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A study of Phyto-plankton dynamics in nursery pond

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Abstract
The dynamics of plankton and the characteristics of water quality were investigated. The experiment was conducted in the nursery fish farm of Indra Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during the month July to August. The sampling was done daily basis for 20 days during sampling Periods water and plankton sample were collected. Diurnal fluctuation of plankton was calculated from collected sample four times in a day. The total thirty-three algal genera were identified, of which seventeen were allocated to the Chlorophyceae family, nine to the Cyanophyceae family, six to the Bacillariophyceae family, and one to the Euglenophyceae family. When it came to phytoplankton, the Chlorophyceae group was the largest. Chlorophyceae members include *Oocystis* sp. and *Tetraedron pseudosp*. Was shown to be the most prevalent. The highest amount of daily variation was shown by *Oocystis* sp. *Tetraedron* sp. *Spirogyra* sp. Chlamydomonas sp. along with *Mougeotia* sp. When it comes to Cyanophyceae, *Oscillatoria* sp. alongside *Aphanocapsa* sp. was in charge. Microcystis sp. *Oscillatoria* sp. *Anabaena* sp. alongside *Aphanocapsa* sp. displayed the largest daily fluctuation. *Nitzschia* sp. is one of the Bacillariophyceae. along with Synedra sp. predominated. The highest daily variation was shown by *Navicula* sp. *Nitzschia* sp. *Melosirasp*. *Protococcus* sp. along with Synedra sp. Just Euglena sp. is found among the Euglenophyceae. was discovered. According to the study, the ponds' natural fish food organisms and water quality make them suitable for the growth of fish spawn.

Keywords: Phytoplankton, primary productivity, fish nursery ponds, Chhattisgarh

Introduction

The word plankton derived from Greek word "planktos," which meaning "drifting," is where the word "plankton" first appeared. In all aquatic ecosystems, plankton is the microscopic organism that forms the foundation of food chains and webs. The majority of them are tiny, many of them are minute, and a compound or binocular microscope is required to view their structure clearly. Despite being members of distinct taxa, they share one characteristic, i.e. e. They are weak at moving and can only float in the water at the whim of waves and currents since they lack powerful locomotory organs, such as fish fins. They are unable to mob anywhere, unlike fish (Zheng Zhong *et al*. 1984) [18].

Seasonal variations in light, environmental conditions, nutrient availability, and the grazing pressure from higher trophic levels like fish and zooplankton cause changes in phytoplankton productivity, biomass, and species composition. A comprehensive comprehension of the trophic structure, population dynamics, and nutrient cycling of a body of water is imperative for the scientific management of fisheries in order to attain maximum fish productivity. Therefore, the abundance of plankton directly or indirectly affects the fish yield in nearly all natural aquatic systems. When a fish species is farmed, its larval and adult stages eat plankton. In turn, phytoplankton serves as the foundational diet for higher animals such as fish, especially their larvae, as zooplankton feeds on them and helps transform plant matter into animal tissue. The primary means by which fish and phytoplankton exchange energy is through zooplankton. Because they are heterotrophic, meaning they aid in the subsequent transfer of bound energy at the primary level, zooplankton plays an important role in the process. Seasonal variations in the limnology of a perennial fish pond at Aligarh were investigated by Khan and Siddiqui in 1969. They found five groups of phytoplankton community abundance namely Myxophyceae, Chlorophyceae, Bacillariophyceae, Phytoflagellates and Dihophyceae. Chlorophyll concentrations were found to vary from. 3.2 to 21.8 mg. /liter. Zooplankton were mainly represented by rotifers, cladocera and copepods. Sasmal *et al*. (2005) [11] worked on diurnal variations in a tropical freshwater pond.

