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ORIGINAL ARTICLE OPEN ACCESS

Screening of Dominant Aquatic Plants in Polluted Sites of Kolaghat Thermal Power Plant Area, West Bengal, India

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Abstract

Industrial pollution significantly threatens biodiversity, especially in regions experiencing fast industry with urbanization. The proliferation of industrialization has led to significant habitat alteration and disturbance of natural ecological processes. Waterborne pollutants are introduced into aquatic ecosystems by both point and non-point sources, including industrial wastewater discharges and agricultural runoff. Aquatic macrophytes are significant constituents of aquatic ecosystems which are frequently affected by these contaminants. These plants also serve as significant bioindicators of ecological stress and the effects of pollution on ecosystem health. Monitoring of such plants is thus crucial for devising and executing management strategies that can reduce water body pollution and rehabilitate water quality. The present study has focused on the distribution and diversity of aquatic plants in the heavily polluted areas of Kolaghat. The significance of the present investigation is to utilize selected aquatic plants for management of water pollution.

Keywords: Aquatic plants, Industrial pollution, Phytosociology, Density, Frequency, Abundance.

Introduction

The rapid advancement of industry and society has resulted in extensive sewage discharge, causing significant pollution of numerous aquatic bodies and reservoirs thought the globe, hence inflicting considerable harm to the ecological environment. Among numerous approaches for managing polluted water bodies, employing aquatic plants to assimilate nutrients and removing them via harvesting is a straightforward, effective, and economical method (Wang *et al.,* 2025). Aquatic plants are defined as plants that thrives in water or saturated soil, encompassing both herbaceous and woody species. There are several categories of aquatic plants, including submerged, floating, and emergent species. Aquatic plants are essential elements of freshwater ecosystems and are commonly utilized for evaluating water quality and site restoration (Mazumder and Sarkar, 2020). These plants were severely affected by contaminated water of industrial areas. Suspended particles, heavy metals, and pesticides discharged into aquatic environments influence the chemical and biological properties of surface water. Contaminated water persists in entering neighbouring water bodies due to inadequate dam construction, and the discharge of coal ash from the Kolaghat Thermal Power Plant into these locations remains predominantly unregulated. At the Kolaghat Thermal Power Plant, the power conserved capacity has increase (Maity *et al.,* 2016).

A number of ecologists formulated several methods of description and classification to analyze plant communities, a field of ecology referred to as phytosociology (Sarkar and Mazumder, 2016). The phytosociological evaluation of any plant assemblage is an essential aspect in the study of ecosystems (Best 1988; Sarkar *et al.,* 2017). Phytosociology examines plant communities, their composition, development, and interspecies connections within the environment. In comparison to terrestrial ecosystems, the intricacy of aquatic ecosystems has led to a comparatively delayed investigation of the allelopathic effects of aquatic plants (Shu *et al.,* 2024). The quantity of species in aquatic habitats significantly exceeds that in terrestrial ecosystems of same dimension. The allelopathic effects of aquatic plants encompass interactions among aquatic plants, their influence on aquatic animals, and their impact on phytoplankton (Shu *et al.,* 2024).

Material and Method

This study examines the phytosociology of the aquatic flora in various polluted aquatic and semi-aquatic habitats in the Kolaghat Thermal Power Plant and adjoining areas. It is a premier thermal power plant in West Bengal, which is located at Mecheda, approximately 55 km from Kolkata (Latitude 22°25'52" N and Longitude 87°52'30" E) in the district of Purba Medinipur (Mondal *et al.,* 2016). The Rupnarayana River flows to the right of this plant. It is affiliated with the Southeastern Railway. A significant population inhabits in the study sites. The vegetation survey was undertaken during pre mansoon, mansoon and post mansoon season of 2022 and 2025. To fulfill this purpose, frequent excursions were scheduled at all locations at least once a week. The expeditions were organized to facilitate the collection of most abundant plants at various growth phases. All plants observed at the field sites were collected and meticulously identified. The random quadrate approach was employed to examine the phytosociological characteristics of watery plants. For phytosociological investigation of the macrophytes, 10 quadrats (50 x 50 cm) were randomly established at various locations within the aquatic habitat where the plants were present. The quantity of individuals and percentage cover value for each plant species were documented (Mishra 1968; Mishra *et al.,* 1997).

