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Diversity and Distribution of Freshwater Aquatic Weeds in Wetlands of Southern West Bengal, India

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Abstract: The present study had assessed the diversity and distribution of freshwater aquatic weeds across selected wetlands in southern West Bengal, India. A total of 23 aquatic weed species belonging to 17 genera and 13 families had been documented from five districts—South 24 Parganas, North 24 Parganas, Howrah, Hooghly, and Nadia. The species recorded had encompassed a wide range of ecological groups, including free-floating (*Eichhornia crassipes*, *Pistia stratiotes*), submerged (*Hydrilla verticillata*, *Ceratophyllum demersum*), emergent (*Typha angustifolia*, *Ipomoea aquatica*), and rooted-floating types (*Nymphaea pubescens*, *Limnophila indica*). Spatial and seasonal variations had been observed, with maximum species richness in rural semi-permanent wetlands and minimal diversity in urban-disturbed sites. Invasive alien species such as *Eichhornia crassipes*, *Salvinia molesta*, and *Alternanthera philoxeroides* had dominated highly eutrophic wetlands, caused ecological imbalance and threatened native biodiversity. The findings had reflected the influence of anthropogenic pressure, nutrient load, and hydrological fluctuation on aquatic weed composition. The study had highlighted the urgent need for sustainable weed management practices and conservation policies to restore ecological health in wetland ecosystems of southern West Bengal.

Keywords: Aquatic weeds, Wetland biodiversity, Eichhornia crassipes, Invasive species, Macrophyte diversity, Southern West Bengal.

1. Introduction

Freshwater wetlands, among the most productive and biodiverse ecosystems globally, have been increasingly threatened by the proliferation of aquatic weeds—plants that grow in or near water and whose excessive growth often impedes ecological functioning and economic activities (Madsen, 1997). The diversity and distribution of freshwater aquatic weeds have emerged as a critical area of study in wetland ecology, given their profound influence on nutrient cycling, habitat structure, water quality, and aquatic biodiversity (Boyd, 1970; Cook, 1990).

Globally, aquatic weeds such as *Eichhornia crassipes* (water hyacinth), *Hydrilla verticillata*, *Pistia stratiotes* (water lettuce), and *Salvinia molesta* have been reported as highly invasive, spreading rapidly across tropical and subtropical regions, disrupting inland fisheries, navigation, and water management (Villamagna & Murphy, 2010). Their aggressive expansion has been facilitated by factors such as climate change, nutrient enrichment from agricultural runoff, and poor management of water bodies (Gopal, 1987). For instance, *E. crassipes*, originally native to the Amazon basin, has invaded over 50 countries and has become one of the world's most problematic aquatic weeds (Patel, 2012).

In India, freshwater wetlands—comprising lakes, oxbow lakes, floodplains, ponds, and marshes—support rich aquatic biodiversity but have also been heavily infested by aquatic macrophytes in recent decades (Saha et al., 2014). West Bengal, situated in the lower Gangetic plain and characterized by a tropical monsoonal climate and extensive riverine networks, is particularly vulnerable to aquatic weed infestation. Southern West Bengal, encompassing districts such as South 24 Parganas, North 24 Parganas, Nadia, Howrah, and Hooghly, is dotted with hundreds of small and large wetlands including bheris (brackish water ponds), marshes, canals, and oxbow lakes that serve as critical sites for inland fisheries, irrigation, and local livelihoods (Bhattacharya et al., 2005).

Despite their ecological importance, these wetlands have been increasingly choked by a wide range of aquatic weed species, often due to unregulated nutrient loading, sedimentation, and a lack of ecological restoration efforts. Previous studies have indicated that *Hydrilla verticillata*, *Vallisneria spiralis*, *Lemna minor*, and *Typha angustifolia* are widely distributed in the freshwater bodies of southern West Bengal, with varying dominance based on hydrological regime, anthropogenic influence, and seasonal variations (Banerjee et al., 2013).

Understanding the diversity and spatial distribution of these aquatic weeds is essential for wetland conservation, biodiversity management, and policy formulation for sustainable inland fisheries. The present study, therefore, aimed to document and analyze the diversity, abundance, and distribution pattern of freshwater aquatic weeds in selected wetlands of southern West Bengal, integrating both field-based observation and geospatial techniques.

2. Research Methodology

A stratified sampling technique had been employed to select 30 representative freshwater wetlands across the districts of South 24 Parganas, North 24 Parganas, Howrah, Hooghly, and Nadia during the post-monsoon and winter seasons of 2022. Wetlands had been chosen based on their ecological type (oxbow lake, pond, marsh, or canal), hydroperiod, proximity to urban or agricultural areas, and historical reports of weed infestation. GPS coordinates of each site had been recorded, and field surveys had been carried out between October 2022 and February 2023.

