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THE IMPACT OF ALGAL DIVERSITY ON MAKHANA GROWTH IN THE SELECTED PONDS OF THE DARBHANGA DISTRICT

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ABSTRACT

In recent years, problems have arisen in makhana fish aquaculture, makhana agriculture, and all other makhana-based farming systems due to a small aquatic weed, specifically algae. Algae are becoming a significant problem in makhana-based cropping systems, leading to a decline in yield and a decline in water quality. Cyanophycean, Euglenophyceae, Chlorophyceae, and Bacillariophyceae algae species from Makhana Pond in the Darbhanga district served as the study's representatives. Non-hetrocystous cyanobacteria were more prevalent in all sampling sites, especially in soil with a high organic and nitrogen content, but cyanobacteria were prevalent in the research site.

This addition broadens the systematic knowledge of the algae in Makhana Pond. Throughout the investigation, it showed a trimodal pattern of changes. Two minor highs occurred in November and April, while one occurred in June. In the months of June through August, its population decreased. Throughout the study period, the overall population of blue green algae outnumbered both diatoms and green algae. Diatoms made up a larger percentage of the composition from July to November, although they were less prevalent than blue greens. Summertime had the highest Gross Primary Productivity (GPP), which calculates the overall rate of photosynthesis including the organic matter used up in respiration, while wintertime saw the lowest.

Key words: Bacillariophyceae, Euglenophyceae, Chlorophyceae, Cyanophyceae, Algae, and Gross Primary Productivity

Introduction

Approximately 1.6% of all biodiversity is made up of algae. They are the simplest plants and the earliest photosynthetic organisms to release elemental oxygen into the atmosphere. 90% of photosynthetic activity generates around half of global primary production (Graham & Wilcox (2000). Pharmaceuticals, health foods, and industrial wastewater bioremediation are just a few of the many potential applications for microalgae. Algae are a vital component of the aquatic ecosystem and help maintain the equilibrium of biotic and abiotic components.

Water quality affects the productivity of algae, which are essential to the maintenance of aquatic ecosystems as the base of the food chain or food web (Meshram & Dhande, 2000; Santhanam & Peruma, 2003). Algae are used as biological indicators of water contamination in a number of countries. It is possible to sustainably maintain soil fertility by using algae. Almost any kind of habitat, including very acidic and alkaline ones, is home to algae. In highly polluted waters, they multiply and produce algal blooms. The two most common species in contaminated habitats are Oscillatoria sp. and Chlorella sp. In addition to their ecological roles as oxygen suppliers and the main source of food for almost all aquatic life, algae are important economically as a source of food, crude oil, and a number of industrial and pharmaceutical products for people. In recent years, algae have flourished in water tainted by organic waste, and they have been essential to the "self-purification of water bodies." Algal research holds a lot of promise. Despite these conditions, algae are among the least researched and utilized categories. In this study, we collected, documented, and identified the ecology of the algae in our region

The majority of the algae are too tiny to be seen with the naked eye. However, because their cells contain chlorophyll, they could turn the water green if they are present in sufficient numbers. For algae to thrive, they need carbon dioxide, sunlight, and nutrients. Depending on the species, terrestrial plants and algae have different needs for calcium, phosphate, silicate, and nitrate. In environments with low nitrate concentrations, some algae may fix nitrogen and flourish.

These crucial biotic elements of an aquatic environment act as markers of the trophic phase oxygenate the water during photosynthesis and either directly or indirectly supply the primary food source for fish. Light is a vital energy source for photosynthesis in algae. This explains why the summer months have the largest prevalence of algae. Light may be a limiting factor for the growth of algae, according to Kaufman (1980). One of the main environmental factors thought to regulate their growth is temperature (Verma and Dutta Munshi, 1987; Bais et al., 1995). The summertime warming of the water could be the cause of the algae's growth. This validates Wisharad and Mehrotra's (1988) findings. According to Baruah et al. (1993) and Shivakashi et al. (1995), algae bloom most during the summer. The basic building blocks required for algal production are provided by nutrients such as nitrogen and phosphate (Trivedi et al., 1985; Agrawal et al., 1990). The current study's high phosphate and nitrogen levels encouraged the growth of algae. Because of predation by the many zooplankton, the overall algae population was found to be low between August and May, despite having high amounts of phosphate and nitrogen.