Plants were extracted, meticulously cleansed, and individually gathered in polyethylene bags. Upon drying, the obtained plants were pressed between newspapers, while specimens gathered from free-floating and rooted floating sources were preserved in a 4% formalin solution (Cook, 1996). Macrophytes were categorized by species and assigned numerical identifiers, with data collected regarding their frequency, abundance, and density at the respective locations. The species are identified using standard texts, laboratory instructions, and pertinent papers for comparison (Das *et al.,* 2018; Dey *et al.,* 2019; Mazumder and Sarkar, 2020; Mazumder *et al.,* 2021). Several specialists and personnel were interviewed to verify identification. Aquatic vegetation can be examined and assessed through several methodologies.

This communication calculates various phytosociological characteristics, including abundance, relative abundance, frequency, relative frequency, density, and relative density, to assess the diversity of the linked flora in contaminated water bodies of the study sites. An Importance Value Index was established to evaluate the overall influence of a species.

Density

Density is an expression of the numerical strength of a species where the total number of individuals of each species in all the quadrats is divided by the total number of quadrats studied. Density is calculated by the equation:

$$\text{Density} = \frac{\text{No. individuals of the species}}{\text{Total No. of plots sampled}}$$

Abundance

It is the study of the number of individuals of different species in the community per unit area. By quadrats method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is represented by the equation:

$$\text{Abundance} = \frac{\text{No. individuals of the species}}{\text{Total No. of plots in which the species is present}}$$

Frequency (%)

This term refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage. It is calculated by the equation:

$$\text{Frequency (\%)} = \frac{\text{No. of plot in which the species is present}}{\text{Total No. of plots sampled}} \times 100$$

Relative Density (%)

Relative density is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$\text{Relative Density} = \frac{\text{Density of the species}}{\text{Density of all the species}} \text{ x } 100$$

Relative Abundance (%)

Relative Abundance is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$\text{Relative Abundance} = \frac{\text{Abundance of the species}}{\text{Abundance of all the species}} \text{ x } 100$$

Relative Frequency (%)

The degree of dispersion of individual species in an area in relation to the number of all the species occurred.

$$\text{Relative Frequency (\%)} = \frac{\text{Frequency of the species}}{\text{Frequency of all the species}} \times 100$$

Importance Value Index

This index is used to determine the overall importance of each species in the community structure.

In calculating this index, the percentage values of the relative frequency, relative density and relative abundance are summed up together and this value is designated as the Importance Value Index or IVI of the species.

IVI= Relative Frequency + Relative Density + Relative Abundance

Result

This study identified the predominant aquatic plant species in polluted areas of the Kolaghat Power Plant, West Bengal, India, affected by effluent discharge and thermal pollution. The aquatic vegetation of the site is composed of *Eichhornia crassipes* (Mart.) Solms, *Nelumbo nucifera* Gaertn., *Pistia stratiotes* L., *Trapa natans* L., *Lemna trisulca* L., *Spirodela polyrhiza* L., *Nymphaea nouchali* Burm.f, *Monochoria hastata* (L.) Solms, *Lemna perpusilla* Torr., *Utricularia bifida* L (Table 1). Among the plants *Eichhornia crassipes* (Mart.) Solms has the highest Density, Abundance, Frequency and IVI (Figure 2-5). Nelumbo nucifera Gaertn., *Pistia stratiotes* L., *Trapa natans* L. have also good IVI in comparison to others (Table 2). The lowest IVI was record for *Nymphaea nouchali* Burm.f (Figure 5).

Table 1: Density, Abundance and Frequency of the collected plants

Name of the Plant	Density	Abundance	Frequency
Eichhornia crassipes (Mart.) Solms	5.466	6.833	80.000
Nelumbo nucifera Gaertn.	3.366	4.590	73.333
Pistia stratiotes L.	2.833	5.000	56.666
Trapa natans L.	1.900	3.800	50.000
Lemna trisulca L.	0.466	4.666	10.000
Spirodela polyrhiza L.	0.333	3.333	10.000
Nymphaea nouchali Burm.f	0.133	1.333	10.000
Monochoria hastata (L.) Solms	0.133	2.000	6.666
Lemna perpusilla Torr.	0.400	6.000	6.666
Utricularia bifida L.	0.133	4.000	3.333

Table 2: Relative Density, Relative Abundance, Relative Frequency and Importance Value Index of the collected plants.

