International Journal of Biology Research
www.biologyjournal.in
ISSN: 2455-6548
Received: 15-09-2021, Accepted: 30-09-2021, Published 16-10-2021
Volume 6, Issue 4, 2021, Page No. 1-4

Phytoplankton diversity in commercial fish farm

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Abstract
Survey on the phytoplankton diversity were conducted at commercial fish farming pond in Bishnupur district of Manipur during 2017, 2018 and 2019 for their diversity and periodicity of occurrence. Phytoplankton are inseparable associates of the environment. There is a direct correlation of phytoplanktons to the physicochemical properties of water. Among the district of Manipur, Bishnupur is one of the leading fish producing districts. The present study was to understand the diversity and distribution pattern of microalgae in commercial fish farming pond. In the present study, 58 species of phytoplanktons belonging to 47 genera under 4 separate classes *viz*., Chlorophyceae (grass – green algae), Euglenophyceae (euglenoids), Bacillariophyceae (diatoms), Cyanophyceae (Blue-green algae) of 4 different divisions *viz*., Chlotophyta, Euglenophyta, Chrysophyta, Cyanophyta. Among the identified phytoplankton species Chlotophyceae (37.93%) formed the dominant group, followed by, Cyanophyceae (32.76%), Bacillariophyceae (24.14 %) and Euglenophyceae (5.36 %), respectively. The fluctuations in the physico-chemical parameters like pH. Temperature, DO, BOD, Turbidity, hardness, nitrate, phosphate and were also been monitored. The result provides a primary documentation of the phytoplankton community and its diversity and basic understanding hydrological variables in commercial fish farming ecosystem.

Keywords: phytoplankton, diversity, commercial fish farming, physico-chemical parameters

Introduction

Bishnupur district is lies in the south-western part of valley region in the Manipur state. Bishnupur district with it's headquarter at Bishnupur which is 27 km. from Imphal. Phytoplankton represents the microscopic algal communities of commercial fish farming pond and the pioneer of aquatic food chain. The productivity of an aquatic system is directly related to diversity of phytoplankton. It is too small for wave action and too shallow for major temperature differences from top to bottom. They are source of food for fish, zooplankton and other aquatic organisms. These freshwater communities are extremely sensitive to environmental variations. Phytoplanktons are the microscopic free floating algal communities of water bodies and productivity of an aquatic system is directly related to diversity of phytoplankton. The phytoplanktonic study is a very useful tool for the assessment of water quality and productivity of any type of water body and also contributes to understanding of lentic water bodies (Pawer *et al*., 2006) [27]. Phytoplankton includes several thousands or microalgae belonged to Chlorophyta (Green algae), Cyanophyta (Blue green algae, Bacillariophyta (Diatoms), Euglenophyta (Pigmented flagellate or phytoflagellated) etc. they respond quickly to environmental changes and are used to assess the ecological status of water body. They are used for assessing the degree of pollution or serve as bioindicators of water quality (Mandhare and Pangle, 1995) [23]. Phytoplankton has been used recently as an indicator to observe and understand changes in the ecosystem because it seems to be strongly influenced by climatic features (Li *et al*., 2000; Soni and Thomas, 2014) [22, 35]. The quality of water has been assessed by the qualitative and quantitative studies of phytoplankton. Phytoplanktons are floating microscopic as well as autotrophic components of the plankton community and a key part of aquatic ecosystems. Their diversity and succession in commercially organized fish ponds are largely ignored. In the present study an attempt has been made to assess the phytoplankton diversity and distribution and fluctuation in the hydrological variables in the commercial fish farming ponds.

Materials and Methods

The study was carried out on the monthly basis from January 2017 to December 2019. The commercial fish farming ponds were selected from three different area of the district *viz*., Oinam, Toubul and Kumbi for the present study. All the collections were made between 8 am to 10 am by monthly during the study period. Phytoplankton samples were collected by filter from commercial fish farming pond water through plankton net with 25 µm mesh size. The filtrate was immediately preserved in 4 % formaldehyde. The phytoplankton samples were observed thoroughly under microscope and have been identified with the help of standard literature (Fritsch, 1935; Desikachary, 1959; Round, 1971; Prescotte, 1984; Anand, 1998 and Roy & Munshi, 2010) [10, 7, 31, 29, 1, 32] and surface water samples were collected from the selected fish farming pond during the study period and analyzed in the laboratory for important few physico-chemical parameters such as pH. Temperature, DO, BOD, Turbidity, hardness, nitrate, phosphate as per standard procedures (APHA, 2005) [3].