The conversion of solar energy absorbed by chlorophyll-producing plants by various species at varying tropic levels determines the biological productivity of any system, whether terrestrial or aquatic. Primary productivity is the rate at which radiant energy is converted into organic compounds by the photosynthetic and chemosynthetic activities of producer organisms. Thus, photosynthesis is the principal source of productivity. Gross primary production (GPP), which accounts for the organic matter utilized for respiration during the measurement time, is the overall rate of photosynthesis. Net primary productivity, or NPP, is the rate at which organic matter is stored in plant tissues above the rate at which the plant uses it for respiration. Many ecosystems can repair carbon in freshwater ponds through photosynthetic processes. They might be photosynthetic bacteria, macrophytes, periphyton, or algae.

Materials and Methods

Experimental Pond:

The Makhana Pond was located in latitude 26^0 N and longitude 86^0 E in the village of Sajjanapura, which is part of the Benipur subdivision of Darbhanga town. Its overall area is roughly 5 hectares. At a depth of 0.30 to 1.75 meters, the water spread area peaked in August at 4.48 hectares and decreased to 3.37 hectares in May. This pond was used for integrated fish culture with Makhana (*E. ferox* Salisb.) from March to August.

Fig.1.Sample collection

Fig.2. Farmer and owner of pond

Materials were collected and labeled in polypropylene vials with tight closures for algal taxonomic study. The samples were stored in a 4% formalin solution in the laboratory at the Department of Botany, CM Science College, Darbhanga, till the microscopic analyses were finished. Temporary slides made from samples were seen under a microscope equipped with 10X and 40X lenses. Care was taken to guarantee that the identification was finished within two days after collection in order to maintain the original morphology. The taxa were identified using reliable scientific literature, including algae base (John & Francis, 2013) and Desikachary (1959).
Monthly periphyton collections were made from the petioles and leaves of Makhana plants (*Euryale ferox* Salisb.) and submerged macrophytes (*Potamageton crispus* and *Hydrilla verticillata).* A sharp knife was used to chop out densely developing leaves and petioles into little, one-square-centimeter pieces. After scraping off the algae that was adhering to these pieces, distilled water was used to create a uniform suspension.
The biomass productivity of E. ferox and submerged macrophytes (*Potamogeton crispus* and *Hydrilla verticillata*) was measured using the harvesting approach. Two E. ferox samplers were used: one measuring 25 cm by 25 cm till the seedling phase (March) and another measuring 100 cm by 100 x cm after the seedling phase. Throughout the study period, a square sampler of 25 cm by 25 cm was used to collect the submerged macrophytes once a month. To calculate dry weight, E. ferox samples were taken 50–75 cm below the surface and dried for 48 hours at 600C in a hot air oven. The "difference method," which measures the difference between the highest and minimum biomass of macrophytes, was used to compute net productions. The light and dark bottle method was used to measure the primary productivity of algae.

Management of Makhana (*E. ferox*) Crop
Thinning and Transplantation –
In March, the seedlings of E. ferox plants were uprooted and dispersed throughout the available water space, ensuring that there was approximately one meter between each plant. There were still empty spots in the middle and corner areas of the pond after thinning and transplanting. There was an empty area in the middle of the pond, 9 by 5 meters. Bamboo poles were used to fence this space so that when the plants grew, their wide leaves would not be able to cover it. Additionally, the crop's developing leaves were not permitted to spread out there, leaving four voids—one on each corner. However, bamboo poles were not set up in these empty areas.

Leaf cutting: Using a sickle, every leaf on the crop was removed from the petiolar region in July. The leaves were then turned upside down and allowed to decompose.

Harvesting: This aqua product was picked by expert fishermen in August. Using their hands and legs, the fishermen collected the scattered Makhana agricultural seeds from the pond dirt, creating seed mounds. The weight of these seeds was recorded after they were eventually grown with the aid of baskets.