Name of the Plant	Relative Density	Relative Abundance	Relative Frequency	Importance Value Index
Eichhornia crassipes (Mart.) Solms	36.043	16.443	26.086	78.573
Nelumbo nucifera Gaertn.	22.197	11.047	23.913	57.157
Pistia stratiotes L.	18.681	12.031	18.478	49.191
Trapa natans L.	12.527	9.143	16.304	37.975
Lemna trisulca L.	3.0769	11.229	3.260	17.567
Spirodela polyrhiza L.	2.197	8.021	3.260	13.479
Nymphaea nouchali Burm.f	0.879	3.208	3.260	7.348
Monochoria hastata (L.) Solms	0.879	4.812	2.173	7.865
Lemna perpusilla Torr.	2.637	14.437	2.173	19.249
Utricularia bifida L.	0.879	9.625	1.086	11.591

Discussion

Most regions exhibit a relatively homogeneous composition characterized by a mixture of plant species. Among the plants reported in this study *Eichhornia crassipes* (Mart.) Solms, *Nelumbo nucifera* Gaertn., *Pistia stratiotes* L., *Trapa natans* L. are most abundant in comparison to others. The frequency and density of these plants are also much higher in comparison to others. The dominance of plant species at polluted locations and its possible effects on these ecosystems is of considerable ecological importance. Several contemporary researches highlighted that these plants are good accumulator of pollutants (Ali *et al.,* 2020). Yasar *et al.,* (2018) reported that *Pistia stratiotes* L. is a superior candidate for the phytoremediation of pollutants due to its greater susceptibility compared to other aquatic flora. *Eichhornia crassipes* also demonstrates a notable capacity to absorb and detoxify various environmental pollutants, offering an effective approach to combat pollution issues (Monroy-Licht *et al.,* 2024). It is also recognized for its substantial ability to accumulate many aquatic contaminants (Coimbra *et al.,* 2023). It is widely distributed in freshwater bodies with slow-moving waters and demonstrated high resistance to adverse environmental conditions (Rani *et al.,* 2021; Ulaganathan *et al.,* 2022). Multiple investigations indicate that *Trapa natans* L. possesses significant phytoremediation capabilities for the extraction of heavy metals and other inorganic pollutants (Sweta *et al.,* 2015; Kumar and Chopra, 2018). Abd Rasid *et al.,* (2019) reported that *Nelumbo nucifera* was able to remove the organic contaminants from the surface water. It is fact that in severely contaminated areas, only a limited number of very resilient species with significant prevalence persist. Aquatic plants serve as significant bioindicators of water quality, with their growth frequently impeded or promoted by pollution.

Since few decades aquatic plants have been employed to remediate and recycle wastewater for agricultural and industrial applications. The selection of suitable plants for the reclamation, rehabilitation, and bioremediation of contaminated water is critically important. When choosing aquatic plants for the remediation of contaminated water bodies, it is essential to perform a comprehensive assessment of water quality and pick species with specific purifying attributes suitable for various aquatic environments. Implement adaptive strategies according to local conditions, prioritizing indigenous flora in contaminated aquatic environments. This approach can not only remediate contaminated aquatic environments but also preserve a stable natural ecosystem, prevent the introduction of non-native species, and mitigate the unpredictable consequences associated with species invasion. Industrial effluents, when released into the ecosystem or applied to agricultural land, pollute the soil by heavy metals along with organic contaminants (Antil, 2012). The released contaminants can be absorbed by plants via several organs and as a result morphological modification has been occurred. These morphological changes impact not just individual plants but also have wider consequences for ecosystem stability. Many studies indicate substantial decreases in leaf size and leaf count on trees located in polluted areas (Sen *et al.,* 2017). The aggregate influence of industrial pollution on flora presents a considerable obstacle for ecosystem preservation and administration.

