KNOWLEDGE FLAME
E-ISSN: 3049-1541
International Multidisciplinary Research Journal (KF-IMRJ)
(An International Indexed & Peer Reviewed Journal
Impact Factor: 5.292 https://knowledgeflame.in PRGI Reg. No. MAHMUL/2024/89852

Macrophytes Biodiversity and Ecological Significance in Chhatrapati Sambhajinagar District

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Abstract:

A comprehensive survey of the waterways in the Chhatrapati Sambhajinagar district of Maharashtra, India, reveals a rich and diverse population of submerged aquatic macrophytes. The study documented 24 distinct species distributed across 9 families, establishing crucial baseline data for ecological management and conservation. The Hydrocharitaceae family is overwhelmingly dominant, accounting for 12 species, or 50% of the total recorded diversity.

Aquatic macrophytes play a dual and critical role in freshwater ecosystems. They are essential for maintaining water clarity, providing structural habitats for fish and invertebrates, cycling nutrients, and stabilizing sediments. However, these vital plant communities are under significant threat globally from eutrophication, pollution, and reduced light availability. Conversely, their excessive growth can lead to nuisance conditions, classifying them as "aquatic weeds" that impair water flow and ecosystem balance. The research connects this biodiversity assessment to a broader body of work on phytoremediation, highlighting the potential of specific macrophytes species to absorb and accumulate heavy metals, offering a foundation for developing natural, cost-effective water treatment strategies.

Keywords: Aquatic vegetation, Wetland areas, submerged, and floating macrophytes, Biodiversity, aquatic resources

1. The Ecological Role of Aquatic Macrophytes:

Submerged aquatic macrophytes, or hydrophytes, are indispensable components of healthy freshwater ecosystems, particularly in shallow lakes. Their functions are multifaceted and foundational to ecological stability.

• **Ecosystem Engineering:** They are essential for maintaining clear water conditions by inhibiting sediment re suspension, which controls water turbidity. They also stabilize shorelines and lake bottoms.

• **Habitat and Refuge:** Macrophytes provide critical structural habitats that significantly influence fish communities. They offer shelter for zooplankton, macro-invertebrates, and fish, protecting them from predation. They also serve as breeding and sheltering environments.

• **Nutrient Cycling and Water Quality:** These plants play a vital role in nutrient dynamics. Their ability to generate high biomass allows them to accumulate biogenic compounds,

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effectively absorbing nutrients like phosphorus and nitrogen from the water column. They also produce oxygen and are involved in biogeochemical processes such as bio mineralization and elemental cycling.

• **Food Web Support:** As primary producers, macrophytes harness solar energy that sustains the entire ecosystem. They provide food for a variety of aquatic organisms and support the proliferation of zooplankton and benthic fauna.

• **Bio-indication:** Due to their sensitivity to changes in water quality, aquatic macrophytes serve as effective bio indicators of water pollution and potential ecosystem degradation.

2. Threats and Management Challenges:

Despite their ecological importance, macrophytes populations face a global decline, and their management presents significant challenges.

• **Primary Stressors:** The primary threats to these populations include eutrophication (nutrient enrichment), untreated sewage discharge, and industrial pollutants. These factors alter the physicochemical characteristics of water, negatively impacting biodiversity.

• **Light Limitation:** A key factor contributing to the decline of submerged macrophytes is the widespread decrease in underwater light availability. This is often caused by frequent algal blooms, which are fueled by nutrient pollution and block the sunlight necessary for macrophytes growth.

• **Restoration Difficulties:** The restoration of submerged macrophytes in urban lakes is often hindered by inherent constraints such as elevated nutrient loading, artificially regulated water levels, and limited littoral zones.

• **The Problem of Overgrowth:** While essential, the excessive growth of certain macrophytes can create nuisance conditions, classifying them as aquatic weeds. Dense, monotypic stands can:

- Adversely affect the diversity of invertebrate and fish populations.
- Lead to eutrophication when large quantities of decaying plant matter accumulate.
- Hinder water flow, obstruct reservoir inlets, and interfere with recreational activities.

3. Biodiversity Survey in Chhatrapati Sambhajinagar District:

The study was conducted to identify, document, and assess the abundance and distribution of submerged aquatic macrophytes in the Chhatrapati Sambhajinagar district.