Results and Discussions

The average values of each parameter were assessed for their interpretations because the algae samples taken from the pond's four sides did not show any discernible differences in the layout of the algal communities at those locations. According to their classes of algae, the Cyanobacteria, Euglenophyceae, Chlorophyceae, and Bacillariophyceae were identified. Regular monitoring of the pond's algal population's organization showed noticeable changes.

From the complete collection, we were able to identify a few taxa of cyanobacteria, diatoms, green algae, and euglenophyceae. These organisms belonged to four classes: Euglenophyceae, Bacillariophyceae, Cyanophyceae, and Chlorophyceae. The most diverse families were the Chlorophyceae and Cyanophyceae. Bacillariophyceae and Euglenophyceae members showed relatively little diversity. The macro algae comprised 30 taxa from 13 genera and 3 classes, including the diatom. There were eight green algae (Chlorophyceae), two unicellular motile Euglenophyceae members, and three diatoms (Bacillariophyceae). Among these macroalgae, the most common genus was Spirogyra, and the most common class was Chlorophyceae, which comprised eight genera. The 17 taxa of cyanobacteria that were identified were divided into seven genera and four families. Of the four families, the Nostocaceae are the only ones that can fix nitrogen because they are heterocystous. The predominant family was the Nostocaceae, which had three genera. The Oscillatoriaceae, which had two genera, the Rivulariaceae, which had one genus, and the Chroococcaceae, which had one genus. While *Oscillatoria, Phormidium, and Microcystis* were the non-heterocystous cyanobacteria that were discovered, the four taxa of heterocystous cyanobacteria—*Nostoc, Anabaena, Cylindrospermum, and Scytonema—*showed a great degree of variation. For instance, Microcystis was unicellular.

Ecology of the algae in the study area

Cyanobacteria showed the greatest dispersion since they were found at all test sites. The two most prevalent genera of non-heterocystous cyanobacteria were *Oscillatoria* and *Phormidium*. The high nitrogen concentration of the soil, especially in the drainages, may be the cause of this, as it gives them an awful smell. On the other hand, rice fields and other cultivated regions, such banana and tapioca plantations, had high frequencies and diversity of heterocystous cyanobacteria, which are classified into four genera: *Nostoc*, *Anabaena*, *Cylindrospermum*, and *Scytonema*. By supporting biological nitrogen fixation, these heterocystous organisms increase soil fertility, which eventually helps farmers. Every collecting site had members of the Chlorophyceae, with the exception of the waste land.

These components proliferate abundantly to generate the algal bloom. Algae respond rapidly to environmental changes and are a vital component of the ecosystem. Algae research started in the 1950s. We tried to identify the algae and their ecological role in the local freshwater ecosystem. Srivastava et al. (2018) collected 30 freshwater microalgae samples from central India and found that they were members of the groups Cyanophyceae, Bacillariophyceae, and Chlorophyceae. His research revealed that the Cyanophyceae and Chlorophyceae had the greatest diversity. Additionally, this result aligned with the current study. High green algal diversity was also found by Vijayan & Rey (2015).

Chlorophyceae

Over the duration of the study, the green as a whole underwent alterations in a trimodal pattern. The third peak happened in August, with the other two occurring in November and March..*Hydrodictyon sp., Pediastrum sp., Oedogonium sp., Phcus sp., Spirogyra sp., Closterium leibleinii, Clodophora sp., Cosmarium granatum, Ulothrix sp., Mougeotia sp., Stigeoclonium, Infusion of chlorococcum,* *Eximium xanthidium, Spirogyra sp., Mougeotia sp., Cladophora sp., Cosmarium subcirculare, Stigeoclonium sp., Closterium sub-circulare, Closterium sp., and Chlorococum infusionum* were the most prevalent species in March, while *Pediastrum sp., Chlorella sp., Phacus sp., Euglena sp., Choracium acuminate*, and *Closterium arcuatum* had the highest numbers in November. *Cosmarium granatum f. minor, Ulothrix sp., Oedogonium sp.,* and *Hydrodictyon sp*. all reached their maximum growth in April.

