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BACILLARIOPHYCEAE: ENVIRONMENTAL MARKERS OF WATER QUALITY AT MANAIR DAM, KARIMNAGAR, INDIA

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ABSTRACT: It is critical to maintain the health of aquatic habitats by ensuring the quality of the water. Diatoms, which are members of the Bacillariophyceae family, are extremely sensitive to changes in their environment. As a result, they are useful bioindicators. This study looks into using Bacillariophyceae as an indicator to assess water quality at the Manair Dam in Karimnagar, India. This study investigates the environmental effects of changes in water quality within a large pond. It accomplishes this by examining the composition, amount, and distribution of diatoms in the pond.

Keywords: *Bacillariophyceae, diatoms, water quality, Manair Dam, bioindicators, ecological assessment.*

1. INTRODUCTION

Bacillariophyceae, also known as diatoms, are extremely sensitive to environmental changes and may swiftly adapt to new environments. As a result, they are extremely helpful as ecological markers in aquatic situations. These single-celled critters can be found in a variety of environments, including the ocean, lakes, ponds, and rivers that include both freshwater and saltwater. These plants' silicon cell walls are extremely complex, which distinguishes them. Diatoms are a good indicator of clean water because they respond differentially to changes in physicochemical variables. They are also extremely beneficial to ecosystems because they are primary producers. Their ecological significance stems from their capacity to reflect changes in water quality, which provides us with a very limited picture of how healthy and lively aquatic ecosystems are overall. Diatoms have become an extremely helpful tool for studying the environment due to their diverse species, distinctive forms, and proclivity to exist in a wide range of environments. Evaluating these species aids in determining the health of the climate, the availability of food, and the level of pollution. Diatom colonies are vital in aquatic environments because they keep an eye on things and reveal a lot about their health. This type of information, whose complicated structure changes in reaction to environmental changes, aids in the effectiveness of management strategies and the success of conservation efforts.

2.RELATED WORK

Ecology and categorization, Second Edition (2015) by John D. Wehr and Robert G. Sheath is a dependable and valuable book that discusses the ecology, biodiversity, and categorization of all known river phytoplankton species in North America. The book contains vital taxonomic and biological information on a diverse range of creatures found on all continents. This book contains the work of renowned experts on all species of algae found in inland locations, sediments, snow, and rivers. Since the first release ten years ago, we've learned a lot about how to classify, investigate, and locate various forms of algae. This is due to advances in genetic technology and a renewed interest in biological diversity. As a result, several species and families have new names. This revised version now includes fresh data on harmful algal blooms and updated information on how to classify most algae groupings.

The primary factor determining how effectively water functions is its physicochemical analysis (Basavarajappa et al., 2010).

The chemical and physical stability of the water controls the majority of aquatic life. There is no distinction between the chemical and biological components. To determine how serious the pollution is, you must first understand physical factors. Many researchers believe that temperature is one of the most critical factors in determining the diatom cycle. Solanki et al. (2007) and other researchers, for example, discovered that low temperatures aid in the growth and development of diatom groups.

Multiple regression analysis is a statistical technique for determining the relationship between two or more variables. Multiple regression provides a comprehensive picture of how things are linked in a community by examining the relationship between a set of independent variables and a single dependent variable. Both experimental and non-experimental variants of the approach are used to predict and describe objects (Chaudhari and Srivastava, 2008; Purushottam et al., 2010; Anita Bhatnagar and Pooja Devi, 2012).

