IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 14, Issue 10 Ser. IV (October 2020), PP 15-20
www.iosrjournals.org

Survey of Phytoplanktons in Makhana Pond Water of North Bihar

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Abstract
During the present study, phytoplanktons were represented by Cyanophyceae, Chlorophyceae and Bacillariophyceae from Makhana Pond of Darbhanga district. The Chlorophycae was rich in species Diversity being represented by 17-species followed by Cyanophyceae and Bacillariophycae with 6 and 5 species, respectively, in Makhana pond. The phytoplankton density was recorded highest during April 2008 and the lowest during December 2008. It exhibited trimodal pattern of fluctuations during the study period. Among the three peaks, two were in November 2008 and April 2009, and one minor peak in June 2009. In November 2008 it was recorded as 3637 U/L. But in December 2008 its density dropped suddenly to 989 U/L and after that the increase continued till April 2009, where the total phytoplankton population recorded the highest peak (4208 U/L). But in May 2009 the number phytoplankton decreased to 1528 U/. During June to August 2009 there was a trend of decrease in its population. In order of dominance, the phytoplankton were as Chlorophyceae > Bacillariophyceae > Cyanophyceae contiributing 74.6%, 14.0% and 11.4% respectively. The total population of green algae dominated over blue greens and diatoms throughout the study period. The percentage composition of diatoms was more than that of blue greens but during July 2008 to November 2008, July 2009 and August 2009, the former was recorded lesser in number than the later. Gross Primary Productivity (GPP), which is the total rate of photosynthesis including the organic matter used up in respiration during the measurement period was maximum during summer months and minimum during winter months.

Key Words: *Phytoplanktons, Cyanophyceae, Chlorophyceae, Bacilliophyceae, Gross Primary Productivity*

Date of Submission: 26-10-2020 Date of Acceptance: 06-11-2020

I. Introduction

Phytoplanktons are the autotrophic components of the plankton community and a key factor of ocean, seas and freshwater basis ecosystem. Most phytoplankton are too small to be individually seen with the unaided eye. However when present in high enough numbers they may be appear as a green discoloration of the water due to the presence of chlorophyll within their cells. The growth of Phytoplankton depends on the availability of carbon dioxide, sunlight and nutrients. Phytoplanktons like terrestrial plants require nutrients such as nitrate, phosphate, silicate and calcium at various levels depending on the species. Some phytoplanktons can fix nitrogen and can grow in areas where nitrate concentrations are low.

Phytoplanktons are minute and microscopic plants which are able to spend their whole life floating in water. These are important biotic components of an aquatic ecosystem which provide not only the most important food item of the fishes either directly or indirectly but also oxygenate water during their photosynthesis and can be used as an indicator of the trophic phase (Nasar and Dutta Munshi, 1976, Verma and Dutta Munshi, 1987).

The density and diversity of phytoplankton are controlled by several physicochemical factors of water (Anupma, 2020: Communicated). Light plays a significant role as an energy source for photosynthesis by phytoplankton. This is the reason behind the presence of the highest number of phytoplankton during summer. Kaufman (1980) suggested that light is a limiting factor for phytoplankton growth. The temperature has been considered as a major environment factor to control their growth (Verma and Dutta Munshi, 1987; Bais et. al., 1995). The proliferation of phytoplankton during summer months could be attributed to the increasing water temperature. This confirms the findings of Wisharad and Mehrotra (1988). Baruah *et. al.,* (1993) and Shivakashi *et. al.,* (1995) also reported maximum growth of algae during summer months. Nutrients like nitrogen and phosphorus provide basic materials for phytoplankton development (Trivedi *et. al*., 1985; Agrawal *et.al.*, 1990). The high content of phosphate and nitrogen favored phytoplankton growth during the present study. But during August' 98 and May' 09 the total phytoplankton population was recorded to be low inspire of high content of nitrogen and phosphate which was due to predation by the abundant zooplankton.

The biological productivity of any system whether aquatic or terrestrial involves the trapping of solar energy by chlorophyll bearing plants and its transformation within the system by different organisms at different tropic levels. The rate at which the radiant energy is converted by photosynthetic and chemosynthetic activity by producer organisms to organic substances is called primary productivity. Thus primary productivity is the product of photosynthesis. The total rate of photosynthesis including the organic matter used up in respiration during the measurement period is called Gross Primary Productivity (GPP). Net Primary Productivity (NPP) is the rate of storage of organic matter in plant tissues in excess of the respiratory use by the plant. Photosynthetic fixation of carbon in fresh water ponds may occur by various communities. These communities may be phytoplankton, macrophytes or periphyton and photosynthetic bacteria.