Results and Discussion

Phytoplankton in the commercial fish farming pond water was represented by four classes of algae *viz*., Euglenophyceae, Chlorophyceae, Bacillariophyceae and Cyanophyceae. During the present observation 58 species of phytoplankton species were identified of these Cholorophyceae includes 22 species followed by Cyanophyceae 19, Bacillariophyceae 14 species and Euglenophyceae occupied only 43species. Monthly distribution of phytoplankton was shown in Figure 1 and percentage wise contribution of phytoplankton groups are shown in Figure 2. Diversity of planktonic species during the present study period has been given in Table 1. Phytoplanktons are sensitive to the environmental changes and their distribution varies considerably with respect to seasons, water quality and nutrient concentration. Similar observation was also reported by Thirugnamoorthy and Selvaraju, 2009 [36]; Ganai *et al*., 2010 [11]; Manickam *et al*., 2012 [24]. Planktonic communities are influenced by the prevailing physico-chemical parameters and these determine their abundance, occurrence and seasonal variations (Rothhaupt, 2000) [30].

Cholorophycean species contributed maximum diversity in various fish farming ponds and were the most dominant class during the months of February to April (Fig. 1), it contribute about 37.93 % of the total phytoplankton population (Fig. 2). Genus like *Ankistrodesmus, Chlorella, Chlorococcum, Cladophora, Closterium, Coelastrum, Cosmarium, Crucigenia, Euastrum, Gleocysts, Hydrodictyon, Netrium, Oocystis, Pediastrum, Scenedesmus, Selenastrum, Spirogyra, Staurastrum, Tabellaria* and *Ulothrix* were recorded which is followed by Cynophyceae contributing 32.76 % from the total phytoplankton population. Cyanophycean diversity was highest during the month of late rainy and winter season *i.e*., from October to January. This class was represented by *Anabaena,Anabaena, Anabaenopsis, Aphanocapsa, Arthrospira, Chroococcus, Eucapsis, Gomphosphaeria, Lyngbya, Merismopedia, Microcystis, Nostoc* and *Oscillatoria*, respectively. In the case of Bacillariophyceae which if 24.14 % of contribution among the phytoplankton diversity. For this diatoms group *Achnanthes, Amphora, Cyclotella, Cymbella, Fragilaria, Gomphonema, Gyrosigma, Melosira, Navicula, Nitzschia, Pinnularia, Suriella* and *Synedra* were found.

Euglenophyceae contributed minimum of 5.36% in the total phytoplankton species. Throughout the present study this group was mostly represented by *Euglena* and *Phacus*. Some what similar to the present investigation were reported by Devi and Singara (2007) [8], Goopinath and Ajit (2014) [12], and Ansari *et al*. (2015) [2] in their study from different regions. The seasonally distribution of phytoplankton diversity shows dominance pattern as Chlorophyceae > Cyanophyceae > Bacillariphyceae > Euglenophyceae. In contrast earlier observation of Hudder (1995) [14], Joseph (2012) [17] and Singh (2015) [34] reported that Cyanophyceae is most dominated among the four classes. Chlorophyceae group contributed 37.93 % of total phytoplankton is suggested that higher value of nutrients favoured the growth of this group. Chlorophycean members were recorded higher during the months of January to May. But many workers have reported blue green algae as a dominant group during these periods (Zacharias and Joy, 2007; Khanna and Indu, 2009 and Jeyabhaye, 2010) [37, 19, 16]. The dominant nature of Chlorophyceae species are the characteristic feature of eutrophic environment which have high concentration of nutrient especially phosphate and nitrate (Neelam *et al*., 2009) [26]. In the present study maximum population of algae was observed during the months when the temperature was recorded higher.

The occurrence of rich phytoplankton diversity results generally at the place where there are high levels of nutrients, together with favorable environmental conditions (Kumar and Radha, 2012) [21]. According to the Philipose (1967) [28] Chlorophyceae group dominate the water that is rich in nutrients such as nitrate and phosphate. In the present study also class Chlorophyceae were abundantly found in the rainy season while minimum count was recorded summer season which is similar with observation of Korgaonkar and Bharamal (2016) [20] they reported that comparatively higher values of Chlorophyceae in monsoon season than in summer season.