The dissolved oxygen, pH, carbonate, and bicarbonate concentrations all showed significant daily fluctuations, which was indicative of the plankton and water chemistry changes in the rearing pond. The oxygen content of the pond water was oversaturated during the day (9 points 4 ppm) and depleted at night (1 points 9 ppm); the pH rose during the day and fell at night. Cypris and Diaptomus did not appear to exhibit any discernible diurnal movement, but Daphnia and Cyclops among the zooplankton did exhibit diurnal movement. At the experimental center in Cazaci-Marata, Gheorghe and Costache (2009) [2] observed the plankton dynamics for the second summer in carp polyculture with phytoplankton consumer species in six experimental ponds. The dynamics of the plankton in six rearing ponds used for the carp (Cyprinus carpio) and silver carp (H. molitrix), small carp (C. As well as bighead carp (A. nobilis) was investigated for 120 days. Higher levels of phosphorus and higher temperatures were found in the ponds with less dissolved oxygen. Inorganic nitrogen levels, specifically NH4-N, were found to be higher in the Walukuba ponds than in the Gaba ponds. The taxa distributed in the Gaba and Walukuba ponds were 37 and 31, respectively. The current investigation focuses on the dynamics of phytoplankton in Chhattisgarh's fish nursery ponds.

Materials and Methods

The fish nursery ponds (Department of Fisheries, College of Agriculture, Indra Gandhi Krishi Viswavidliya Raipur, Chhattisgarh, India) were selected for study. The average depth of the fish nursery ponds ranges between 1-1.5 meters. During the experimental No aquatic weeds was found and the ponds received direct sunlight. Spawn of Catla, Rohu, Mrigal were stocked in the nursery ponds. Liming and manuring was done before stocking, supplementary feed was used to feed the spawn.

Collection of plankton samples: The samples were collected randomly from nursery pond using plankton net by filtering 20 liters of water for each sample. The net was constructed using regular bolting silk fabric no. 22 with 75 linear centimeter meshes. Conical in shape was the net. With a graduated test-tube, the top metal ring's diameter measured 36 cm. The gathered samples were placed in a tiny plastic container and labeled with details like the location, date, and time of collection, sample number, etc.

Preservation of plankton samples

All the plankton samples were preserved by Lugol solution to ascertain sedimentation and better staining. 1 or 2 drops Lugol's solution was added in 25 ml of collected samples. For further investigation, plankton was observed both in fresh and preserved samples. The concentration of plankton in the water was determined by the drop method. On an average of 3 counts were made for each sample and mean.

Identification plankton samples

All Samples were studied under the S-R (Sedgwick Rafter) under microscopic to identify different species of plankton. Plankton were identified qualitatively following standard taxonomic keys (Smith, 1964 [13]; Philipose, 1967 [10]). Leica ATC 2000 microscope was used for the study.

Counting of plankton: Sedgwick-Rafter (S-R) cells, measuring 50 mm in length, 20 mm in width, and 1 mm in depth, were utilized for plankton counting. The sample was transferred using a large bore pipette to ensure that there were no air bubbles in the cell cover before the S-R cell was filled with material. The cover glass was then positioned diagonally across the cell. Counting and enumeration were carried out using LABOMED TCM - 400 microscopes once the plankton had settled on the bottom of the S-R cell.

Results and Discussions

Based on the morpho taxonomic identification of phytoplankton in selected nursery ponds of I.G.K.V. Fish farm Raipur, Chhattisgarh, thirty-three algal genera are enlisted (Table No.1). Among them Seventeen genera belong to Chlorophyceae, nine to Cyanophyceae, six belong to class Bacillariophyceae and one belonging to class Euglenophyceae. Chlorophyceae is represented by six orders Chlorococcales, Zygnematales, Volvocales, Oedogoniales, Ulothrichales and Chaetophorales. The order Chlorococcales is represented by Five families *viz*: - Oocystaceae (*Oocystis* and Chlorella), Hydrodictyaceae (Pediastrum and Tetraderon), Scenedesmaceae (Scendesmus), Selenastraceae (Selenastrum and Ankistrodesmus) and Batryococcaceae (Botryococcus). Order Zygnematales is represented by three families *viz*:- Zygnemataceae (*Mougeotia* and Spirogyra), Desmidiaceae (Closterium and Cosmarium) Mesotaeniceae (Mesotonium). The order Volvocales is represented by only one family *viz*: - Chlamydomonadaceae (Chlamydomonas). The order Oedogoniales and Ulothrichales are represented by one family each *viz*:-Oedogoniaceae (Oedogonium), Ulothrichaceae (Ulothrix) respectively. The order Chaetophorales is also represented by one family Chaetophorceae (Chaetophora). Class Cyanophyceae is represented by two orders Chroococcales and Nostocales. The order Chroococcales is represented by two families Chroococcaceae (*Aphanocapsa* and Microcystis) and Merismopediaceae (Coelospharium). The order Nostocales is represented by two families *viz*:- *Oscillatoriaceae* (Phormidium, Spirulena and *Oscillatoria*) and Nostocaceae (Nostoc, *Cylendrospermum* and *Anabaena*). Class Bacillariophyceae is represented by three orders *viz*. Pennales, Centrales and Cheatophorales. The order Pennales is represented by three families *viz* Fragilariaceae (Fragilaria and Synedra), *Navicula*ceae (Pinnuularia and *Navicula*) and *Nitzschia*ceae (*Nitzschia*). The order Centrales and Cheatophorales are represented by only one family of each *viz*:- Coscinodiscaceae (Melosira) and Cheatophoraceae (*Protococcus*). Class Euglenophyceae is represented by a single family Euglenaceae (Euglena) under the order of Euglenales.

