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Investigation of emergent aquatic macrophytes in the Chhatrapati Sambhajinagar District

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Abstract:

Aquatic plants are vital components of aquatic ecosystems, serving as a source of food and habitat for fish, wildlife, and various aquatic organisms. Factors such as eutrophication, sewage discharge, and industrial effluents significantly impact these aquatic communities. Seasonal changes can lead to a marked reduction in the diversity of aquatic plants. Establishing baseline data is essential for assessing these impacts and maintaining the health of aquatic environments.

A comprehensive survey was conducted to assess the presence of aquatic weed populations in the waterways of the study area, and the findings were meticulously recorded. The survey results reveal that Chhatrapati Sambhajinagar district boasts a rich diversity of emergent macrophytes, with a total of 105 species identified. The district is particularly characterized by a predominance of macrophytes from the Cyperaceae family, which includes 44 species, alongside 7 species from the Nymphaceae family and 8 species from the Poaceae family.

Keywords: Aquatic plants, Lake Management, Wetlands, Emergent-Submerged-Floating macrophytes, Diversity, and Water resources.

Introduction

Aquatic weeds represent one of the most prolific elements within global aquatic ecosystems. These undesirable plants proliferate in water bodies such as ponds, lakes, reservoirs, and other permanent water sources, including oceans. If not properly managed, they can lead to significant economic losses, ecological challenges, and detrimental effects on aquatic ecosystems, irrigation, navigation, public health, and the development of fisheries in any nation. The intensive exploitation of natural water resources, including rivers and engineered water bodies like dams, reservoirs, lakes, and canals, has been severely impacted by increased nutrient loads and pollution, primarily resulting from domestic sewage and industrial effluents. The introduction of unmanaged aggressive exotic species has further exacerbated the global issue of aquatic weeds. This problem is particularly acute in tropical and subtropical regions, where high temperatures foster rapid weed growth and proliferation.

Aquatic plants are among the most productive organisms on the planet, having both beneficial and detrimental effects on aquaculture. These plants thrive in lakes and waterways worldwide and have garnered significant attention in recent decades due to their adverse impacts, which have been intensified by human activities. Complete removal of these weeds has proven nearly impossible and ecologically impractical.

Numerous aquatic plants, including seaweeds, are recognized for their ability to generate industrially significant products such as agar, alginates, and carrageenan. Consequently, these plants are cultivated commercially on a global scale and have evolved into a distinct industry. The potential for transforming aquatic plants into essential resources such as food, fertilizers, bio-filters, fuel, and raw materials for key commercial sectors is promising, particularly given their abundant presence in India. There are various opportunities to utilize these aquatic plants in productive ways, leading to their designation as 'aquatic plants' rather than 'aquatic weeds.'

The challenge posed by weeds in fishery water quality is more pronounced in tropical and subtropical regions compared to temperate areas. Nonetheless, aquatic weeds have emerged as a 'global issue.' Freshwater ecosystems are vital components of every geographical area on Earth, providing habitats for a diverse array of species, including plants, fish, birds, insects, and other animals. The interactions between these organisms and their physical environment contribute to the ecological balance, as the plants offer food and shelter to various organisms inhabiting or near the water. Therefore, the aquatic plants within these water bodies significantly impact not only the aquatic ecosystems but also the adjacent areas. Research indicates (WR, 2001) that approximately 12% of all animal species reside in freshwater ecosystems, with many additional species closely linked to these environments. In India, over 140 plant species have been identified as aquatic weeds in and around different types of water bodies. The states of West Bengal, Orissa, Bihar, Assam, Tripura, and Manipur experience the highest levels of weed infestation, ranging from 40% to 70%, while other states report infestations between 20% and 5% (Philipose, 1968).

Aquatic macrophytes are categorized into several classes, including planktonic algae, filamentous algae, surface-floating weeds, emergent weeds, submerged weeds, and marginal weeds. The majority of lake ecosystems are influenced by their littoral vegetation and associated metabolic processes. Consequently, it is essential to provide a concise overview of the key characteristics of macrophytes, particularly their morphological and physiological adaptations, to understand their contributions to freshwater productivity (Philipose, 1968). Macrophytes are known to compete with the planktonic populations in lakes, leading to adverse effects due to their coverage of surface areas or rapid growth rates that can result in nutrient shortages. The presence of floating and emergent vegetation in lakes leads to progressive changes and supports a nutrient-rich environment (Sharma and Singhal, 1988). Aquatic plants play a crucial role as food sources, providing nourishment, shade, and shelter for various aquatic organisms. Additionally, these plants serve as a substrate for numerous micro and macro-fauna, which utilize the roots, stems, and leaves of both floating and submerged macrophytes for habitat and attachment. On an international scale, researchers have made significant contributions to the study of phytoplankton diversity.

