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Assessment of Effect of Environmental Factors on Diatoms

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Abstract: ***Diatoms, as they possess a great sensitivity towards the environmental factors, serves as the environmental indicators. There are various environmental factors to which the diatoms reacts differently. Growth and the diversity of diatoms can be used to evaluate the conditions of the corresponding ecosystem. The effect of various factors such as pH, temperature, UV rays and nutrients have been studied in this article. Those factors showed an observable changes in the diatom population.***

Keywords: Diatoms, UV rays effect, algae, Bacillariophyta.

1. Introduction

Diatoms are unicellular, eukaryotic, microscopic algae belonging to the class Bacillariophyta. They are photosynthetic and commonly seen in golden brown, abundant in both freshwaters as well as the marine environment. Diatoms are a type of microscopic algae belonging to the group of photosynthetic organisms called Bacillariophyta. They are found in various aquatic environments, including oceans, lakes, rivers, and even damp soils. Diatoms are an essential component of the phytoplankton community, playing a crucial role in the Earth's carbon and oxygen cycles. Diatoms have a unique cell wall made of silica, known as a frustule. The frustule consists of two overlapping halves that fit together like a petri dish (Vashishta et al., 1960).

Diatoms are incredibly diverse, with an estimated 100, 000 to 200, 000 species identified so far. Their diversity is attributed to the wide range of environmental conditions in which they can thrive, because diatom communities respond sensitively to changes in water quality, they are often used as indicators of environmental conditions in aquatic ecosystems. Monitoring changes in diatom populations can provide insights into the health of water bodies. Different species of diatoms have varying tolerance levels to environmental stressors, such as pollution. Some species are more resilient to pollutants, while others are highly sensitive. Monitoring the presence and abundance of different diatom species can provide insights into the overall health of an aquatic ecosystem (Zhang et al., 2018). They are particularly sensitive to changes in nutrient levels, especially nitrogen and phosphorus. Excessive nutrient inputs, often resulting from agricultural runoff or urban activities, can lead to eutrophication. Diatom communities can reflect changes in nutrient concentrations and help identify areas experiencing nutrient pollution. They can exhibit preferences for specific pH ranges. Changes in water acidity can influence the composition of diatom communities. Acid rain, for example, can alter pH levels in aquatic environments, affecting diatom populations. Monitoring diatom diversity can indicate variations in water pH.

Diatoms can accumulate heavy metals from their surrounding environment. Elevated concentrations of heavy metals, such as mercury, lead, and cadmium, can be toxic to diatoms and disrupt their normal growth. By studying diatom communities, researchers can assess the presence and impact of heavy metal pollution in water bodies. The decomposition of organic matter, such as sewage or agricultural runoff, can lead to oxygen depletion in water bodies. Some diatom species are more tolerant to low oxygen levels, while others are sensitive. Changes in diatom assemblages can indicate the presence of organic pollution and its impact on oxygen levels. Diatoms are also used in sediment quality assessments. The composition of diatom assemblages in sediment samples can provide historical information about past environmental conditions and help identify trends in pollution over time (Arumugham et al., 2023). Diatoms are employed in bio - assessment programs, where the health of aquatic ecosystems is evaluated based on the diversity and abundance of diatom species. Comparing the observed diatom community structure to reference conditions helps identify impaired water quality.

2. Review of Literature

Arumugham et al. (2023) in the study in Kanyakumari district, Tamil Nadu, explores freshwater diatom diversity in six ponds. Gomphonema montanum is the predominant species. Correlation analysis reveals positive links between diatoms (Nitzschia sp., Navicula sp., etc.) and nitrate, phosphate, lead in St - 2 and 6. CCA analysis shows calcium, chloride, pH, alkalinity, silica, ammonia favour dominant species in St - 3 and 4. Anthropogenic influence is noted in parameters like total alkalinity, nitrite, phosphate. Pollution assessment indicates heavy pollution in St - 2, 4, 6, and lower pollution in St - 1, 3, 5, emphasising the study's contribution to understanding freshwater ecosystem health in the region.

Mendhekar (2023) described that Cyanobacteria were successfully isolated from freshwater through a technique

employing nutrient - saturated glass fibre filters. However, the concurrent presence of heterotrophic bacteria was significantly diminished by a factor of 2 to 15. To achieve a more pronounced reduction in the levels of accompanying heterotrophic bacterial contaminants, a broad - spectrum antibiotic known as imipenem was utilised. When compared to certain other Plactam antibiotics, this β - lactam antibiotic, which inhibits peptidoglycan biosynthesis, demonstrated increased efficacy in facilitating the growth of axenic Cyanobacteria cultures by lowering the levels of heterotrophic bacterial contaminants associated with the newly isolated cyanobacteria.