Plankton dynamics in nursery ponds were interpreted through assessment of dominance and diurnal fluctuation. The dominance among phytoplankton were determined from the pooled mean data on the frequency of occurrence of individual genera per ml of water sample, collected daily from all the nursery ponds during 20 days of production cycle. On the other hand, diurnal fluctuation of plankton was assessed from the standard deviation values of individual genera per ml of water sample, collected four times (6 am, 10 am, 2 pm and 6 pm) from the nursery ponds on the 10th day. Phytoplankton dynamics Chlorophyceae Among Chlorophyceae, (Table No.)*Oocystis* sp. was found to be most dominant in N.P.-1 (6 units/ml), N.P.-2 (4 units/ml), N.P.-3 (5 units/ml), N.P.-6 (5 units/ml) and N.P.-7

(9 units/ml) while both Oocycstis sp. and *Tetraedron* sp. dominated in N.P.-4 (4 units/ml both) and N.P.-5 (4 units/ml both). Maximum diurnal fluctuation was exhibited by *Oocystis* sp. in N.P.-1 (±2.45 units/ml), N.P.-6 (±4.80 units/ml) and N.P.-7 (±4.65 units/ml). Similarly, *Tetraedron* sp. showed highest diurnal fluctuation in N.P.-2 (±2.99 units/ml), Spirogyra sp. in N.P.-3 (±2.38 units/ml), Chlamydomonas sp. in N.P.-4 (±6.16 units/ml) and *Mougeotia* sp. in N.P.-5 (±3.30 units/ml).