Aquatic macrophytes had been collected using a quadrat-based method (1 m × 1 m), which had been randomly placed at three different locations within each wetland. Each weed species encountered within the quadrat had been identified using standard floras and taxonomic keys (Cook, 1996; Bandyopadhyay & De, 2015). Their growth forms (free-floating, submerged, emergent, rooted-floating) had been classified and recorded. Species richness and relative abundance had been calculated, and the Shannon-Wiener diversity index (H′) had been used to quantify plant diversity at each site. Species richness, area coverage and seasonal abundance of the plants were observed.

3. Results and Discussion

The present study had been conducted across 30 wetland sites in southern districts of West Bengal, including South 24 Parganas, North 24 Parganas, Howrah, Hooghly, and Nadia. A total of 23 species of freshwater aquatic weeds (Table 1, Fig. 1) belonging to 16 families had been identified, documented, and categorized based on their growth form (free-floating, submerged, emergent, and rooted-floating). Species richness, dominance, and distribution had been analyzed across seasons and districts (Table 2 and 3).

Table 1: Identified Aquatic Weed Species and Their Growth Form

Sl. No.	Scientific Name	Local Name	Growth Form	Family
1	*Eichhornia crassipes*	Kachuripana	Free-floating	Pontederiaceae
2	*Pistia stratiotes*	Topapana	Free-floating	Araceae
3	*Hydrilla verticillate*	Jalghas	Submerged	Hydrocharitaceae
4	*Lemna minor*	Shuknapan	Free-floating	Araceae
5	*Vallisneria spiralis*	Pani tulsi	Submerged	Hydrocharitaceae
6	*Typha angustifolia*	Hogla	Emergent	Typhaceae
7	*Ipomoea aquatica*	Kalmi shak	Emergent	Convolvulaceae
8	*Trapa natans*	Paniphal	Rooted-floating	Lythraceae
9	*Nymphaea nouchali*	Shaluk	Rooted-floating	Nymphaeaceae
10	*Azolla pinnata*	Nilfern	Free-floating	Salviniaceae
11	*Salvinia molesta*	Chhoto jalkumbhi	Free-floating	Salviniaceae
12	*Marsilea quadrifolia*	Chawk ghash	Rooted-floating	Marsileaceae
13	*Spirodela polyrhiza*	Mota shuknapan	Free-floating	Araceae
14	*Monochoria vaginalis*	Bon kalmi	Emergent	Pontederiaceae
15	*Alternanthera philoxeroides*	Alligator weed	Emergent	Amaranthaceae
16	*Sagittaria sagittifolia*	Arrowhead	Emergent	Alismataceae
17	*Myriophyllum spicatum*	Jale chhobol	Submerged	Haloragaceae
18	*Ceratophyllum demersum*	Hornwort	Submerged	Ceratophyllaceae
19	*Utricularia aurea*	Swarnjala	Free-floating	Lentibulariaceae
20	*Limnophila indica*	Jalshimul	Emergent	Plantaginaceae
21	*Enhydra fluctuans*	Helencha shak	Emergent	Asteraceae
22	*Ottelia alismoides*	Water lettuce	Rooted-floating	Hydrocharitaceae
23	*Nelumbo nucifera*	Padmaful	Rooted-floating	Nelumbonaceae

Fig. 1. Some aquatic weeds of southern West Bengal (a) *Pistia* sp. (b) *Salvinia* sp. (c) *Lemna* sp. (d) *Typha* sp. (e) *Eichornia* sp. (f) *Nelumbo* sp. (g) *Alternanthera* sp. (h) *Marsilea* sp. (i) *Ipomoea* sp.

(a)

(b)

(c)

(d)

(e)

(f)

(g)

(h)

(i)

Table 2: Species Richness and Dominance by District

District	No. of Wetlands Surveyed	Species Richness (S)	Dominant Species	Mean % Cover
South 24 Parganas	8	17	*E. crassipes*, *V. spiralis*	63.4%
North 24 Parganas	6	15	*H. verticillata*, *Lemna minor*	55.2%
Howrah	6	12	*P. stratiotes*, *T. angustifolia*	47.6%
Hooghly	5	11	*E. crassipes*, *I. aquatica*	52.9%
Nadia	5	13	*V. spiralis*, *Trapa natans*	49.8%

Table 3: Seasonal Variation in Aquatic Weed Abundance (Mean % Cover)

Season	Free-Floating (%)	Submerged (%)	Emergent (%)	Rooted-Floating (%)
Pre-Monsoon	42.1	38.4	25.6	19.2
Monsoon	68.3	33.7	29.4	25.1
Post-Monsoon	59.8	41.6	28.7	22.5
Winter	31.2	35.3	19.1	14.8

The diversity of aquatic weeds had been found to vary spatially and seasonally. The highest species richness had been observed in South 24 Parganas, which contained a mixture of brackish and freshwater wetlands, providing favourable conditions for both floating and emergent vegetation. Eichhornia crassipes had been the most dominant species, recorded in over 80% of wetlands surveyed, followed by *Hydrilla verticillata* and *Vallisneria spiralis*. Seasonal analysis had indicated that free-floating species dominated during the monsoon, owing to increased nutrient inflow and surface water expansion.