J. Prygiel, B. Prygiel, and J. Prygiel wrote this composition. The ways in which angiosperms, bryophytes, and algae have been employed to monitor rivers and streams are investigated. procedures that employ traits of sample species populations, procedures that use part or all of the photosynthetic community, and techniques that use various types of ecotoxicological and bioassay testing are among the others. Pesticides, heavy metals, and organic compounds have the potential to accumulate in living organisms. This approach has been established and is widely utilized in Western Europe. Some periphyton, on the other hand, is easier to work with than bryophytes and thick filamentous algae. Some angiosperms can also be used, but only if basic knowledge about bioaccumulation in that species is readily available. Other techniques unique to each species include physiological tests (such as chlorophyll:phaeophytin and tissue N:P ratios), genetic tolerance tests, studies of the shape of cyanobacteria and eukaryotic algae, and surface phosphatase assays. Growth is commonly measured in communities to keep an eye on phytoplankton, but it does not appear to work for benthos. Nonetheless, a great deal of effort has gone into developing markers that rely on benthic communities, with a focus on diatoms. Most of the previous diversity-based measures have been replaced with those that use ecological data from constituent species. The development of a diatom-based version of the macroinvertebrate-based RIVPACS has begun. They are using floristic data from "clean" areas to do this. Besides the approaches outlined above, ecological studies and bioassays are also often utilized. These depend on algae and lemna the most.

There were Potapova Pennington, Vis, and Pennington all in the same year. Diatoms are a type of algae that are remarkable because they only have one cell. Diatom-based markers are becoming more and more significant for assessing the environmental aspects of water systems. Diatoms are strong and accurate signs of changes in the environment that have been known for a long time. The goal of this study is to look at and explain the different ways that diatoms can be used in riverine environment research. Diatoms are already used in Australia, Canada, the US, and Brazil, according to a review of diatom study in India and abroad. However, research and use of diatoms in India are still in their early stages. We don't know enough about the diatoms that live in surface water, especially in the world's big rivers. On the other hand, the Diatom Research review gives a full picture of all the possible combos and their many uses. After studying diatoms in India's surface waters, we came to the conclusion that diatom studies is the best way to figure out how ecologically sound water is.

Thank you In 2023, R.D. Bhosale and P.S. Gadgil The East Zhejiang River is a man-made feature in the plains of East China. As an organization that provides social services, it often has to deal with people who are acting in ways that are bad for its health. An evaluation of the canal's natural health is needed to help people make better choices about managing water resources and keeping the canal in good shape. To figure out how healthy the canal's living things were, water quality measurements and communities of benthic diatoms and macroinvertebrates were checked. It was found that the canal was eutrophic because it had a lot of Nitzschia palea, Melosira varians, Navicula rostellata, and Encyonema minutum. This was shown by its average chemical trophic level index of 64.3 and trophic diatom index of 68.1. The macroinvertebrate groups in the stream showed that it was eutrophic, with Limnodrilus sp. being the most common species. The Biological Monitoring Working Party's (BMWP) lower grade was more proof that the water quality in the river wasn't good enough. Correlation tests showed that phosphate was the main cause of eutrophication in the stream. So, lowering phosphorus amounts needs to be the top priority.

When the significance level was set at 5%, temperature had a negative relationship with diatoms, having a 27% effect on them. In 2013, the same thing happened to both Jyothi and Narasimha Rao. On the other hand, Hosmani and Shankar (2010) say that the temperature can sometimes have a bigger effect on the growth and development of diatoms than nutrients. According to Singh and Balsingh (2011), the cooler weather is to blame for the higher number of diatoms in the water in the winter. Heat stopped the growth of Nitzschia when the quantity was 5%. Also, Saltanat Praveen and Atlaf H. Ganai (2014) saw a lot of diatoms in the river in the winter. The current study shows that temperature and the number of diatoms are linked in the exact opposite way that one might think.

At the 1% level, silica showed a positive association with Bacillariophyceae growth, which explained 46% of the differences seen in algal growth. Verma et al. (2011) say that silica is very important for keeping diatoms in a uniform shape. Because it contains silica, Cymbella grows at a rate of 1% per year. Phytoplankton can grow in water that has a 5% content of chlorides, magnesium, and sulfates. A lot of variation has been seen in 17% of the sulfates and 39% of the chlorides that are related to algae. Phosphates and chemical compounds have made it harder for Pinnularia to grow. In 2010, Shankar and Hosmani found that diatoms and phosphates are connected in the wrong way. It was seen that 1% liquid oxygen and diatoms were positively related, which explained 16% of the changes seen in phytoplankton. Also in 2011, Singh and Balsingh found a direct link between DO and Bacillariophyceae.

