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ALGAE AS BIO INDICATORS OF WATER POLLUTION IN FRESH WATER LAKE OF AJMER

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ABSTRACT

Pollution of freshwater ecosystems and the health of humans are both negatively impacted by water pollution, which is a global environmental issue of great concern. For the purpose of efficient management and the preservation of water bodies, it is essential to monitor the levels of pollution and conduct water quality assessments. The freshwater lake of Ajmer, more particularly Anasagar Lake, serves as the setting for this investigation on the use of algae as bioindicators of water pollution in the lake. The function that algae play in aquatic habitats is essential, and these ecosystems are susceptible to changes in water quality factors such as the amounts of dissolved oxygen, pH, and harmful compounds. Algae play a key role in these ecosystems. As a consequence of this, they are capable of acting as useful indicators of the general health and the level of pollution present in a body of water. In the course of the research that was carried out, water samples were taken on a regular basis from a variety of sites inside Anasagar Lake, and samples of algae were also collected. The concentrations of nutrients, the amounts of dissolved oxygen, the temperature, and the pH of the water were all assessed as water quality metrics. Through examination and classification at the microscopic level, the species composition and abundance of the algae were uncovered. The findings indicated that there is geographic heterogeneity in the levels of pollution inside the lake since they demonstrated changes in the water quality indicators that were measured at various sample locations. Certain species were more common in severely contaminated places, while others were prominent in comparatively cleaner portions of the gradient. These unique patterns were seen in algal communities, and they corresponded to the pollution gradient. The research demonstrates that algae have the potential to serve as reliable bioindicators for assessing the level of water pollution in Anasagar Lake. It is feasible to identify regions of concern and follow changes in water quality over time by analyzing the species makeup of algal communities as well as the quantity of those communities. The deployment of specific pollution reduction techniques and the maintenance of the lake environment can both benefit from this knowledge. The use of algae as bioindicators is, all things considered, a method that is both efficient and cost-effective for determining the level of water pollution in freshwater lakes. The findings of this study contribute to a greater knowledge of water quality management and conservation activities in ecosystems that are analogous to Anasagar Lake. These findings give useful insights on the pollution state of Anasagar Lake.

Keyword: Algae, Palmer, Garrett, Louies Laclereq, Organic pollution

Introduction

Anasagar Lake at Ajmer

Every one of the big lakes is struggling with a severe pollution issue that is causing unpleasant odors to be released, as well as silt deposits and choking from excessive algae growth. The utilization of algae as a biological indicator, in addition to their variety and dispersion, may be utilized for the purpose of fish monitoring and surveillance in order to evaluate pollutants. Hosmani and Bharathi (1980), Hosmani and Naganandi (1998), and Mahadev and Hosmani (2005) are credited with some important contributions to the field. "Algae as indicators of organic pollution" was researched by Mahadev et al. (2008) and Mahadev et al. (2009). The groundbreaking work that Palmer (1969) did served as the foundation for this investigation. Hosmani (2013) produced the "Algal index of pollution" based on the observation of 269 reports written by 165 writers who indicated that algae were tolerant to organic pollution. This index was derived from the data. The proportional number of algae was used to provide a score to the pollution index. The index, which was established by Louies-Laclereq (IDSELS) 2008 and Lecointe (2003) and has been utilized by various researchers (Palmer, 1969; Nygoard, 1976; Kelly, 2006; Hosmani, 2013; Hosmani and mruthunjays, 2013), is based on the existence of just one species in every water body. Killy (2006) employed diatoms and algae as an indication of the ecological state of the area and outlined the precise process of sampling and calculating the water quality. He also used diatoms as an indicator of water quality. This index not only identifies the percentage of anthropogenic pollution that falls within the range of low to high, but it also provides an estimate of the organic pollution. In addition, it establishes the degree of pollution in the water that has been degraded. Algae were gathered from eight different sites of Anasgar Lake for the purpose of this study. The sample collections were conducted on a seasonal basis over the course of two years, starting in 2015 and continuing through 2017. The physical, chemical, and biological characteristics of water bodies are the constituent parts that make up a lake's ecology. Lakes make for excellent environments for the study of the dynamic processes that occur within ecosystems. Lakes are significant components of ecosystems because people rely on them for a wide variety of services, including the provision of drinking water, the disposal of waste, fisheries, agricultural irrigation, industrial activity, and recreational opportunities. According to Likens (1985), a lake and the watershed that surrounds it are frequently regarded to represent a single ecosystem.The Kumaun Himalaya is located in the Lesser Himalayas zone between 28 degrees 43 minutes and 55 seconds north latitude and 30 degrees 49 minutes and 12 seconds east longitude, and it has a total area of 21,035 kilometers squared. It serves as a paradigmatic example of the geological architecture that characterizes the whole Himalayan area. As a result, Kumaun is one of the most representative sectors of the vast mountain system. Additionally, it is blessed with improved beauty and a diverse range of natural water resources. The Kumaun area has been generously endowed by mother nature with a vast number of lakes and rivers, each of which has an average annual flow that is greater than 2.0 million m3. During the middle of the 20th century, people became concerned about the effects that cultural eutrophication may have on Himalayan lakes such as Nainital, Bhimtal, Naukuchiatal, and Sattal, among others.