The annual mean value and standard deviation of the physico-chemical parameter were recorded from the commercial fish farming pond is presented in Table 2. The water was found light green in colour to dark green in colour during the course of work. Temperature recorded in the commercial fish farming pond water was 28.25 ± 3.520C, where as the pH of water was found almost neutral during study period (7.12 ± 0.21). Total hardness was 8.52 ± 1.32 mg/l. in the present study DO, BOD values were recorded as 6.15 ± 0.56 mg/l and 3.25 ± 0.84 mg/l respectively with the turbidity value of 5.62 ± 0.75 NTU. Nutrients like nitrate and phosphate were found correspondingly in 6.43 ± 0.96 mg/l and 5.21 ± 0.86 mg/l (Table 2). In the present work there were good amount of nitrate and phosphate were observed and have higher growth of phytoplankton was recorded. Jyotsna *et al.* (2014) [18] also observed maximum members of phytoplankton in the month of April. According to Munawar (1970) [25] regular supply of nitrate encourage the growth of diatoms. Ansari *et al*. (2015) [2] reported presence of phosphate, nitrate, silicate and total hardness promoted the growth of diatoms. Euglenophyceae was reported maximum during the months were temperature and nitrate values were noted higher. Previous studies on freshwater environment showed that higher temperature and nitrate concentration favours the growth of euglenoids (Jasprica *et al*., 2006) [15]. Seeneyya (1971) [33] reported that temperature above 250C was good for the growth of Euglenophyceae. The high temperature, chloride, TDS and BOD might have played an important role in growth and development of Euglenophyceae (Ansari *et al*., 2015) [2].

In the present study the values of physico-chemical parameter fluctuates greatly during different observation period. This may be due to various physico- chemical factors which are modifying the diversity of phytoplankton. Devika *et al*. (2006) [9] suggests that physico-chemical conditions had a direct relationship on phytoplankton diversity in aquatic ecosystem. The pH, DO alkalinity and dissolved nutrients are important for phytoplankton population (Bais and Agarwal, 1990) [6]. Ashok *et al*. (2015) [5] observed that DO possess an indirect relation with temperature.

The phytoplankton diversity is largely influenced by interaction of a number of physico-chemical and biological factors acting simultaneously. According to Harikrishnan *et al*. (1999) [13] the maintenance of a healthy aquatic ecosystem depends on physico-chemical and biological diversity of the ecosystem. From the present observation it is difficult to point out any single factor which is responsible for the fluctuations and abundance in phytoplankton diversity. The present study reveals that variation in the abundance of phytoplankton is explained with abiotic factors. Thus it may be recorded that the density of phytoplankton is dependent on different abiotic factors either directly or indirectly.

The present study provides an insight into the diversity and ecology of phytoplankton in the commercial fish farming pond. From the results, noted that the ecological conditions of pond support a rich diversity of phytoplankton. The experimental fish farming pond had a diversified group of phytoplankton dominated by Chlorophyceae species followed by Cyanophyceae, Bacillariophyceae and Euglenophyceae. Results indicated that the values of physico-chemical factors were responsible for the diversity of phytoplankton in commercial fish farming pond.

Table 1: List of phytoplankton from three different site of commercial fish farming ponds (2017 – 2019)