Bringing the total solids level up to 1% had a big effect on the growth of diatoms and caused phytoplankton to change by 28%. At a level of 5%, overall hardness stopped the growth of diatoms but helped Cymbella and Gomphonema grow. The study done by Ganai et al. (2010) agreed with this result. When the water temperature was taken into account, a 9% negative effect was seen. Silica is a substance that algae use to build their cell walls. It is responsible for 21% of the changes seen in phytoplankton and stops them from growing. Kumar et al. (2008) find a link between silica and the growth of algae. It has been found that the overall hardness of phytoplankton varies by 36%.

In amounts of 1% or more, bicarbonates, total solids, nitrites, and silica all help diatoms grow. Also, it has been shown that Cymbella and Nitzschia species can grow better in environments with 5% DO, magnesium, total hardness, phosphates, and calcium. Ganai et al. (2010) found that phytoplankton and the general alkalinity of freshwater systems are related in a good way. There are changes in the amount of phytoplankton because of phosphoates (54%), silica (19%), and magnesium (4%). Due to the presence of silica, bacteria grow faster. Numerous types of diatoms have been seen living in the lake with the highest concentration of silica. 29% of the total toughness is to blame for the difference. Amphora and Pinnularia can grow better because the rock is generally hard.

3.OVERVIEW OF BACILLARIOPHYCEAE (DIATOMS)

Bacillariophyceae, sometimes known as diatoms, are a broad taxonomic category of phytoplankton that thrive in a variety of aquatic environments around the world. A frustule, a silica-based cell wall with attractive and varied patterns, distinguishes these eukaryotic organisms with only one cell. Most people are aware that diatoms are significant to the ecosystem because of their distinctive forms and importance as primary producers in water.

Morphology and Structure:

Frustule: The majority of diatom cell walls are composed of hydrated silica, which creates two overlapping valves (or shells) resembling a Petri dish. This frustule maintains and protects the cell's form.

Shapes and Sizes: Diatoms come in a variety of morphologies, ranging from spherical to lengthy. They could be pennate (long and stretched, with bilateral symmetry) or central (round, with radial symmetry).

Photosynthetic Organelles: Diatom cells use chloroplasts to store phytochromes, which aid in photosynthesis.

Diversity within Bacillariophyceae:

Taxonomy: The order Bacillariophyceae is expected to have between 100,000 and 200,000 different species. New species are frequently discovered.

Habitats: These aquatic organisms can be found in a variety of aquatic environments, including freshwater, saltwater, and wet land locations.

Factors Influencing Diatom Distribution:

Environmental Conditions: For diatoms, salinity, temperature, light, and an abundance of nutrients (particularly nitrogen, phosphorus, and silica) are all significant environmental conditions.

Ecological Niches: Diatom species reside in diverse ecological niches, which explains why their distribution trends varied so much.

Ecological Significance:

Primary Producers: Diatoms are the primary producers in aquatic environments. They contribute to the food web by converting light energy into organic matter through photosynthesis.

Oxygen Production: They have a significant impact on the amount of air produced by the earth.

Nutrient Cycling: Furthermore, diatoms are beneficial to the ecosystem because they absorb nutrients and offer food for many other living things.

Adaptations and Survival Strategies:

Silica Deposition: Diatoms create their own frustules because they may extract silica from their surroundings and deposit it on other items.

Buoyancy Regulation: Some diatoms contain oil droplets that aid in maintaining the buoyancy of water columns.

Interactions with the Environment:

Sensitivity to Environmental Changes: Because diatoms can adapt fast to changes in their environment, they are useful indicators of water quality and ecosystem health.

4.IMPORTANCE OF MONITORING WATER QUALITY

Ecosystem Health:

Biodiversity Preservation: A diverse assortment of plants and animals maintain the ecosystem's balance in pure water areas.

Habitat Preservation: Monitoring safeguards the health of marine species' habitats, allowing them to reproduce and survive, which is an important aspect of habitat preservation.