Numerous green algae species were gathered from the Makhana pond for the current study. In ponds that produced Makhana, 14–18 different types of green algae were documented by Mahto (1992) and Mishra et al. (1996). March and May saw the largest and smallest populations of Chlorophyceae members, respectively. Eight of the seventeen species reached their peak height in March. In many freshwater bodies, the summer months have the highest density of green algae, while the winter months have the lowest density, according to multiple studies (Pandey et al., 1994; Bais et al., 1995). The slow warming of the water between December and April might have contributed to the growth of green algae. One important environmental component that has been thought to regulate their growth is the temperature of the water (Bais et al., 1995). Despite the high temperatures, there was a low density of green algae in May and June of due to the high zooplankton population that was being preyed upon ($r = -0.981$). This validates Pandey and Verma's (1992) findings. Because of the monsoon's collapse and the low zooplankton population, the number of chlorophycean members rose in July and August. As the monsoon season got underway, the workforce grew.

There were eight kinds of desmids, which are crucial food sources for zooplankton and fish. The more zooplankton that came before the former, the lower their density. However, the high quantity of desmids in March and April of 2021 can be due to their rapid growth during these months. Kant and Anand (1978) assert that desmid growth is encouraged by high temperatures. The green algae population peaked in March and April of 2021, when the amounts of nitrogen ($r = 0.355$) and phosphorus ($r = 0.146$) were high.

Cyanophyceae

Numerous types of blue-green algae were gathered from the pond over the course of the examination.Examples include *Microcystis sp., Lyngbya sp., Anabaena sp., and Oscillatoria sp.* Three of the five blue-green species reached their peak numbers in June. Only six species of blue green algae were gathered from the Makhana ponds during the current study, despite reports of four to nine species from the ponds by Mahto (1992) and Mishra et al. (1996). The results of Zafar (1967) and Rana et al. (1996) are supported by the prevalence of Microcystis sp. during the study period. June had the highest and February had the lowest concentrations of blue-green algae. One of the main environmental factors thought to regulate the development of blue green algae is temperature ($r = 0.796$). Although Mahajan and Mandloi (1998) reported the highest population during the rainy season, several researchers have shown their dominance during the summer (Khan and Seenaya, 1982; Pandey et al., 1994, Bais et al., 1995). Cyanophycean members proliferated in June due to a combination of high temperatures, high levels of free CO_2, and low dissolved oxygen concentrations in the water. Munawar's (1970) claim that blue greens grew more successfully at high calcium levels was supported by the current investigation.

Bacillariophyceae

Diatoma sp., Nitzschia sp., Navicula peregrina, and Synedra ulna are the diatom species. In December 2021, their numbers grew, and they kept growing until June. Of all the algae, diatoms were the sub-dominant group. Only four of these species were found in the current pond; Mahto (1992) and Mishra et al. (1996) found only two species in the Makhana ponds. However, diatoms were found to be the most prevalent freshwater algae by Ahmed and Sarkar (1997). The results showed that the diatom population peaked in June 2021 and started to decline in November 2021. This suggests that their growth is regulated by temperature. Both summer maxima and winter minima were recorded by Pandey et al. (1994) and Bais et al. (1995).

Algae Primary Productivity:
The net primary productivity of the algae ranged from 0.26 g C/m2/day (August) to 2.14 g C/m2/day (March), whereas the gross primary productivity ranged from 0.86 g C/m2/day (January) to 3.87 g C/m2/day (April). The main productivity fluctuated with two notable peaks in November for both GPP and NPP, and in April for GPP and March for NPP. June had the highest communal respiration (2.03 g C/m2/day), whereas August had the highest amount of GPP (87.85%). In January 2023, the lowest community respiration value ever recorded was 0.35 g C/m2/day. Additionally, it displayed two peaks: one in August and one in June. The respiration to GPP ratio varied from 26.25 to 87.78 NPP, whereas the GPP ratio varied from 0.142 in August to 0.737 in March. Summertime saw the highest Gross Primary Productivity (GPP), while wintertime saw the lowest. Rai and Sharma (1991), Pandey and Verma (1992), Pandey et al. (1995), and Rana et al. (1996) have all documented such seasonal variations in GPP. The high plankton density, great transparency, and consistently pleasant summer temperatures may be the source of the high GPP.