II. Materials and Methods:

Experimental Pond:

The Makhana Pond under study was situated in the western side of Darbhanga town (latitude 26^0 10'N and longitude 85^0 54'E) in the Mohalla Wajitpur. It covers an area of about 0.48 hectare. Water spread area was maximum (0.48 ha) during August and minimum (0.37 ha) during May with depth ranging from 0.30 to 1.75 m. integrated fish culture with Makhana (*E. ferox* Salisb.) was carried out in this pond for a period from July 2008 to August 2009.

Soil samples were collected from four corners of the pond at monthly intervals. The air dried samples were analyzed for pH, organic carbon, nitrogen, phosphorus, potassium following Trivedi *et. al*., 1985. Monthly plankton samples were collected from a plankton net of mesh size 0.01 mm. phyto – and zoo – plankton were identified following Needham and Needham (1962). The plankton samples were analyzed by drop count method and expressed in Unit Per Litre (U/L).

Periphyton was collected from the leaves and petioles of Makhana plants (*Euryale ferox* Salisb.) and submerged macrophytes (*Hydrilla verticillata* and *Potamageton crispus*) at monthly intervals. Small pieces of one sq. cm. area of leaves and petioles with dense growth were cut out with the help of a sharp scalpel. The algae attached with these pieces were scrapped off and the homogenous suspension was made with distilled water. Drop count method was applied for counting and the number of periphytons per. sq. cm. was calculated with the help of the following formula –

Periphyton individuals/cm^2 = A x V/v x 1/s

Where, A = Average number of individuals per drop

V = Value of scrapped periphytons (ml.)

v = Value of one drop (ml.)

S = Area of scrapped piece (sq. cm.)

Harvesting method was adopted to estimate the biomass productivity of *E. ferox* and submerged macrophytes (*Hydrilla verticillata* and *Potamogeton crispus*). A sq. sampler measuring 25 cm x 25 cm. was used in every month during the study period to collect the submerged macrophytes whereas, for *E. ferox* two samplers, one sampler measuring 25 cm x 25 cm. was used till the seedling phase (March) and another sampler measuring 100 cm x 100 x cm. was used after seedling phase. Sample of *E. ferox* were collected at 50 cm. – 75 cm. depth and were dried at 60^0C in a hot air oven for 48 hrs. to determine dry weight. Net productions were calculated by "difference method" i.e. difference between maximum and minimum biomass of macrophytes. Phytoplankton primary productivity was measured by employing the light and dark bottle method.

Management of Makhana (*E. ferox*) Crop

Thinning and transplantation –

To maintain the distance between two plants of *E. ferox*, their seedling were uprooted in March 2009 and where transplanted all over the available water space keeping a gap of about one metre in between two plants. During thinning and transplantation vacant spaces were left in two regions of the pond – central region and corner region. In the centre of the pond, 7 m long and 3 m. broad vacant space was left. This space was enclosed with the help of bamboo poles, so that with the maturation fo the plants, their sprawling leaves could not cover this space. Four vacant spaces one on each corner were also left and the sprawling leaves of the crop were not allowed to spread in theses spaces. But in these vacant spaces, bamboo poles were not erected.

Cutting of leaves –

In July' 09 all leaves of the crop were cut off from the petiolar region with the help of sickle and then the leaves were left to decay after keeping these in inverted position.

Harvesting –

In August' 09, this aqua – crop was harvested by skilled fishermen. The scattered seeds of Makhana crop present in the pond soil were gathered by the fishermen with the help of hands and legs and the heaps of seeds were made. These seeds were finally lifted – up with the help of baskets and weight was taken.

III. Results and Discussions

The phytoplankton samples, collected from the four sides of the pond did not reveal any significant variation in the phytoplankton community structure at the four sides of the pond and therefore, average values of each parameter were taken into the consideration for their interpretations. Analysis of phytoplankton community structure were made with reference to spectrum, population density, species diversity, species richness, species evenness, concentration of dominance, redundancy with reference to their classes of algae, viz. Cyanobacteria, Chlorophyceae and the Bacillariophycea. Periodical observation on the phytoplankton community structure in the pond revealed apparent variations, details of which may be described as follows under the respective heads of the parameters under reference.