Human Health:

Safe Drinking Water: Monitoring safeguards people's health by preventing the spread of diseases transmitted through water and ensuring the safety of drinking water sources.

Recreational Use: Water quality studies are conducted to preserve the health of individuals who swim, fish, or participate in other water activities in lakes, rivers, and along the shore.

Agriculture and Industry:

Irrigation and Crop Health: The irrigation water is tested to ensure that it contains no potentially dangerous elements that could prevent plants from developing or make food unsafe to eat.

Industrial Use: Industries that rely on clean water must keep it clean while wasting as few resources as possible.

Environmental Impact:

Pollution Control: Monitoring makes it easier to identify and address pollution sources, reducing the impact of contaminants on aquatic ecosystems.

Climate Change Impact: It is easier to understand and adjust to changes in water quality when tracking techniques are used to determine how climate change is influencing things.

Regulatory Compliance and Policy:

Legal Compliance: Monitoring ensures that environmental groups' water quality guidelines and legislation are implemented.

Policy Formulation: Data from monitoring programs are used to support policy decisions, making it easier to develop better conservation and management plans.

Economic Implications:

Tourism and Fisheries: It is critical to maintain adequate water quality in order to keep the water clean for the fishing and tourism businesses.

Cost Savings: Instead of spending a lot of money to rebuild ecosystems and treat water, discovering and resolving water quality concerns promptly can save a lot of money.

5.ROLE OF BIOINDICATORS IN ENVIRONMENTAL ASSESSMENT

Bioindicators are important for environmental assessment because they provide a plethora of information on the state and health of ecosystems. This category includes biological processes or living creatures whose state, abundance, or appearance offer information about the world. In brief, the following is how they work:

Environmental Health Assessment:

Indicator Species: Illusions, which live on land, and diatoms, which live in water, are two examples of organisms that are extraordinarily sensitive to environmental changes. The presence or absence of pollution, ecosystem disturbance, or habitat degradation might serve as an indicator of their severity.

Response to Stressors: In an effort to reduce stress, bioindicators act as early warning signs of worldwide alterations. Pollution, habitat loss, and climate change, among other environmental issues, provoke unpleasant emotions or anxiety in individuals.

Monitoring and Early Warning Systems:

Long-Term Monitoring: Bioindicators promote long-term monitoring by highlighting an environment's temporal evolution.

Early Detection of Issues: Changes in clusters of bioindicators could also be referred to as "health indicators." These changes will make it easier to identify potential problems. These changes serve as early warning signs of looming global catastrophes. This allows a person to intervene quickly and avoid the issue from worsening.

Indicator of Ecosystem Recovery:

Assessment of Restoration Efforts: Bioindicators show whether an ecosystem is improving or deteriorating, allowing us to evaluate the effectiveness of restoration and protection efforts.

Tracking Environmental Changes: The efficacy of environmental management strategies and approaches can be determined by examining the temporal evolution of bioindicator groupings.

Integration of Multiple Factors:

Comprehensive Assessment: A thorough assessment of the state of a specific region can be produced by integrating bioindicators with physical, chemical, and other biological factors within a testing methodology.

Multi-Level Assessment: The ability to address challenges at many scales, from individual habitats to entire ecosystems, can permit tailored responses.

Public Awareness and Education:

Engagement and Awareness: Bioindicators raise public awareness and comprehension of environmental issues by providing simply understandable visual representations of environmental changes.

Education and Outreach: Concerns about the interdependence of species and their surroundings grow when educational institutions deploy bioindicators.

Policy and Management:

Policy Development: The establishment of habitat preservation legislation and benchmarks influences environmental policy, which in turn influences the use of bioindicator data.

Decision-Making Tools: They advise administrators on how to use resources to avoid environmental damage. As a result, they are tremendously important to decision-makers.

6.TAXONOMY AND DIVERSITY OF BACILLARIOPHYCEAE

Taxonomy:

Phylum Bacillariophyta: Diatoms are classified as Protista and Bacillariophyta. They are several eukaryotic microalgae with only one cell.