Macrophytes are a vital component of aquatic ecosystems. They not only provide food for aquatic invertebrates but also effectively accumulate heavy metals (Chung and Jeng, 1974). Various aquatic plants, such as water hyacinth, water lettuce, and duckweeds, demonstrate considerable potential for phytoremediation (bioremediation) of polluted or wastewater due to their inherent ability to efficiently remove toxic substances (Nirmal kumar et al., 2008). This area of research is intended to be further explored by current researchers.

The presence of specific aquatic plants is often beneficial in fish ponds. However, inadequate management of their growth can negatively impact water productivity by depleting available nutrients and limiting sunlight penetration, which may lead to oxygen supersaturation or depletion. An overabundance of aquatic weeds can restrict the habitat available for fish, hinder fishing activities, contribute to gradual siltation, and create environments conducive to unwanted fauna and parasites, potentially harming the existing fish population. Additionally, these weeds can provide shelter for predatory and invasive fish species, which tend to overpopulate due to their high reproductive rates and feeding habits. Such conditions can diminish the food supply for cultivable carp species, ultimately resulting in reduced fish production. Furthermore, gases like hydrogen sulfide and methane, produced by aquatic weeds and subsequent anaerobic decomposition, pose risks to fish health. Conversely, a limited presence of aquatic weeds can be advantageous, as they serve as a natural food source for many fish species (Mandal et al., 2010), contribute organic matter to the pond's bottom, and help maintain adequate oxygen levels. When decomposed, they also act as natural fertilizers. The current research provides foundational insights into the diversity of emergent macrophytes in the Chhatrapati Sambhajinagar district of Maharashtra, which will be valuable for the management and control of aquatic plant species.

Materials and methods

Study area:

Chhatrapati Sambhajinagar, previously known as Aurangabad, is situated in the Deccan region, primarily within the Godavari River basin, with some areas extending into the Tapi River basin. The city is distinguished by its hilly landscape and semi-arid climate. It is positioned at coordinates N 19° 53' 47" – E 75° 23' 54", with latitude ranging from 19 to 20 degrees north and longitude from 74 to 76 degrees east. The Ajanta mountain range encircles the city. Chhatrapati Sambhajinagar District, formerly Aurangabad District, is a significant area within the Marathwada region of Maharashtra (see Fig. 1). The district covers an area of 10,100 km², with 37.55% classified as urban and the remainder as rural. It is predominantly located in the Godavari River Basin, with portions extending towards the northwest of the Tapi River Basin.

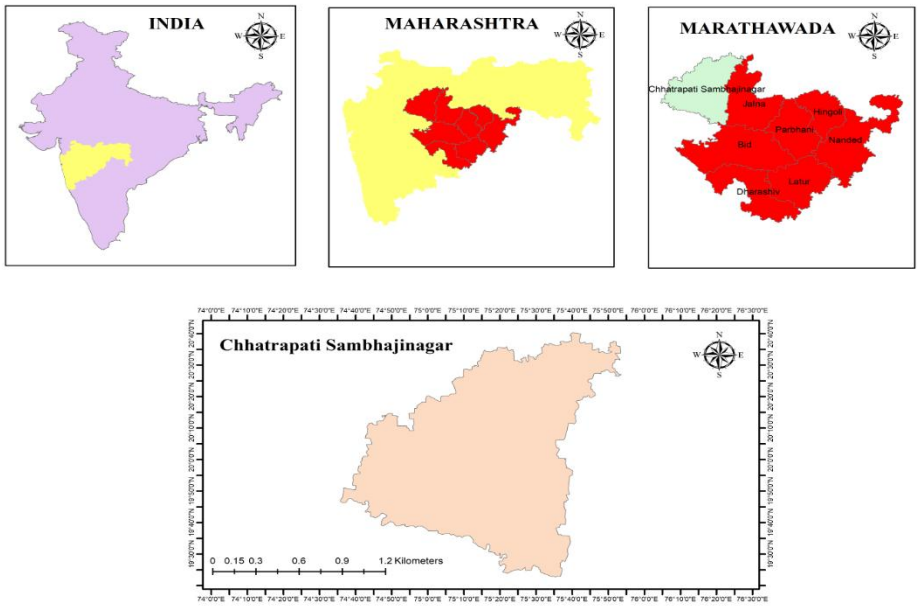

Figure 1: Map showing the location of the Chatrapati Sambhajinagar district within the study area.