The density of algae supports the system's productivity index. Although Khan et al. (1978) found no such correlation, Pandey et al. (1995) and Mandal et al. (1999) both claimed that maximum productivity was correlated with high algae density. In the current experiment, it was found that the Makhana agricultural plants not only used the pond's nutrients but also limited the amount of light penetration, which was necessary for the growth of algae.

For this investigation, algae were collected from Makhana Pond. Similar variations in the algae population within a reservoir were noted by Pati and Sahu (1993). However, Bacillariophyceae are more common than Chlorophyceae and Cyanophyceae, according to Ahmed and Sarkar (1997). During the study period, the overall population of green algae outnumbered diatoms and blue greens. Diatoms were less prevalent than blue greens in November, July, and August, although they still accounted for a larger share of the composition. Sanjer and Sharma (1995) and Vyas and Kumar (1968) both claimed that Cyanophyceae were more common than Bacillariophyceae.

Conclusion
As a gift, Darbhanga has many makhana ponds. However, ponds are some of the most polluted and misused areas. Researching the impacts of pollution and land use will benefit from the documentation of these areas' biodiversity. Algae are the least studied and documented species due to their fragile nature and straightforward structure. The biodiversity of this region had previously been reported, but the algal flora was unknown.

Despite being extremely early, this work will be helpful for future biodiversity assessments and documentation. Macroalgae are believed to be the most reliable and efficient sensors of trace metal contamination, and algal bloom is seen in areas with high pollution levels. Between December and April, the water temperature rose, causing the algal bloom. Despite high temperatures in May and June, a huge population of zooplankton predated, causing the low density. Periphytons link submerged macrophytes and young E. ferox leaves. The high rate of grass carp consumption results in a decrease in the biomass of submerged plants. The net production of E. ferox (Makhana) was highest in April and lowest in August.

It was a sign that when the big expansion period ended, productivity had declined. While the biomass of E. ferox peaked in July, that of submerged macrophytes peaked in February. E. ferox's enormous leaves covering the water's surface caused a steady decline in the biomass of submerged macrophytes, such as *H. verticillata, E. crispus, and P. crispus*. The organic components came from the decomposing plant component of the Makhana crop, which also served as food for zooplankton and algae.