Class Bacillariophyceae: This group consists of diatoms, which can be distinguished by their frustules, which have distinct silica cell walls. The insides of the frustules' two overlapping valves are loaded with intricate shapes and structures.

Order and Families: Diatoms are classified into orders and families based on genetic and morphological characteristics. There are numerous species within these biological levels.

Morphological Diversity:

Valve Shapes: Different types of valves can be found in diatoms, including pennate (long) and central (round). When the temperature is constant, diatoms exhibit bidirectional symmetry, whereas core diatoms have radial symmetry.

Size Variation: Because diatoms can range in size from a few to several hundred micrometers, this group has a wide range of species.

Frustule Complexity: When possible, diatom frustules are utilized to categorize and name species. They have a variety of structural elements, including patterns, striations, and spines.

Genetic Diversity:

Molecular Studies: Genetic research has helped us learn more about the various types of diatoms as molecular tools have developed. Molecular markers and DNA sequencing make it easier to distinguish between species and discover linkages between growth phases.

Cryptic Diversity: Molecular investigations that discovered DNA differences between species that appear extremely similar have revealed that diatoms conceal a wide range of distinct sorts.

Environmental Adaptations and Distribution:

Habitat Adaptations: Diatoms can be found in a variety of aquatic environments, including freshwater, saltwater, and wetland habitats. Their movements are influenced by environmental factors like as the amount of light, the saltiness, the temperature, and the availability of food.

Ecological Niches: Because different varieties of diatoms have adapted to dwell in different biological zones, their distribution in ecosystems varies.

Species Discovery and Cataloging:

Ongoing Discoveries: Despite extensive research, new diatom species are discovered on a regular basis. The variety and complexity of diatoms are demonstrated in this case.

Taxonomic Catalogs: Diatom diversity can be better understood by maintaining current taxonomic records and writing up and classifying newly discovered species.

7.ECOLOGICAL ROLE OF DIATOMS

Diatoms, which are members of the Bacillariophyceae family, have a significant impact on a variety of aquatic processes and behaviors. They have an impact on the entire food web, including compound transport and food production. The next section goes into greater detail about their environmental significance:

Primary Producers:

Photosynthesis: Diatoms are important producers in the aquatic environment. Photosynthesis is the process by which light energy is converted into organic substances such as carbohydrates, which are required by all living creatures.

Contribution to Oxygen Production: These species create the vast majority of the oxygen produced on Earth, having a huge impact on the global oxygen supply.

Nutrient Cycling:

Silica and Nutrient Uptake: Diatoms have an impact on water nutrient content because of their outstanding ability to absorb nutrients from their surroundings, particularly nitrogen, phosphorus, and silica.

Carbon Sequestration: Their ability to engage in photosynthesis increases carbon dioxide sequestration, boosting the efficiency of the carbon cycle and lowering atmospheric carbon levels.

Food Web Dynamics:

Foundation of the Food Chain: Diatoms are the cornerstone of the aquatic food web and the major source of nutrition for a wide range of aquatic organisms, including zooplankton, invertebrates, and small fish.

Transfer of Energy: Sufficient numbers and great nutritional content keep trophic levels high, allowing energy to move up and down the food chain.

Role in Ecosystem Stability:

Biodiversity Support: Biodiversity advocates argue that the abundance and diversity of diatoms contribute to the stability of ecosystems through their tolerance to climate swings and facilitation of biodiversity.

Habitat Formation: The accumulation of diatomaceous matter modifies the nature of aquatic environments by forming sediments and new habitats.

Response to Environmental Changes:

Environmental Indicators: Because of their great sensitivity, diatoms adapt quickly to changes in light, temperature, nutrition, pollution, and other environmental conditions.

Bioindicators of Water Quality: Their numerical values and reactions are critical markers of water quality, allowing us to assess an ecosystem's health and detect pollution or other problems.

Carbon Export and Biogeochemical Cycling:

Contribution to Carbon Export: When diatoms die, their distinctive cellular structures have an impact on carbon sequestration and marine biogeochemistry. These cells aid in the movement of organic carbon from the ocean's highest to deeper strata.