Chlorophyceae

During the course of study, 17 – species of green algae were recorded from the pond. The population density of this group fluctuated from 603 U/L in May 2009 to 3540 U/L in March 2009. The green as a whole recorded a trimodal pattern of fluctuations during the study period. Two distinct peaks observed were in November' 2008 and March' 2009 whereas, the third one in August' 2009. In order of dominance the green algae were as *Hydrodictyon* sp. (33 U/L in December 2009 and January 2009 to 236 U/L in April 2009) >*Pediastrum* sp. (20 U/L in May' 2009 to 210 U/L in November 2008)>*Oedogonium* sp. (43 U/L in January 2009 to 206 U/L in April 2009) > Chlorella sp. (8 U/L in May 2009 to 205 U/L in November 2008) > Phcus sp. (20 U/L in June 2009 to 192 U/L in November 2008) >*Spirogyra* sp. (2 U/L in December' 2008 to 183 U/L in March 2009) >*Euglena* sp. (15 U/L in May 2009 to 183 U/L in November 2008) >*Mougeotia* sp. (18 U/L in August 2008 to 182 U/L in March 2009) >*Ulothrix* sp. (22 U/L in August 2008 to 181 U/L in April 2009) >*Characium acuminata* (19 U/L in May 2009 to 180 U/L in November 2008) >*Closteriumleibleinii* (12 U/L in May 2009 to 180 U/L in July 2008) >*Cladophora* sp. (30 U/L in May 2009 to 177 U/L in March 2009) >*Cosmarum supergranatum* f. minor (28 U/L in May 2009 to 174 U/L in April' 2009) >*Cosmarium* su circulare (26 U/L in May' 2009 to 173 U/L in March 2009) >*Stigeoclonium* sp. (53 U/L in December' 2008 and January 2009 to 171 U/L in March 2009) >*Closterium arcuatum* (17 U/L in May 2009 to 171 U/L in November 2008) >*Closteriumsub crassum* (28 U/L in May 2009 to 171 U/L in March' 2009) > Closterium sp. (15 U/L in May' 2009 to 168 U/L in March' 2009) >*Chlorococcum infusionum* (10 U/L in May 2009 to 166 U/L in March' 2009) >*Xanthidium eximium* (28 U/L in August 2008 to 51 U/L in June 2009 and July 2009) >*Spirogyra sp*., *Mougeotia sp*. *Cladophora sp*., *Cosmarium subcirculare*, *Stigeoclonium sp.*, *Closterium sub – circulare*, *Closterium sp.*, and *Chlorococum infusionum* recorded their highest number in March 2009 whereas, *Pediastrum sp*., *Chlorella sp*., *Phacus sp*., *Euglena sp.*, *Choracium acuminate*,*Closterium arcuatum* recorded their highest number in November 2008. But the peak month for the growth of *Hydrodictyon sp.*, *Oedogonium sp*., *Ulothrix sp*., *Cosmariumsupergranatum* f.minor was observed in April 2009.

During the present investigation 17 – species of green algae were collected from the Makhana pond. Mahto (1992) and Mishra *et al.*, (1996) reported 14 to 18 – species of green algae from Makhana cultivating Ponds. The total population of Chlorophycea members were recorded the highest during March 2009 and the minimum during May 2009. Out of 17 – species, 8 – species showed their highest peak in March' 2009. The highest peak during May was also reported in Makhana swamps. Various workers have observed maximum density of green algae during summer and the minimum during winter in different fresh water bodies (Pandey *et. al.*, 1994; Bais *et. al*., 1995). Proliferation of green algae from December 2008 to April 2009 could be attributed to the progressively increasing water temperature. Water temperature has been considered as a major environment factor to control their growth (Bais et. al., 1995). In spite of high temperature during May 2009 and June 2009, low density of green algae was recorded due to predation of high population of zooplankton ($r = -0.981$). This supports the finding of Pandey and Verma (1992). During July 2009 and August 2009 the population of Chlorophycean members increased due to break down of mansoon and low population of zooplankton. Various workers observed a spurt in their population after the onset of mansoon (Pati and Sahu, 1993). Desmids were reprensented by 8 – species which are important source of food for zooplankton and fishes. Their density decreased with increase in population of zooplankton predating upon the former. But during March 2009 and April 2009, high population of desmids might be due to their rapid growth during these months. Kant and Anand (1978) observed that high temperature favors the growth of desmids. During March 2009 and April 2009, the population of green algae recorded to be the maximum when the concentration of nitrogen ($r = 0.355$) and phosphorus ($r = 0.146$) were high.