3.1. Study Area Profile

• **Location:** The Chhatrapati Sambhajinagar district (formerly Aurangabad) is located in the Marathwada region of Maharashtra, India, as depicted in the provided maps (Fig. 1).

• **Geography:** Situated in the Deccan region, the district's terrain is hilly and lies primarily within the Godavari River basin, with some areas extending into the Tapi River basin. The district spans an area of 10,100 km².

• **Climate and Hydrology:** The climate is semi-arid, with an average annual rainfall of 710 mm, mostly concentrated during the monsoon season (June to September). The Godavari River and its tributaries (Purna, Dudhna, Shivna) are the main waterways.

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3.2. Survey Methodology: Data was collected through systematic surveys of major waterways and water bodies during three distinct seasons (rainy, winter, and summer). Field excursions were conducted over two primary periods: June 2005 to May 2007 and June 2018 to 2022. Macrophyte specimens were collected by hand from shallow littoral zones, rinsed, preserved in 10% formalin, and identified to the species level using standard scientific literature.

3.3. Key Findings on Species Distribution

The survey confirmed that the district hosts a significant diversity of submerged macrophytes, with a total of **24 species from 9 different families** identified. The Hydrocharitaceae family is the most prevalent group in the region.

Table 1: Family-wise Distribution of Submerged Macrophyte Species

Sr. No.	Family of Submerged Macrophyte	Number of Species	Percentage of Total Species
1	Ceratophyllaceae	2	9%
2	Characeae	1	4%
3	Fabaceae	1	4%
4	Haloragaceae	2	8%
5	Hydrocharitaceae	12	50%
6	Najadaceae	1	4%
7	Nymphaeaceae	1	4%
8	Pontederiaceae	1	4%
9	Potamogetonaceae	3	13%
Total		**24 species**	**100%**

The survey documented a variety of species, including *Cabomba caroliniana* (Fanwort), *Ceratophyllum demmersum* (Coontail), *Hydrilla verticillata* (Oxygen weed), *Vallisneria spiralis* (Eelgrass), and multiple species from the *Potamogeton* (Pondweed) and *Najas* (Water nymph) genera.

4. Phytoremediation Potential and Broader Research:

This biodiversity study is part of a larger body of research by the authors that explores the practical application of macrophytes in environmental management, specifically phytoremediation.

• Focus on Metal Uptake:

A significant portion of the research by Jadhav, Babare, and colleagues investigates the capacity of various aquatic plants to absorb, accumulate, and translocate heavy metals from contaminated water.

• Scientific Evaluation:

This potential is quantified using established phytoremediation indices, including:

- **Bioaccumulation Factor (BAF)**
- **Bioconcentration Factor (BCF)**
- **Metal Enrichment Factor (MEF)**

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Metal Translocation Factor (MTF):

• **Promising Species:** Rigorous studies on species such as *Ceratophyllum demersum*, *Ceratophyllum submersum*, and *Azolla caroliniana* have revealed high BCF and MEF values, identifying them as promising candidates for use in wastewater treatment and wetland restoration. Other species like *Arundo donax L.*, *Pistia stratiotes*, and *Eichhornia crassipes* have also been assessed for their bioabsorption capabilities.

• **Limitations and Future Directions:** The source acknowledges that most of the metal uptake data is based on controlled, short-term assessments. Future work is needed to validate these findings through field-scale applications and pilot studies. Further research is also required on seasonal variations in metal uptake and the safe disposal or reuse of the resulting metal-laden biomass.

5. Conclusion:

The study concludes that the Chhatrapati Sambhajinagar district possesses a remarkable diversity of submerged aquatic macrophytes, with 24 species identified across 9 families. The dominance of the Hydrocharitaceae family (12 species) is a key finding.

The significance of this research lies in its establishment of a crucial ecological baseline. This data is vital for:

• Formulating conservation and management strategies for local water bodies.
• Addressing issues of eutrophication and excessive plant growth.
• Informing aquatic ecosystem restoration efforts.
• Supporting the development of phytoremediation techniques for pollution control.

The body of work bridges fundamental floristic documentation with applied environmental science, laying the groundwork for implementing cost-effective, eco-friendly water treatment solutions in India. It also calls for increased scientific focus on the specific roles of submerged macrophytes to better understand and manage aquatic habitats.

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