The climate of Chhatrapati Sambhajinagar is semi-arid, with average annual temperatures ranging from 17 to 33 °C. The rainy season spans from June to September, followed by winter from October to February, and summer from March to May. The majority of the district's rainfall occurs during the monsoon season, with an average annual precipitation of 710 mm. Outside of the southwest monsoon period, when humidity levels rise, the air in the district is typically dry. The summer months are the driest, with afternoon relative humidity generally between 20 and 25%. Wind speeds are usually light to moderate, increasing during the latter part of the hot season and throughout the monsoon. During the hot season, winds primarily originate from the west to the north. In contrast, during the southwest monsoon season, they mainly come from the southwest to the northwest. Throughout the remainder of the year, winds predominantly blow from the northeast to the southeast, shifting to southwesterly and northwesterly directions in January and February. A significant portion of the district is situated within the Godavari basin, while a smaller area in the northeastern region falls within the Tapi Basin. The Godavari River, along with its tributaries—Purna, Dudhna, and Shivna—serves as the principal waterway in the district. Other notable tributaries include the Sukna, Khelna, Kham, Gulathi, Shivbhadra, and Girija rivers. Based on the drainage patterns and geomorphological features, the district has been comprised of 52 distinct watersheds.

Survey Methodology:

Aquatic macrophytes from the designated study area were systematically collected across three distinct seasons: rainy, winter, and summer. Seasonal surveys, involving multiple visits, were conducted to gather data on both littoral and submerged vegetation, as outlined by Narayana and Somashekar (2002). Over a four-year period, from June 2018 to 2022, aquatic plants, particularly macrophytes, were documented through these surveys, which included regular excursions at short intervals to collect and identify plant samples from the study areas. A sufficient number of field excursions were carried out to sample and record observations throughout the study duration, ensuring the collection of valuable macrophyte species. The Aquatic Plant Sampling Protocols (Parsons, 2001) were adhered to during the macrophyte sampling process. Samples were collected manually from the littoral zone and the exposed marginal areas of the sampling sites. Given that most of these species are herbaceous, they were carefully uprooted, rinsed, and washed to minimize mud content before being pressed under newspapers or placed in polyethylene bags, depending on availability and field requirements, for immediate identification. This methodology was consistent with the approaches utilized in the recent research published by Narasimha and Benarjee (2016). The collected plant specimens were identified and verified against regional floras and relevant literature (Adoni, 1985; Cook, 1996; Garad et al., 2015; Gupta, 2001; Henry et al., 1989; Jain and Rao, 1976; Subramanyam, 1962; Yadav and Sardesai, 2002), as well as regional checklists for hydrophytes from various credible published sources, supplemented by the expertise of botanists when available for confirmation.

Results and discussion

Aquatic plants play a crucial role as a significant food source for both humans and animals. Research on aquatic macrophytes is essential for understanding the dynamics of aquatic ecosystems. However, many aquatic macrophytes can proliferate excessively and become problematic. Consequently, investigations were conducted over three consecutive years, focusing on the macrophytes found in major water bodies as well as adjacent marshlands and wetlands. During this period, the presence or absence of emergent macrophytes was meticulously recorded. The areas surrounding the studied water bodies were populated by various wild weed species, which serve as ecotone species between wetlands and terrestrial environments; however, these were not included in the current study unless they were observed at the sampling sites. The sampling locations within the major water bodies and wetland areas exhibited a rich diversity of emergent macrophyte species. A total of 105 emergent macrophyte species were documented over the four-year study period from the littoral and sub-littoral zones of selected sampling stations in the district. This compiled list represents the emergent macrophytes observed, though it is not comprehensive. A summary of the recorded emergent macrophytes is provided in Table 1.

Table 1: Compilation of emergent macrophytes identified in significant water bodies, their surrounding areas, and wetlands within the study region.