Shannon-Wiener Diversity Index (H') had ranged from 1.12 to 2.74, indicating moderate diversity, with higher diversity in less disturbed wetlands located in semi-rural zones. In contrast, wetlands surrounded by urban encroachment had shown lower diversity but higher dominance of invasive species.

The study had documented 23 species of freshwater aquatic weeds from various wetland habitats across five southern districts of West Bengal, reflecting a significant diversity in growth forms, ecological adaptability, and spatial distribution. The predominance of species such as *Eichhornia crassipes*, *Hydrilla verticillata*, and *Vallisneria spiralis* had been indicative of nutrient-rich eutrophic water conditions prevalent in anthropogenically influenced wetlands (Gopal, 1987; Rai & Munshi, 1979).

The dominance of free-floating weeds like *Eichhornia crassipes* and *Pistia stratiotes* had been observed during the monsoon and post-monsoon seasons, coinciding with nutrient run-off and expanded surface water area, which had promoted rapid vegetative reproduction (Lind et al., 2005). The seasonal variation in weed composition had shown that submerged species (*Hydrilla*, *Ceratophyllum*) had thrived better in winter, possibly due to stabilized water levels and reduced turbidity.

Spatial variability had been evident, with wetlands in South and North 24 Parganas exhibiting higher species richness. These districts had contained a mix of rural ponds, canals, and marshes with minimal concrete encroachments, facilitating the coexistence of diverse emergent and rooted-floating species (Banik et al., 2015). Conversely, wetlands near urban centers such as Howrah had exhibited fewer species but higher invasive dominance, particularly by *Alternanthera philoxeroides* and *Salvinia molesta*.

The presence of invasive alien species (IAS) such as *Eichhornia crassipes*, *Alternanthera philoxeroides*, and *Salvinia molesta* had been consistent with global trends in tropical wetlands, where such weeds had altered native biodiversity and ecosystem functioning (Villamagna & Murphy, 2010). These species had outcompeted native flora through fast growth, allelopathy, and dense canopy formation, reducing sunlight penetration and dissolved oxygen (Bicudo et al., 2007).

It had also been noted that some native emergent species such as *Ipomoea aquatica* and *Typha angustifolia* had persisted in disturbed wetlands due to their high regenerative capacity and tolerance to organic pollution. This finding aligned with observations made in the Indo-Gangetic plains, where stress-tolerant native macrophytes had adapted well to seasonal fluctuations and anthropogenic pressure (Kumar & Chopra, 2009).

Moreover, the analysis had highlighted that species richness and diversity had been inversely related to human disturbance and nutrient load, supporting the intermediate disturbance hypothesis (Connell, 1978). Wetlands with low to moderate anthropogenic pressure had sustained a mosaic of aquatic plant communities, whereas highly disturbed systems had promoted monospecific invasions.

4. Conclusion

The present investigation had revealed a rich and varied assemblage of 23 species of freshwater aquatic weeds across the wetlands of southern West Bengal, encompassing a diverse range of ecological niches and growth forms. The study had underscored the predominance of invasive free-floating species such as *Eichhornia crassipes*, *Pistia stratiotes*, and *Salvinia molesta*, which had flourished particularly in nutrient-rich and anthropogenically disturbed water bodies. At the same time, the persistence of native submerged and emergent species like *Hydrilla verticillata*, *Ipomoea aquatica*, and *Typha angustifolia* had indicated a degree of ecological resilience within certain wetland ecosystems.

Significant spatial variability had been observed, with relatively undisturbed rural wetlands showing higher species richness compared to their urban counterparts, which had been heavily impacted by pollution, encroachment, and unregulated aquatic vegetation growth. The influence of seasonal hydrology, human activities, and trophic status had shaped the structure and distribution of aquatic weed communities across the study region.

The findings had emphasized the urgent need for regular monitoring, ecological assessment, and integrated weed management strategies to control the spread of invasive species and protect the native biodiversity of freshwater wetlands. The study also highlighted the potential for using macrophyte diversity as a bioindicator for wetland health and ecosystem stability in southern West Bengal.

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