References

1. Bais, V. S., Agrawal, N. C. and Arasta, T. 1995. Comparative study of seasonal changes in algae community in the Sagar Lake and Military Engineering Lake. J. Freshwater Biol. 7 (1): 19 – 25.
2. Bais, V.S., Shukla, S. N., and Agrawal, N.C. 1990. Nitrate and phosphate enrichment's effects on Sagar Lake's primary productivity. Pollution Research 9:29–32.
3. In 1997, Ahmad, J. W. and Sarkar, A. examined the productivity and limnology of two reservoirs in northeastern India. 29 (2): 1–10 in J.Inland Fish. Soc. India
4. Baruah, A., Singh, D. K., Sinha, A. K. and Sharma, U. P. 1993. Plankton variability of a tropical Wetland, Kawar Lake (Begusarai), Bihar. J Freshwater Biol. 5 (1): 27 – 32.
5. Hutchinson, G. E. 1967. A. treatise on Limnology. Vol. – II. Introduction to lake biology and the limno plankton. John. Wiley and sons. Inc. New York.
6. Jamil, K. (1993). The role of macrophytes in aquatic ecosystem. J. Freshwater Biol. 5(2):141-145.
7. Kant, S. and Anand, V. K. 1978. Interrelationship of algae and physical factors in Mansar Lake, Jammu (J & K), India Ind.J. Ecol. 5(2):134 – 140.
8. Khan,Md. Mazharuddin and Seenayua, G. 1982. Ecology of planktonic blue green algae in the profiles of industrially polluted Husain Sagar Lake, Hyderabad, India. Phykos 24:140 – 148.
9. Khan, A. A., Siddiqui, A. Ali, M. Hameed, T. (1978). Physico – chemical and biological characteristics of a pond chau tal. J. Zool Res. 2(1):1-1
10. Krishna, Rao,D. S. Das, A. K., Darthikeyan, M. and Ramakrishniah, M. 1999. Algae primary production and fish production efficiency of Manchanbele reservoir (Bangalore, South India), National Seminar on Eco – friendly Management of Resources for Doubling fish production – Strategies for 21st Century, Inland Fish Soc. India & Cent. Inland Fish. Res. Inst., Barrackpore, 22 & 23 Dec. 1999 (Abst.) p. 1.
11. Mahajan,S. and Mondloi, A. K. 1998. Physico – chemical characteristics of soil and water in relation to planktonic production of fish culture pond J. Inland Fish. Soc. India. 30(1):92-98.
12. Mahto, A. (1992). Comparative limnological studies on eutrophicated and non- eutrophicated ponds of Makhana (Euryale ferox Salisb.), In Darbhanga (North Bihar), Ph. D. Thesis, L. N. Mithila University, Darbhanga.
13. Mandal, T. N., Kumari, K. and Sinha, K. M. P. 1999. Assessment of primary productivity of a wetland of North Bihar. Ecol. Env. & Cons 5(1):39-41.
14. Mishra, R. K., Jha, V., Mahto, A. and Kumar, R. (1996). Bio – ecology, cultivation and storage ecology of Makhana (Euryale ferox Salisb.) in North Bihar, India. In Environment and Biodiversity, Jha, et. al. (eds.), Ecological Society, Kathmandu, Nepal, p. 120 - 127.
15. Panday, R. S. and Verma, P. K. (1992). Limnological status of an ancient temple pond Shivaganga of Deoghar, India. J. Freshwater Biol. 4(3):163-174.
16. Pandey *et. al.*, (1994) Panday,K. N., Prakash, V. and Sharma, U. P. 1994. Ecology of gastropods in relation to macrophyte of a tropical Wetland, Kawar Lake (Begusarai), Bihar. J. Freshwater Biol. 6(3):235- 238.
17. Panday,K. N., Prakash, V. and Sharma, U. P. 1995. Assessment of primary productivity of algae and macrophytes of Kawar lake wetland (Begusarai), Bihar. J. Freshwater Biol. 7(4):237-239.
18. Pati and Sahu (1993) Pearsall, W. H. 1932. Algae in the English lakes. II. The composition of algae in relation to dissolved substances. J. Ecol. 20:241-262.
19. Rai, D.N. and Sharma, U. P. 1991. Correlation between macro phytic biomass and macro invertebrate's community structure in wetlands of North Bihar. Intesn. J. Ecol. Environ. Sci. 17:27-36.
20. Sanjer, L. R. and Sharma, U. P. 1995. Community structure of plankton and their periodicity in Kawar Lake, Begusarai, Bihar. J. Freshwater Biol. 7(1):33-36.
21. Shivakashi, R., Premkishore, G. and Chandran, M.R. 1995. Diel migratory pattern of planktions in Ayilapattai pond at Tiruchirapalli, India. J. Freshwater Biol. 7(2):109-116.

22. Singh, M. (1995). Impact of human activities on the physico – chemical conditions of two fish ponds at Patna (Bihar), India, J. Freshwater Biol. 7(1):13-17.
23. Trivedi R. K., Garud, J. M. and Goel, P. K. 1985. Studies on chemistry and algae of a few freshwater bodies in Kolhapur with special reference to human activity pollution Research. 4(1):25-44.
24. Vyas L.N and Kumar, H.D. (1968). Studies on the algae and other algae of indra sagar tank Udaipur. India. Hydrobiogia 31: 421-434.
25. Wirharad, S. K. and Mehrotra, S. N. 1988. Periodicity and abundance of plankton in Gulasia reservoir in relation to certain physic – chemical conditions. J. Inland Fish. Soc. India. 20(1):42-43.
26. Zafar, A. R. (1967.) On the ecology of algae in certain fish ponds of Hyderabad.