters, their density is more, Patrick (1973). It should also be noted that only temperature may not account for variations in phytoplankton densities, as other factors including high pH, alkalinity, carbon dioxide and nutrients are also responsible for the organic production (Pulle *et al*., 2003). Thus, it may be drawn to conclusion that the composition of phytoplankton is dependent on multiple abiotic factors either directly or indirectly. Microcystis, only member of Cyanophyceae recorded during the study period, was observed during the monsoon in Muddy pond and disappeared with the onset of post monsoon & winters, also it has been recorded that the maximum abundance of blue-green algae (Cyanophyceae) during summer months in Kumaon lakes (Sharma *et al*., 1979). This obviously points towards the availability of sufficient sunlight and high-water temperature. The taxa emphasis with reference to pollution index (Palmer C.H, 1980); supporting the fact that Beni River being a local access is more prone of getting polluted. The maximum density of phytoplankton was found post monsoon i.e. October and minimum were recorded during monsoon i.e. August and September in the present study. In the tropics the amount of rainfall plays a significant role in shaping up the various seasonal biological rhythms (Carter G.S, 1960).

The density of phytoplankton clearly shows a dynamic with respect to monsoon, with the onset of monsoon the density of phytoplankton is minimum, as the monsoon declines in mid-September a slight increase, followed by maximum density in October (post monsoon) can be seen.A study showed that the proliferation of plankton has been attributed to increase in winter temperature and photoperiodicity in Gularia reservoir (Wishard and Mehrotra, 1988). Also, it has been proposed that the number of genera and species of different algal groups were maximum during summer, declined during monsoon and again increased during winter (Rani and Shivakumar, 2012), a similar pattern of decline in density of phytoplankton followed by an increase is seen in the current study (Figure 1). The fact that peaks of phytoplankton abundance appear at different periods in different years and the cause of reduced plankton yield is the result of rains that diluted the pond water (Sreenivasan, 1964) has been proposed.

It can be concluded that heavy rainfall leading to dilution of the water body results in the reduction of plankton community. There is a significant difference seen in the quantity of plankton in different water bodies during the experimental period. Dissolved oxygen and total dissolved solids are also showing significant differences among the stagnant and flowing water bodies with higher levels in river and comparatively lower levels in the pond ecosystem, i.e. Muddy pond water- 5.6mg/l and that of Beni River- 6.12mg/l. It can be predicted from the current study that regularly managed pond is higher in both the qualitative and quantitative manners rather than the bi-monthly managed stone pitched pond followed by open access local Beni River, which might get polluted at this rate without considering proper measures.

Since the nutritional profile is another factor that can also be included for the estimation of different planktonic communities in the sites mentioned, there is still lot more scope in the current studies to continue and further studies

on the effects on phytoplankton production in the fish ponds along with all year extended monitoring is recommended in future studies.

## References


A.P.H.A. Standard methods for the examinations of water and wastewater. American Public Health Association, Washington, D.C., New York, 1992, 874.

Agostinho AA, Thomaz SM, Minte-Vera CV, Winemiller KO. Biodiversity of the Parana River floodplain. – In: Gopal B, Jumk WJ, Davis JA (eds) Biodiversity in wetlands: assessment, function and conservation, Backhuys Publishers, Leiden, 2001; 1:89-118.

Ariyadej C, Tansakul P, Tansakul R, Angsupanich S. Phytoplankton diversity and its relationship to the physicochemical environment in the Banglang reservoir, Yala Province, Songklanakarin. J Sci. Technol. 2004; 26(5):595-607.

Carter GS. Tropical climates and biology. Nature, lond, 1960; 127-843.

Claude E. Boyd. Phytoplankton and its impact on water quality. Global Aquaculture Alliance. 2017.

Gopal B, Zutshi DP. Fifty years of hydrobiological research in India. Hydrobiologia. 1998; 384:267-290.

Goswami K. and Trakroo M. Das. An overview of qualitative and quantitative composition of phytoplankton community at Lake Nainital. Journal of Pharmacognosy and Phytochemistry 2019; 8(2): 1800-1804.

Margalef R. Correspondence between the Classical types of lakes and structural and dynamic properties of their populations. Verh. Int. Verien Theor. Angew. Limnology. 1964; 15:169-175.

Mishra A, Chakraborty SK, Jaiswar AK, Sharma AP, Deshmukhe G, Mohan M. Plankton diversity in Dhaura and Baigul reservoirs of Uttarakhand. Indian J. Fish. 2010; 57(3): 19-27, 2010.

Ojha P. Phytoplankton diversity in an irrigation cum fish culture reservoir. International Research Journal of Natural and Applied Sciences Volume-1, Issue-6 (November 2014) ISSN: (2349-4077).

Palmer CH. Algae and water pollution. Castle House Publications Ltd. 1980.

Patrick. The effect of increasing light and temperature on the structure of diatom communities. Limnology Oceanography. 1973; 16: p 405-421.

Pulle JS, Khan AM. Phytoplanktonic study of Isapur dam water. Ecology and Environmental Conservation. 2003; 9:403-406.

Rani R, Shivakumar K. Physico-chemical parameters and phytoplankton richness in certain ponds of Chidambaram, Cuddalore district of Tamil Nadu. International Journal of Research in Environmental Science and Technology. 2012; 2(2):35-44.

Sharma AS, Pant MC. Certain physico-chemical features of chlorophyll concentration and phytoplankton population in a high altitude lake. Trop. Ecol. 1979; 20: 101-113.

Sreenivasan A. Hydro biological study of a tropical impoundment, Bhavanisagar reservoir, Madras State, Indian for the year 1956-61. Hydrobiologia. 1964; 24: 514-539.

Sukumaran KP, Das AK. Plankton abundance in relation to physicochemical features in a peninsular man-made lake. Environmental Ecology. 2002; 20:873-879.

Wishard SK, Mehrotra SN. Periodicity and abundance of plankton in Gularia reservoir in relation to certain physico-chemical conditions. J. Inland fish. Soc.

1988; India 20 (1): 42-49.
Zohary T, Fishbein T, Kaplan B, Pollingher U. Phytoplankton- metaphyton seasonal dynamics in a newly-created subtropical wetland lake. – Wetlands Ecol Manage Scotland: University of Stirling. 1998, 119.

**How to cite this article:**

Ujjwala Upreti and Ram, R. N. 2020. Qualitative and Quantitative Estimation of Phytoplankton and their Monsoon-Post Monsoon Fluctuations in Different Water Bodies, Tarai Region of Uttarakhand, India. *Int.J.Curr.Microbiol.App.Sci.* 9(11): 2662-2669.
doi: https://doi.org/10.20546/ijcmas.2020.911.323