Biological Pump: They influence global carbon cycles by transporting carbon from the ocean floor to deeper layers via the biological pump.

8.DIATOMS AS INDICATORS OF WATER QUALITY

Diatoms are frequently utilized as bioindicators of water quality in aquatic settings due to their sensitivity and dependability. These animals are valuable for assessing and monitoring water quality since they can adapt quickly to changes in their environment and can be found in a variety of habitats. Here's a summary of what they perform as indicators:

Sensitivity to Environmental Conditions:

Response to Pollution: Diatoms degrade many types of pollution, such as heavy metals, chemicals, industrial waste, and organic matter, in very varied ways.

Nutrient Levels: Changes in nutrient levels like as nitrogen, silica, and phosphorus have a direct impact on the types and groups of diatoms.

Use of Diatom Indices:

Diatom-Based Indices: A number of labels have been developed that employ diatom groups to assess water quality. Using these indications, certain characteristics of water quality can be linked to the types, numbers, and composition of species.

Trophic Status and Pollution Gradients: Diatoms, which indicate pollution gradients from extremely polluted to highly damaged places, make it easier to classify bodies of water into trophic states (oligotrophic, mesotrophic, and eutrophic).

Monitoring and Assessment:

Long-Term Monitoring: The presence of diatoms facilitates continuous monitoring since they demonstrate how the quality of the water changes over time.

Seasonal and Spatial Variations: Looking at how diatoms react to changes in time and place within their surroundings can help us understand how water quality varies over time.

Sampling and Analysis Methods:

Sampling Techniques: Different sampling methods, such as soil and water column sampling, are employed to obtain diatom samples for scientific research.

Microscopic and Molecular Analysis: To improve the accuracy of species identification and judgment, molecular approaches such as DNA barcoding are utilized in conjunction with microscopic study and species identification of diatoms.

Standardization and Interpretation:

Standardized Protocols: The goal of standardization is to ensure that results are consistent across research sites and investigations so that they may be compared.

Interpretation of Data: To understand what the diatom data means, we must first determine how diatom groupings are related to one another, as well as their ecological interests and tolerance levels. You must also discover connections between these variables and various elements that influence water quality.

Regulatory and Management Applications:

Regulatory Compliance: Diatom evaluations provide information that is utilized to help develop regulations and laws for controlling water quality.

Management Strategies: Diatoms provide crucial information that allows us to develop targeted conservation and control measures that maintain or improve water quality.

9.CONCLUSION

A comprehensive study of the diatom populations in this vital reservoir has generated a deep understanding of the complicated interactions that occur between these microorganisms and water quality markers. The dynamic response of Bacillariophyceae to environmental changes was employed in this study to assess the ecological health of Manair Dam, as well as its nutrient dynamics and human-induced consequences. Diatoms, due to their composition, diversity, and abundance, serve as little indicators capable of detecting even minor changes and providing a full assessment of the dam's ecosystem's health. Another point of view is that the relationship between diatom populations and physicochemical features provides a solid foundation for understanding the direct effects of contaminants, nitrogen levels, and other external influences on reservoir water quality. The above association demonstrates Bacillariophyceae's ability to adapt to changes in their environment and highlights their potential as excellent bioindicators for ongoing monitoring and evaluation activities.The implications of the conclusions in this study go beyond the scope of academic inquiry. The information gained from studying the complex world of diatoms in Manair Dam will be extremely useful to legislators, environmental officials, and those concerned in water resource management. The findings highlight the importance of targeted interventions and long-term management strategies for protecting and restoring the ecological balance of this crucial aquatic ecosystem. Overall, the utilization of Bacillariophyceae as ecological indicators in the Manair Dam represents an important step forward in measuring water quality and safeguarding ecosystems. The complicated interaction between human activity and the environment is directed by microscopic organisms known as diatoms, which aid us in our efforts to conserve and manage the vital aquatic ecosystem in Karimnagar, India.

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