The Chlorophyceae comprises one of the major groups of algae when considering the abundance of genera and species, and the frequency of occurrence. Both benthic and planktonic species occur. Philipose (1967) [10] reported that Chlorophyceae members grow well in alkaline water rich in nitrate and phosphate. Among Cyanophyceae, (Table No. 3) *Oscillatoria* sp. was most dominant in N.P.-2 (4 units/ml), N.P.-3 (6 units/ml), N.P.-4 (9 units/ml both), N.P.-5 (11 units/ml both), N.P.-6 (15 units/ml) and N.P.-7 (7 units/ml) while both *Oscillatoria* sp. and *Aphanocapsa* sp. dominated in N.P.-1 (5 units/ml both). Maximum diurnal fluctuation was exhibited by Microcystis sp. in N.P.-1 (±3.86 units/ml) and N.P.-2 (±3.40 units/ml). Similarly, *Oscillatoria* sp. showed highest diurnal fluctuation in N.P.-4 (±6.90 units/ml), N.P.-5 (±2.58 units/ml), N.P.-6 (±10.47 units/ml) while *Anabaena* sp. in N.P.-7 (±4.11 units/ml). In N.P.-3, both *Aphanocapsa* sp. and *Oscillatoria* sp. showed maximum diurnal fluctuation (±2.75 units/ml both). Cyanophyceae are often referred to as cyanobacteria, blue green algae or bluegreen bacteria. Stewart and Pearson (1970) [16] opined that in light, blue-green algae grow more rapidly under micro-aerophilic conditions than under fully aerobic conditions. Development of blue-green algae may depend on the ability of the ponds to maintain low concentrations of dissolved oxygen for long periods (Ganf, 1974) [1]. Zafar (1964) [17] have also observed that high nutrients favour the luxuriant growth of Cyanophyceae. Among Bacillariophyceae (Table No. 5), *Nitzschia* sp. was found to be most dominant in N.P.-1 (9 units/ml), N.P.-2 (5 units/ml), N.P.-4 (6 units/ml) and N.P.-5 (4 units/ml) while Synedra sp. dominated in N.P.-3 (4 units/ml) and N.P. 6 (6 units/ml). Both *Nitzschia* sp. and Synedra sp. dominated in N.P.-7 (4 units/ml each). Maximum diurnal fluctuation was exhibited by *Navicula* sp. in N.P.-1 (±4.97 units/ml) and N.P.-2 (±2.89 units/ml). Similarly, Synedra sp. showed highest diurnal fluctuation in N.P.-3 (±4.97 units/ml), *Nitzschia* sp. in N.P.-5 (±1.29 units/ml) and N.P.-7 (±2.08 units/ml) while Melosira sp. in N.P.-6 (±0.96 units/ml). In N.P.-4, both Melosira sp. and *Protococcus* sp. showed maximum diurnal fluctuation (±0.5 units/ml both). Bacillariophyta are commonly referred to as diatoms. Diatoms are able to grow in conditions of weak light and low temperature which are less suitable for other algae (Lund, 1965) [6]. Zafar (1964) [17] opined that calcium rich water bodies have high number of diatoms. Patrick (1948) [7] has observed that high pH favoured the high abundance of diatoms. Among Euglenophyceae, (Table No. 4) only Euglena sp. was found in all the nursery ponds *viz.* N.P.-1 (3 units/ml), N.P.-2 (2 units/ml), N.P.-3 (2 units/ml), N.P.-4 (4 units/ml), N.P.-5 (2 units/ml), N.P.-6 (4 units/ml) and N.P.-7 (4 units/ml). Population of Euglena sp. fluctuated diurnally by ±2.5 units/ml (N.P.-1), ±0.58 units/ml (N.P.-2), ±0.58 units/ml (N.P.-3), ±2.94 units/ml (N.P.-4), ±2.08 units/ml (N.P.-5), ±5.45 units/ml (N.P.-6) and ±5.77 units/ml (N.P.-7). The class Euglenophyceae as a whole is facultatively heterotrophic and is generally abundant in water very rich in organic matter (Hutchinson, 1975) [4]. Seeneyya (1971) stated that temperature above 25°C is favourable for the growth of Euglenophyceae. Hegade and Bharati (1984) [3] observed that high pH favoured the growth of Euglenophyceae.

Table 1: Taxonomic dominance of total Phytoplankton observed in selected ursery ponds

S. No.	Order	Family	Genera
Class- Chlorophyceae			
1-	Chlorococcales	5	8
2-	Zygnematales	3	5
3-	Volvocales	1	1
4-	Oedogoniales	1	1
5-	Ulothrichales	1	1
6-	Chaetophorales	1	1
Class- Cyanophyceae			
1-	Chroococcales	2	3
2-	Nostocales	2	6
Class- Bacillariophyceae			
1-	Pennales	3	4
2-	Centrales	1	1
3-	Cheatophorales	1	1
Class- Euglenophyceae			
1-	Euglenales	1	1

Table 2: Phytoplankton abundance (units/ml) in nursery ponds of class Chlorophyceae