(Chakrapani 2002; Das, 2005; Choudhary et al. 2009) Lakes in the Kumaon area have been undergoing ecological changes over the past few decades that have had an effect on the water quality, rising heavy metal concentration, and increasing algal production. These changes have been attributed to the effects of climate change. Recently, it has come to light that the extensive cultural activities that take place in the catchment regions of the Kumaun lakes are contributing to a decline in the water quality of those lakes (Das and Pandey, 1978). The anthropocene has had a significant impact, both positively and negatively, on the water quality of lakes.

Materials and Methods

Algal samples were collected from different interface sites of Anasagar in acid washed plastic tubes and preserved in 5% formalin and identified with the help of standard references (Prescott, 1951; Desicachary, 1956; Randhawa, 1959). Water samples were collected in acid washed polyethylene bottles and were analyzed for physicochemical characteristics as described in the 'Standard Methods' (APHA-AWWA-WPCF 1998). It was determined how to calculate the Nygaard Trophic State Indices (Nygaard, 1949; Gunale and Balakrishnan, 1981). A list of the macrophytes that were found at the various interaction sites was also compiled. Under controlled experimental settings, the rate of decomposition of several dominating floating and submerged macrophytes was measured as a percentage of their total weight loss. The biomass of each species was also evaluated using the quadrat technique when it was present at the interface site of Lake Anasagar throughout the duration of the time period being considered for the computation of total nutrient release, and the mean yearly values were calculated.

Algae as Indicator of Pollution

According to Stumm and Stumm Zollinger (1972), one of the most significant problems associated with the pollution of inland waters is the gradual enrichment of water with nutrients. This enrichment leads to the mass development of algae, enhanced productivity, and other undesirable biotic changes. According to Sharma and Sharma (1992), the land-water interface of Lake Anasagar has a high algal variety, and the differences in species are caused by the varied types of pollution loads at the various interface areas. In the course of the current research, a total of 123 algal species belonging to 60 genera were examined. These included species such as Actinestrum hantzschii, Ankistrodesmus falcatus, Chlorella vulgaris, Chlorococcum infusionum, Pandorina morurn, Pediastrurn tetras, Scenedesmus acuminatus, S. obliquus, S. quadricauda and Stigeoclonium Several individuals in the workforce have also identified several algae species as an indicative of water contamination.

Trophic State

Indices An indicator that determines the level of eutrophication in lakes was developed by Nygaard (1949) and is based on the number of different algae species that belong to different categories. According to Kohlmann et al. (2018), using Nygaard's Indices as a kind of biomonitoring is a method that is both dependable and cost-effective for monitoring water quality. The trophic indices that are shown in Table 1 suggest that, with the exception of the diatom index, all of the indices demonstrate that Anasagar Lake is in a eutrophic condition. The water body has a highly eutrophic state when the CQ is at its highest possible value (9.11). In their study from 1991, Sharma and Sharma found that the lake had a low level of eutrophication..

Table 1. Nygaard's Trophic State Indices of Anasagar Lake of Ajmer

Index	Calculation	Range of index for Oligotrophic	Trophic Index Eutrophic
Cyanophycean	0.0—0.4	0.4—3.0	3.66
Chlorophycean	0.0—0.7	0.7—9.0	1.66
Diatom	0.0—0.3	0.0—1.75	0.10
Euglenophycean	0.0—0.2	0.0—1.0	0.25
Compound	0.0—1.0	1.2—2.5	1.55

Compound Quotient (CQ)	<2	>6	9.11

Macrophytes

The loading of nutrients has an effect on the composition of macrophytes in terms of both variety and density of the species present. Macrophytes make up a significant portion of the vegetation that may be found at the land-water interface in shallow waterways. According to Sharma (1993), the aquatic vegetation of Anasagar lake consisted of just 39 different species distributed across the floating (6), submerged (8), and emergent (24) zones. In eutrophic lakes, Purohit and Singh (1985) found a lower species diversity than in other types of lakes. The movement of nutrients throughout an aquatic environment is largely influenced by the activities of macrophytes. Not only do they absorb greater quantities of nutrients as a result of increased output, but it is known that certain species take in quantities of nutrients that are much in excess of what is required for their growth.