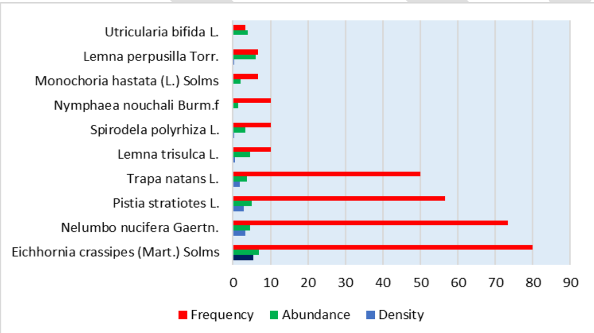

Fig.1: Density, Abundance and Frequency of aquatic plants of the study sites

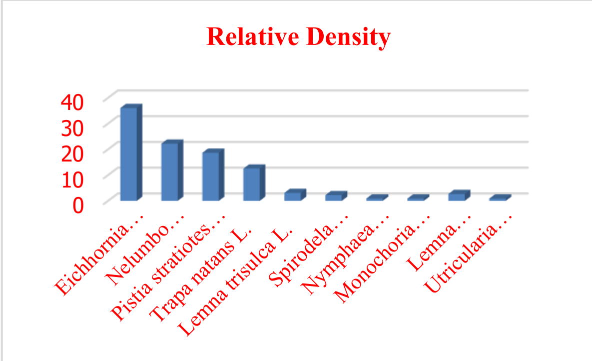

Fig. 2: Relative Density of aquatic plants of the study sites

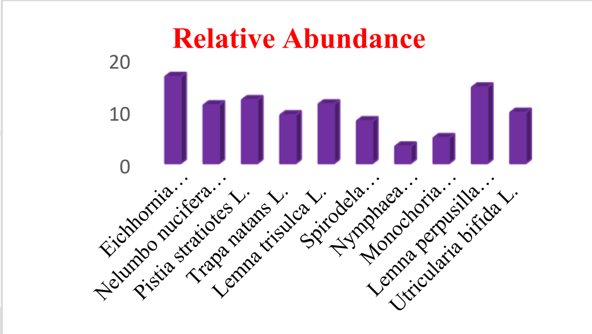

Fig.3: Relative Abundance of aquatic plants of the study sites

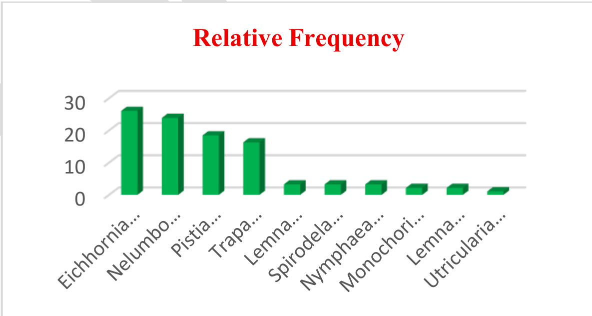

Fig. 4: Relative Frequency of aquatic plants of the study sites

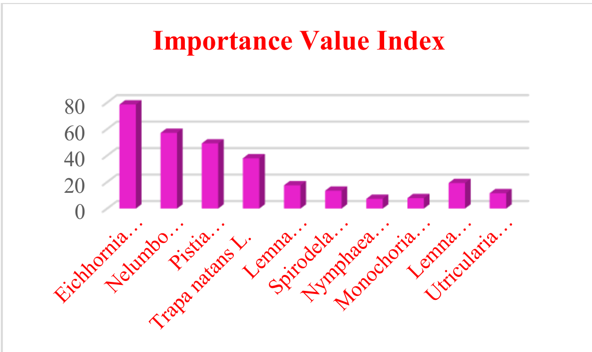

Fig.5: Importance Value Index of aquatic plants of the study sites

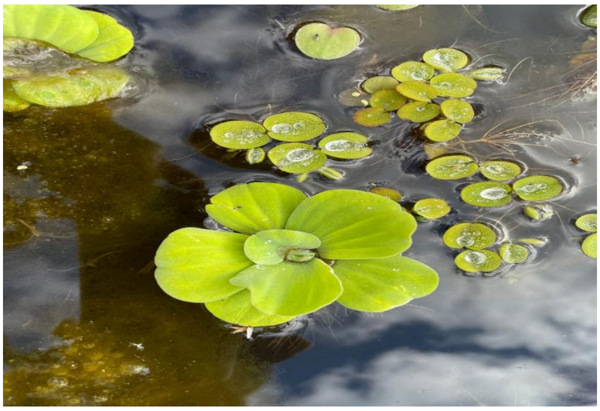

Fig. 6: *Pistia stratiotes* grown in Heavy metal affected regions of study sites

Fig.7: *Trapa natans* grown in Heavy metal affected regions of study sites

Conclusion

The contamination of surface water bodies has catastrophic consequences for aquatic ecosystems, which are increasingly compromised by urbanization, industrial discharges, and agricultural runoff. Increasing pollution levels in freshwater ecosystems result in the decline of native flora and fauna, jeopardizing the viability of these aquatic environments and the broader ecosystem. Aquatic flora can assimilate heavy metals and toxic waste from polluted water. Aquatic plants have been utilized to treat and repurpose wastewater for agricultural and industrial applications. Current research examined the distribution and diversity of aquatic flora in the severely contaminated regions of Kolaghat. Four aquatic plant species were selected as dominant based on their relative abundance, density, frequency, and IVI. The significance and prospective research directions of the present investigation is to utilize selected aquatic plants in water pollution of the management emphasizing their adaptability and biodiversity. Future research may further investigate the ecological impacts of aquatic plants to facilitate the remediation of polluted water in industrial areas.

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