Sl. No.	Phytoplankton	Sl. No.	Phytoplankton
	Euglenophyceae	29	*Cymbella lanceolata* Breb
1	*Euglena gracilis* Mallisch	30	*Fragilaria intermedia* (Grun.)
2	*Euglena sanguine* Ehrenberg	31	*Gomphonema gracile* Ehrenberg
3	*Phacus curvicauda* Swir. Skz.	32	*Gomphonema parvulum* (Kutzing) Kutzing
	Chlorophyceae	33	*Gyrosigma acuminatum* (Kutzing) Rabenhorst
4	*Ankistrodesmus falcatus* (Corda.)	34	*Melosira varians* C. Agardh
5	*Chlorella vulgaris* Bayemick	35	*Navicula cuspidate* Kuetz
6	*Chlorococcum humicola* (Nageli) Rabenhorst	36	*Nitzschia palea* (Kutzing) W. Smith
7	*Cladophora glomerata* (L.) Kutzing	37	*Pinnularia simplex* Her.
8	*Closterium acerosum* (Schrank.) Her.	38	*Suriella elegans* Her.
9	*Closterium ehrenbergii* (Menegh.) ex Ralfs.	39	*Synedra ulna* (Nitzsch.) Her.
10	*Coelastrum indicum* Turner		Cyanophyceae
11	*Cosmarium auriculatum* Reinsch	40	*Anabaena constricta* (Szafer) Geitler
12	*Cosmarium granatum* Brebisson ex Ralfs	41	*Anabaena fertilissima* C.B.Rao
13	*Crucigenia tetrapedia* Kirchner	42	*Anabaena orientalis* S.C.Dixit
14	*Euastrum spinulosum* Nordstedt	43	*Anabaenopsis circularis* (G.S.West) Wolosz.et
15	*Gleocysts gigas* (Kutzing) Lagerheim	44	*Aphanocapsa biformis* A.Br.
16	*Hydrodictyon reticulatum* (L.) Bory	45	*Arthrospira platensis* (Nordstedt) Gomont
17	*Netrium digitus* (Ehrenberg) Roth.	46	*Chroococcus minor* (Kuetz) Nag.
18	*Oocystis elliptica* West	47	*Chroococcus minutus* (Kuetz) Nag.
19	*Pediastrum angulosum* (Her.) Ralfs.	48	*Eucapsis minuta* Fritsch
20	*Scenedesmus armatus* (Chodat)	49	*Gomphosphaeria aponina* Kuetz.
21	*Selenastrum gracile* Reinsch	50	*Lyngbya spiralis* Geitler
22	*Spirogyra longata* (Vaucher) Kutzing	51	*Merismopedia elegans* Lemm
23	*Staurastrum gracile* Ralfs ex Ralfs	52	*Merismopedia minima* Beck.
24	*Ulothrix zonata* (Kuetz)	53	*Microcystis aeruginosa* Kuetz.
25	*Tabellaria flocculosa* (Roth) Kuetz.	54	*Nostoc commume* Vaucher ex Bor. Et Flah.
	Bacillariophyceae	55	*Nostoc muscorum* Ag.
26	*Achnanthes inflate* (Kutzing) Grunow	56	*Oscillatoria curviceps* C.Agardh ex Gomont
27	*Amphora ovalis* Kuetz	57	*Oscillatoria Formosa* Bory ex Gomont
28	*Cyclotella meneghiniana* Kutzing	58	*Oscillatoria princeps* Vaucher ex Gomont

Table 2: Physico-chemical parameters (Mean ± SD) of commercial fish farming pond

Parameters	Commercial fish farming pond water
pH	7.12 ± 0.21
Temp (0C)	26.25 ± 3.52
DO (mg/l)	6.15 ± 0.56
BOD (mg/l)	3.25 ± 0.84
Turbidity (NTU)	5.62 ± 0.75
Hardness (mg/l)	8.52 ± 1.32
Nitrate (mg/l)	6.43 ± 0.95
Phosphate (mg/l)	5.21 ± 0.86

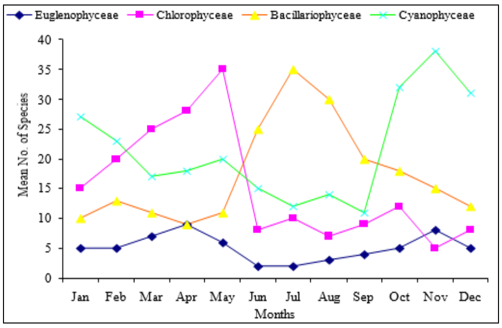

Fig 1: Monthly distribution of phytoplankton in commercial fish farming pond during the study period

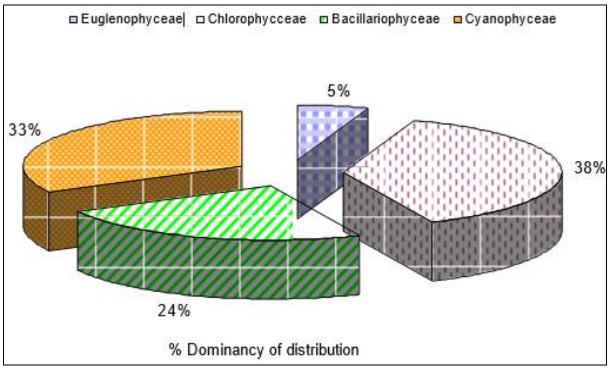

Fig 2: Percentage wise contribution of phytoplankton groups in commercial fish farming pond during the study period.

Acknowledgment

The authors are grateful to the Principal, GB and Head, Department of Botany of Kumbi College, Kumbi for providing the necessary facilities during the course of work.

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