Nutrient Release Potentials

The release of nutrients through the decomposition of macrophytes is an important parameter that is used to evaluate the trophic status of bodies of water that have a low depth and are characterized by the fact that the total biomass productions that occur during the peak growing period are converted into dead matter during the summer season due to exposed sediment in the peripheral zone. Changes in water level over the seasons are a feature of Anasagar Lake, which is likewise affected by the phenomena described above. Table 2 provides the overall biomass output as well as the nutritional content that was determined in kilograms per hectare per year for the various prevalent macrophytes. According to the total annual biomass output per hectare as well as the total concentration of nitrogen, phosphate, calcium, and magnesium in the different macrophyte species, *Trapa bispinosa* and *Azolla pinnata* made a significantly greater contribution to the nutrient enrichment than *Potamageton crispus* and *Vallisneria spiralis* did. According to one study, the process of nutrient enrichment in lakes can be significantly mitigated if certain macrophyte species are eliminated prior to the beginning of the breakdown process. It was also anticipated that macrophytic vegetation, in addition to other sources of nutrients, plays a significant part in the release of nutrients into the lake water and are more responsible for generating eutrophic conditions of freshwater bodies. This information was based on previous research. According to the most recent research, Lake Anasagar has developed a significant level of eutrophication, and this state has the potential to result in an even more rapid decline of this important water body in Ajmer. Recently, the National Lake Conservation Plan (NLCP) expanded to include

Anasagar Lake as one of its target lakes. The avoidance of pollution from point sources that leads to the deterioration of lakes and the protection of lakes in their natural states are the two primary goals of this initiative. This will have a positive effect on the biological components of the water body; nevertheless, in order to enhance the quality of the water, it is also necessary to control the pollution that comes from non-point sources, such as agricultural practices and activities involving washing clothes. This should take place in the area around the lake.

Impacts of climate change on water qualityof lakes

It is well acknowledged that climate change poses a risk to the biological productivity of lakes. The hydrological features of lakes are changed in response to climatic changes. The hydrological and physico-chemical properties of lakes are shifting as a result of alterations in climate, such as the growing pattern of air and water temperature, rate of evaporation, precipitation, humidity, and sun intensity. These changes have been seen in recent decades. The length of the growth season is prolonged at high latitudes, heightened stratification and nutrient loss from surface waters, decreased hypolimnetic oxygen (below the thermocline) in deep, stratified lakes, and an extension in range for many exotic aquatic weeds are all impacts of global warming on lakes.

Temperature

The temperature is one of the most essential aspects that plays a role in the aquatic life. According to Boyd (1982), it is the fundamental environmental component that determines the chemical and biological reactions that take place in water and helps to maintain the ideal level of aquatic biodiversity.According to Meisner et al. (1988) and Boyd and Tucker (1998), the temperatures of lake ecosystems are tightly connected to the temperature of the surrounding air.Therefore, it should come as no surprise that an increase in the temperature of the air is likely to be followed by a corresponding increase in the temperature of the water. According to Sharma and Kumar (2002), the temperature of the water, which is a consistent factor for a variety of physicochemical as well as biological processes in lake ecosystems, changed noticeably with the fluctuations in the temperature of the air.Temperature has a direct impact on plant metabolism, which includes both photosynthetic and respiratory activity. The metabolic rates of primary producers are generally limited by photosynthesis (Dewar et al., 1999), but temperature has a direct influence on these rates. According to Ecke et al. (2005), as water temperatures rise as a result of climate change, this will lead to an increase in the demand for oxygen and can also lead to an increase in the productivity of lakes by causing an increase in the rates of algae growth, bacterial metabolism, and nutrient cycling. The low water levels, high air temperatures, and pristine environments in the Kumaun lakes throughout the summer months contributed to the region's record-breaking high water temperatures.

pH

The decreased rate of photosynthetic activities leads to a reduction in the absorption of carbon dioxide and bicarbonates, both of which are ultimately responsible for an increase in pH. According to Kamble et al. (2009), the low oxygen levels corresponded with high temperatures throughout the summer months. According to Goldman (1972), the enhanced photosynthesis and absorption of dissolved inorganic carbon by planktons throughout the summer might be responsible for the higher pH levels found in the water of the Kumaun lakes.The increase in water temperature has an effect on the chemical processes that occur in the Kumaun lakes, causing the pH to rise and leading to a larger production of alkalinity in the lakes.