Cyanophyceae

During the course of study, 6 – species of blue greens algae were collected from the pond. The population density of this group fluctuated from 43 U/L in February 2009 to 520 U/L in June 2009. In order of dominance, the blue green algae was Microcystis sp. (14 U/L in January' 2009 to 197 U/L in June 2008) > Anabaena sp. (9 U/L in November 2008 to 129 U/L in July 2008) > Oscillatoria sp. (15 U/L in february' 2009 to

119 U/L in June’ 2009) > Spirulina sp. (8 U/L in December 2008 to 55 U/L in May 2009) > Lyngbya sp. (5 U/L in December 2008 to 47 U/L in June 2009). Out of the 5 – species, 3 – species of blue greens recorded their highest number in June’ 2009. There was a trend of decrease in total population of blue greens from 432 U/L in July’ 08 to 43 U/L in February’ 2009. But in March’ 2009 their number increased to 148 U/L and the increasing trend continued till June’ 2009. During July’ 2009 and August’ 2009 their population decreased.

During the present investigation only 6 species of blue green algae were collected from the pond Mahto (1992) and Mishra et. al., (1996) reported 4 to 9 – species of blue green algae from the Makhana ponds. Dominance of Microcystis sp. throughout the study period supports the findings of Zafar (1967) and Rana *et al.* (1996). The total population of blue green algae was recorded highest during june’ 09 and minimum during February 09. Temperature has been considered as a major environment factor to control the growth of blue green algae (r = 0.796). Various workers have reported their dominance during summer (Khan and Seenaya, 1982; Pandey *et.al.*, 1994, Bais *et. al.*, 1995) but Mahajan and Mandloi (1998) observed highest population during the rainy season. Besides high temperature, presence of considerable amount of free CO_2 and low content of oxygen dissolved in water favoured the growth of Cyanophycean members during June 2009. According to Munawar (1970), high calcium favoured the growth of blue greens and during the present study similar findings were observed.

Bacillariophyceae

During the course of study 5 – species of diatoms were recorded from the pond the population density of Bacillariophyceae fluctuated from 126 U/L in November’ 2008 to 551 U/L in June’ 2009. (Table - 6) In order of dominance, the diatoms were as Navicula Peregrina (20 U/L in November’ 2008 to 210 U/L in May’ 2008) > Synedra ulna (50 U/L in October’ 2008 to 190 U/L in June’ 00) Diatoma sp. (25 U/L in December’ 2008 to 102 in July’ 2008) > Nitzschia sp. (14 U/L in January’ 2009 to 78 U/L in July’ 2008). The total population of diatoms during July’ 08 was 373 U/L which showed a trend of decrease till November’ 2008 (126 U/L). But in December’ 2008 their number increased to 136 U/L and a trend of increase continued till June’ 2009 (551 U/L). During July’ 2009 and August’ 2009, the density of diatoms was 327 U/L and 262 U/L respectively.

Diatoms were the sub – dominant group of total phytoplankton. These were represented by only 5 – species from the present pond Mahto (1992) and Mishra *et. al*., (1996) reported only 2- species from the Makhana ponds. But Ahmed and Sarkar (1997) observed diatoms as the most abundant freshwater phytoplankton. The population of diatoms was observed to be the highest during June’ 2009 and the lowest during November’ 2008. This indicates that temperature controls their growth (r = 0.514). Pandey *et. al*., (1994) and Bais *et. al.*, (1995) also reported summer maxima and winter minima.

Phytoplankton Primary Productivity:

The Gross Primary Productivity of Phytoplankton varied from 0.89 g C/m^2/day (January 2009) to 3.86 g C/m^2/day (April’ 2009) whereas, Net Primary productivity between 0.25 g C/m^2/day (August’ 2009) and 3.14 g C/m^2/day (March’ 2009). Primary productivity showed fluctuation and two prominent peaks were observed – one during November’ 2008 for both GPP and NPP whereas, the other during April’ 2009 for GPP and March’ 2009 for NPP. Community respiration was maximum in June’ 2009 (2.03 g C/m^2/day) but its percentage to GPP was maximum in August’ 2009 (87.85%). The lowest value of community respiration was found to be 0.35 g C/m^2/day in the month of January’ 2009. It also showed two peaks – one during June’ 2009 and another during August’ 2008. The percentage of respiration to GPP fluctuated between 26.25 and 87.78 NPP and GPP ratio fluctuated in between 0.142 (August’ 2009) and 0.737 (March’ 2009).