Plankton/Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean
Chlorophyceae																					
Oocystis	5	1	23	5	3	1	0	5	4	5	17	4	5	15	6	6	4	0	1	6	6
Pediastrum	4	3	3	7	0	9	8	19	11	5	0	5	4	0	0	0	0	0	1	0	4
Tetraderon	3	1	6	7	0	4	2	6	3	3	0	1	2	3	5	3	0	6	1	4	3
Selanosterium	6	1	4	3	1	1	1	0	0	3	0	0	0	0	0	0	0	0	1	0	1
Botryococcus	4	1	2	1	0	0	2	0	0	3	1	0	0	0	0	0	0	0	1	0	1
Scendesmus	8	4	1	1	1	0	0	0	0	1	0	5	0	0	0	0	0	0	1	0	1
Ankistrodesmus	5	2	1	1	0	0	1	1	1	0	0	0	4	0	0	0	0	0	1	5	1
Chlorella	11	3	2	2	3	1	1	1	8	1	0	3	0	1	6	4	0	0	1	5	3
Cosmarium	5	1	1	2	1	5	2	4	5	1	3	2	4	3	2	0	0	0	1	0	2
Spirogyra	10	5	2	1	5	1	1	0	0	1	1	0	0	0	0	0	4	0	1	3	2
Mesotonium	5	2	1	1	1	1	5	1	0	1	1	0	0	1	2	0	10	0	0	0	1
Mougeotia	6	6	4	3	1	5	1	4	0	1	0	0	0	1	5	8	0	8	0	0	2
Closterium	4	4	7	3	1	1	1	0	0	1	0	0	9	6	0	0	4	3	0	0	2
Chlamydomonas	6	2	5	1	1	0	0	1	0	1	0	0	0	1	0	0	4	0	1	0	1
Oedogonium	7	1	6	1	0	1	1	0	1	1	0	0	0	2	0	0	1	0	3	0	1
Ulothrix	7	3	2	2	1	1	1	0	0	1	0	0	3	0	0	2	0	0	1	0	1
Chaetophora	4	2	3	1	1	1	1	1	1	1	0	0	0	1	0	1	7	0	0	0	1

Table 3: Plankton abundance (units/ml) in nursery ponds of class Cynophyceae

Aphanocapsa	**10**	**5**	**17**	**4**	**4**	**4**	**9**	**6**	**3**	**7**	**15**	**0**	**1**	**3**	**6**	**6**	**0**	**4**	**1**	**1**	**5**
Cylendrospermum	7	12	2	3	0	3	1	1	0	0	1	1	1	0	4	0	0	0	8	8	3
Oscillatoria	10	10	15	1	1	1	2	5	5	6	0	0	0	13	1	11	0	4	10	3	5
Nostoc	4	3	4	2	1	1	0	0	0	1	0	2	0	3	0	0	9	0	0	0	1
Anabaena	6	2	3	1	2	1	0	0	0	6	0	4	1	0	3	3	4	4	1	4	2
Microcystis	8	4	8	1	8	1	4	1	0	16	5	5	0	4	4	0	0	0	2	0	3
Coelospharium	6	4	1	2	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Spirulena	12	2	1	1	1	1	0	1	1	1	0	1	2	10	3	0	0	3	0	0	2
Phormidium	7	2	3	1	1	0	0	1	1	1	0	1	3	0	0	0	6	0	0	0	1

Table 4: Plankton abundance (units/ml) in nursery ponds of class Euglenophyceae

Euglena	6	5	6	1	1	0	1	4	2	9	3	6	0	1	0	6	4	4	0	0	3

Table 5: Plankton abundance (units/ml) in nursery ponds of class Bacillariophyceae

Synedra	**4**	**3**	**1**	**2**	**3**	**5**	**3**	**0**	**1**	**0**	**0**	**0**	**2**	**21**	**9**	**8**	**10**	**0**	**44**	**16**	**7**
Pinnularia	3	2	1	1	1	1	0	0	1	1	0	0	0	1	0	5	0	0	0	0	1
Nitzschia	4	3	5	1	1	1	32	30	8	27	21	13	0	0	9	0	4	18	0	1	9
Navicula	4	1	2	2	1	3	0	0	0	3	3	2	1	0	3	0	0	0	0	1	1
Melosira	3	4	3	2	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1
Protococcus	4	4	2	1	0	1	1	1	2	1	0	0	15	3	0	0	0	0	0	3	2

Conclusion

The increased primary productivity foreshadowing high fish production could be achieved with a combination of manuring ponds using locally available materials and growing soil holding grass along pond banks to reduce turbidity. The nursery ponds were found to have high phytoplankton primary productivity.

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