Dissolved Oxygen

The presence of oxygen in dissolved form is the single most important ecological feature in maintaining a healthy lake environment and ensuring the continued existence of fishes. According to Wetzel (1983), dissolved oxygen is an essential component in determining the quality of any body of water as well as the productivity of aquatic ecosystems. The decrease in DO could be caused by the organic load that comes from municipal and residential sewage as well as loads of nutrients that occur at different times of the year. Temperature, photosynthesis, respiration, and the processes that lead to decomposition are the primary limiting variables that have an effect on the DO concentration. Warmer temperatures throughout the summer enhance the rates of photosynthesis and decomposition. When all plants die at the conclusion of the growing season, the breakdown of their bodies leads in a significant reduction in oxygen levels. DO levels were observed to be trending downward throughout the summer months due to the increased rate of decomposition of organic matter and the restricted flow of water, which led to the consumption of oxygen from the water.In Lake, dissolved oxygen is the most essential element for the development of nutrients, a vital regulator of metabolic activities of organisms and the community as a whole, and an important quality indicator for the water.The rate of aeration and photosynthetic activity both have an effect on the amount of oxygen that is dissolved in water.

Biological Oxygen Demand

The biological oxygen demand, or BOD, refers to the requirement for oxygen that all biotic organisms have in order to carry out their metabolic processes in aquatic systems. Large numbers of consumers in lakes lead to a rise in the biological oxygen demand, which is proportional to the amount of biodegradable organic material present. In the past twenty years, biological oxygen demand (BOD) has shown a rise during the summer months due to the presence of phosphates, nitrites, and nitrates in the water of Kumaun lake as a result of residential liquid wastes entering the lake through its entrance.

Chemical Oxygen Demand

The chemical oxygen demand (COD) is the amount of oxygen that is used up during the process of oxidizing organic materials. A high concentration of COD showed the presence of all kinds of organic matter; the degree of pollution in the lake water was contributed by biodegradable as well as nonbiodegradable organic matter. The greater concentrations of chemical oxygen demand seen during the summer months were indicative of water contamination caused by the presence of oxidizable organic materials in the lake.

Results and Discussion

According to the scale that Rawson (1960) suggested for oligo- and eutrophic scales, the study demonstrated that Anasagar lake is a eutrophic lake since several of the characteristics, such as conductance, dissolved solids, alkalinity, calcium, magnesium, and chlorides, were recorded at greater than oligotrophic levels. Specifically, the study looked at the levels of these elements in the lake. The lake's eutrophic status can also be determined from its alkaline pH. The process of eutrophication is also significantly impacted by the presence of critical nutrients like nitrogen and phosphorus. These nutrients are brought into the lake as a result of a variety of anthropogenic activities as well as the breakdown of plant matter and plankton waste. Sharma (1993) found that these nutrients were present in the lake in very high proportions. These nutrients encourage the growth of Cyanophyceae, particularly poisonous blooms of Microcystis aeruginosa and Actinomycetes, which contribute a foul odor and pose a significant risk to aquatic life..

CONCLUSION

In conclusion, the research reveals that employing algae as bioindicators is a useful method for determining the degree to which a freshwater lake in Ajmer, namely Anasagar Lake, is polluted with water. According to the findings of the research, different algal communities display various patterns that are directly correlated to the pollution gradient that exists inside the lake. It is feasible to detect regions of high pollution and follow changes in water quality over time by monitoring the makeup of algal communities as well as the number of different algae species. This information is vital for efficiently maintaining the lake's ecosystem and adopting targeted pollution mitigation techniques. This study emphasizes the necessity for extensive monitoring systems that cover diverse parts of Anasagar Lake by drawing attention to the geographical variability of pollution levels inside the lake itself. Performing routine sampling and analysis of the water quality indicators, in addition to determining the species of algae present in the lake, may give extremely helpful insights on the lake's general health as well as its level of pollution. The utilization of algae as bioindicators provides a number of benefits, some of which include financial savings, ease of usage, and high productivity. As a result of their high degree of sensitivity to shifts in the criteria that define water quality, algae are considered to be reliable indicators of pollution levels. In addition, the number of these organisms and the locations in which they are found give vital information that may be used to prioritize conservation efforts and put suitable safeguards in place to maintain and restore the ecology of the lake. The results of this study provide a significant contribution to a more comprehensive knowledge of the management and preservation of water quality in freshwater ecosystems. They serve as a foundation for future study as well as a reference for decision-makers and environmental authorities involved in the preservation and restoration of Anasagar Lake and other bodies of water that are comparable. Overall, the study shows the necessity of continued efforts to preserve and improve the water quality of Anasagar Lake for the benefit of both the environment and human well-being by demonstrating the significance of considering algae as bioindicators for monitoring water pollution. Additionally, the study indicates the value of considering algae as bioindicators for monitoring water pollution. The Author is Thankful to Ms. Akansha Verma Assistant Professor , Aryabhatta college of Engineering and research, Ajmer for helping in data collection and identification of Algae

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