Gross Primary Productivity (GPP) was maximum during summer months and minimum during winter months. Such seasonal changes of GPP was also reported by Rai and Sharma (1991), Pandey and Verma (1992), Pandey *et. al*., (1995), Rana *et. al*., (1996). The high GPP during summer season might be due to high plankton density, high transparency and moderate temperature. Phytoplankton density justify the productivity index of the system. Pandey *et. al*., (1995) and Mandal *et. al*., (1999) also reported maximum productivity due to high phytoplankton density but Khan et. al., (1978) observed no such relation. Two peaks in primary production viz., one in November’ 2008 for both GPP and NPP and another in April’ 2009 for GPP and March’ 2009 for NPP. Bimodal trend of primary productivity was also reported by Krishna Rao *et. al.*, (1999). During the present study the fluctuations of GPP and NPP were in between 0.85 g C/m^2/day to 2.36 g C/m^2/day. Earlier reported about Primary Productivity was 10.95 g C/m^2/day (Primary Production) 10998 g C/m^2/day to 3.412 g C/m^2/day (Primary Production) by Ahmad and Sarkar (1997), 0.8 g C/m^2/day to 3.6 g C/m^2/day (GPP) and 0.3 g C/m^2/day to 2.1 g C/m^2/day (NPP), 0.108g C/m^2/day to 0.304 g C/m^2/day (NPP) and 0.156 g C/m^2/day to 0.323 g C/m^2/day (GPP) by Rai and Sharma (1991), 0.406 g C/m^2/hr to 0.984 g C/m^2/hr (GPP) and 0.313 g C/m^2/hr to 0.703 g C/m^2/hr (NPP) by Pandey and Verma (1992), 30.48 g C/m^2/hr to 237.60 mg C/m^2/hr (NPP) by Pandey et. al., (1995), 0.57 gm C/m^2/hr to 0.75 gm C/m^2/hr (GPP) by Rana et. al., (1996), 430 mg C/m^2/day to 4500 mg

C/m^2/day (GPP) and 312 mg C/m^2/day to 3300 mg C/m^2/day (NPP) by Singh (1995), 56.8 mg C/m^2/hr. to 200.6 mg C/m^2/hr. (GPP) and 51.4 mg C/m^2/hr. (NPP) by Mandal et. al., (1999) 686 g C/m^2/hr (annual GPP) by Krishna Rao *et. al*., (1991), During the present experiment, it was observed that plants of Makhana crop not only utilized by the nutrients of the pond but also checked the penetration of light to an extent that was essential for phytoplankton production.

Phytoplanktons were recorded from Makhana pond in the present study. Mishra *et.al*. (1996) also reported the presence of these algal in Makhana swamps and ponds. Pati and Sahu (1993) observed similar fluctuations of phytoplankton population in a reservoir. But Ahmed and Sarkar (1997) reported the dominance of Bacillariophyceae over Chlorophyceae and Cyanophyceae. The total population of green algae dominated over blue greens and diatoms throughout the study period. The percentage composition of diatoms was more than that of blue greens but during July 2008 to November 2008, July 2009 and August 2009, the former was recorded lesser in number than the later. Vyas and Kumar (1968) and Sanjer and Sharma (1995) observed dominance of Cyanophyceae over Bacillariophyceae.

IV. Conclusion:

Presence of algal bloom in December to April was due to increase in water temperature. But in May and June in spite of high temperature, low density was due to predation by high population of Zooplankton. Young leaves of *E. ferox* and submerged macrophytes get associated by periphytons. Biomass of submerged plant is declined due to the high rate of consumption by the grass carp. The maximum and the minimum net productivity of *E. ferox* (Makhana) were recorded during April and during August respectively. It was the indication that productivity decreased after the end of grand growth period. Maximum biomass of *E. ferox* was during July and for submerged macrophytes during February. Gradual decrease in biomass of submerged macrophytes like *H. verticillata*, *E. crispus* and *P. crispus* was due to gradual increase in the biomass of *E. ferox* giant leaves covering the water surface showed adverse effect on the submerged macrophytes. Decomposed plant part of Makhana crop supplied the organic matter, which besides acting as food for phytoplanktons and zooplanktons.

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Anupma Kumari. "Survey of Phytoplanktons in Makhana Pond Water of North Bihar. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*, 14(10), (2020): pp 15-20.