Mawande et al. (2020) in her studies of the diatoms of the Aurangabad region from water samples of Harsul Lake and Sawangi lake. Further describing the Diatoms she mentioned that they have selective living habitat which are variable according to climate, chemical factors and interference of other biological organisms. Diatoms are indicates past and present ecological questions and they are strongly related to the quality of aquatic system. Diatoms having different geometrical shapes with different taxonomic precision. Due to their unique characteristics they are used in nutrient supplements, antibiotic, anti - cancerous drug, nanotechnology and paleoecology to interpret historical condition from fossils. Present study will help forensic expert to compare with samples in drowning cases of Aurangabad region and to conclude pre and post - mortem drowning. It helps to link suspect and victim to crime and demonstrates the collection and extraction methods for diatoms with minimum loss. The results showed *Nitzschiataylorii Alakananda, Hamilton and N. Karthick* occurs prominently and in abundance. *Ulnariaacus (Kutzing) Aboalssfrom* taxa Araphid with bilateral symmetry of valve and lack of raphe and significant motility, valves are linear with sub - capitate species.

Yun Zhang et al. (2018) in his findings indicates that diatom species, each with distinct optimal growth temperature ranges, respond to warming as anticipated when considering individual temperature preferences. However, in natural settings, the presence of unavoidable and intricate interspecific interactions is likely to impact diatom responses to warming. It is crucial to recognise that these complex interactions play a significant role and should not be overlooked when predicting how organisms will respond to climate warming.

3. Results and Discussions

Effect of UV rays on Diatoms

- UV - B radiation causes shrinkage of the Diatom cell materials. Plasmolysis and cell death may also occur in many species. UV - B radiation affects the normal processes such as growth, survival, pigmentation, motility, as well as the enzymes of nitrogen metabolism and CO2 fixation (Dohler et al., 1984).
- UV - A radiation helps up regulate CO_2 concentrating mechanisms in diatoms like Skeletonema costatum enabling frequent algal blooms under reduced CO_2 availability. It has also shown increased carbonic anhydrase activity by 23 - 27% at low CO_2 levels (Guang et al., 2021).

Effect of pH on Diatoms.

- High pH levels decrease growth and Si deposition rates in freshwater diatom Fragilaria carotonesis, with up regulation of mobile genetic element suggesting potential escape mechanism (Zepernick et al., 2022).
- Diatoms including Fragilaria species showed reduced growth rates at high pH (>9.5) and at pH more than that can cause the ceasing of growth (Soggard et al., 2011).
- In arctic sea ice diatoms (i. e fragilariopsis species), growth rates are maximise at pH 8 - 8.5 and significantly reduced at higher pH levels (Soggard et al., 2011).
- Growth response to pH changes can vary significantly among different strains of same species, indicating a potential for phenotypic plasticity and adaptation to future climate conditions (Pančić et al., 2015).

Effect of temperature on Diatoms.

- Fragilaria species exhibits varied responses to temperature changes with some strains showing increased growth rates at elevated temperature and pH changes (Pančić et al., 2015).
- Fragilaria development was mainly regulated by hydrological conditions and nutrient availability (Tolotti et al., 2007).
- Water temperature and silicate are main environmental factors affecting the growth of diatom species (Zhang et al., 2018).

Effect of Nutrients on Diatoms.

- Chromium [Cr (VI)], inhibited the growth of Diatom species (Fallen et al., 1996).
- Si - limitation changes the configuration and chemical composition of the cell wall of the Diatoms (Chen et al., 2023).
- Nutrients like Nitrogen, Phosphorous, iron and silica are essential for Diatoms growth at low concentrations but can be toxic at high concentrations (Giri et al., 2022).

4. Conclusion

Diatoms are very sensitive to their environmental conditions, as the results suggest, diatoms proliferates only in the environmental conditions within their favourable growth range. Even a slightest of difference in the environmental conditions can have an observable effect on the diatom community. Due to their high sensitivity towards the environmental factors such as change in pH, change in temperature or the nutrient availability, they can be used as an effective indicating organisms of the particular ecosystem.

Elevated pH levels generally have a negative impact on the growth and silica deposition of diatoms, including Fragilaria species. This can provide a competitive advantage to other algal species like cyanobacteria. However, there is variability in the response to pH changes among different strains and species of Fragilaria, indicating potential for adaptation. Historical data also suggest that pH variations have influenced Fragilaria populations over long periods, with local ecological conditions playing a crucial role.

Temperature plays a crucial role in the growth and ecological dynamics of diatoms, including Fragilaria species. While moderate temperatures generally promote growth, species -

specific responses and interactions with other environmental factors such as nutrients and pH can lead to varied outcomes. Understanding these dynamics is essential for predicting the impacts of climate change on diatom populations and their ecological roles.

UV radiation has a multifaceted impact on diatoms and Fragilaria species, primarily causing growth inhibition, photosynthetic damage, and changes in community composition. While some species can acclimate through enhanced anti - oxidative defences, the overall productivity and ecological dynamics of diatom communities are significantly affected. These findings underscore the importance of considering both short - term and long - term effects of UV radiation, as well as the interplay with other environmental factors, to fully understand the ecological implications for marine ecosystems.

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