Sr. No.	Scientific Name (Family)	Common Name
1.	*Aeschynomene aspera* (Fabaceae)	Pith plant
2.	*Aeschynomene indica* (Fabaceae)	Indian jointvetch
3.	*Alisma plantago* (Alismataceae)	Water plantain
4.	*Aiternanthera sessils* (Amaranthaceae)	Joy weed
5.	*Alternanthera philoxeroides* (Amaranthaceae)	Alligator weed
6.	*Ammania baccifera (Lythraceae)*	Red stem
7.	*Aponogeton natanus* (Apotomogetonaceae)	Celon ulvaceus
8.	*Arundo donax* (Poaceae)	Gaint reed
9.	*Bacopa monnieri (Scrophulariaceae))*	Water hyssop
10.	*Canna Indica L. or Canna edulis (Cannaceae)*	Kardal/ Indian shot
11.	*Cabomba aquatica* (Nymphaeaceae)	Aquarium plant
12.	*Chrozophora rottleri* (Ephorbiaceae)	Suryavarti
13.	*Coix aquatic* (Poaceae)	Adlay millet
14.	*Colocasia chamissonis* (Araceae)	Swamp taro

15.	*Colocasia esculenta* (Araceae)	Taro/ Elephant grass
16.	*Commelina benghalensis* (Commelinaceae)	Benghal dayflower
17.	*Commelina hasskarlii* (Commelinaceae)	Kamalini
18.	*Cynodon dictylon* (Poaceae)	Bermuda grass
19.	*Cyprus alopecuroide* **(**Cyperaceae)	Foxtail flat sedge
20.	*Cyperus difformis* **(**Cyperaceae)	Dila
21.	*Cyperus esculentus* **(**Cyperaceae)	Sedge
22.	*Cyperus exaltatus* **(**Cyperaceae)	Gaint sedge
23.	*Cyperus iria* **(**Cyperaceae)	Rice flatsedge
24.	*Cyperus longus* **(**Cyperaceae)	Sweet cyperus
25.	*Cyperus Pseudokyllingoides* **(**Cyperaceae)	Plant form
26.	*Cyperus rotundus* **(**Cyperaceae)	Nagarmotha
27.	*Cyperus sanguinolentus* **(**Cyperaceae)	Purple glume sedge
28.	*Cyperus scariosus* **(**Cyperaceae)	Cypriol
29.	*Cyperus squarrosus* **(**Cyperaceae)	Awned cyperus
30.	*Cyperus Senguinolentus* **(**Cyperaceae)	Flat sedge
31.	*Cyperus stoloniferus* **(**Cyperaceae)	Nut grass
32.	*Echinochloa colona* (Poaceae)	Marsh grass
33.	*Echinochloa stagnina* (Poaceae)	Banti (Marathi)
34.	*Eclipta prostate* (Asteraceae)	Ink plant
35.	*Eleocharis capitata* (Cyperaceae)	Knoblike spikerush
36.	*Eleocharis dulcis (tuberosa)* (Cyperaceae)	Chinese water chestnut
37.	*Eleocharis geniculata* (Cyperaceae)	Spikerush
38.	*Eleocharis plantagenera* (Cyperaceae)	Sedge
39.	*Euryale ferox* (Nymphaceae)	Water Lily
40.	*Fimbristylis alboviridis* (Cyperaceae)	Fimbristyle
41.	*Fimbrystyalis bisumbellata* (Cyperaceae)	Double umbel fimbri
42.	*Fimbrystylis complanata* (Cyperaceae)	Fimbry sedge
43.	*Fimbristylis dichotoma* (Cyperaceae)	Graminoid Fimbry
44.	*Fimbristylis ferruginea* (Cyperaceae)	Common ditch fimbry
45.	*Fimbristylis microcarya* (Cyperaceae)	Fringe rush
46.	*Fimbristylis polytrichoides* (Cyperaceae)	Rusty sedge
47.	*Fimbristylis schoenoides* (Cyperaceae)	Ditch fimbry
48.	*Fuirena cilaris* (Cyperaceae)	Vendranamalona
49.	*Fuirena trilobites* (Cyperaceae)	Three lobed umbrella sedge
50.	*Fuirena wallichiana* (Cyperaceae)	Umbrella grass
51.	*Heliotropium supinum* (Boraginaceae)	Dwarf Heliotrope
52.	*Hygroryza aristata* (Gramineae)	Swimming Grass
53.	*Hygrophila schulis* (Acanthaceae)	Barleria
54.	*Iris pseudacorus* (Iridaceae)	Flag iris
55.	*Ipomoea aquatic* (Convolvulaceae)	Swamp Cabbage
56.	*Ipomoea Carnea* (Convolvulaceae)	Alpvardhini
57.	*Ipomoea indica* (Convolvulaceae)	Mornig Glorry
58.	*Ipomoea fistulosa* (Convolvulaceae)	Beshram
59.	*Juncus effusus* (Juncaceae)	Soft brush
60.	*Jussiaea repens* (Onagraceae)	Primrose

61.	*Justicia americana* (Acanthaceae)	Water willow
62.	*Kyllinga bulbosa* (Cyperaceae)	Korapullu
63.	*Kyllinga melangosperma* (Cyperaceae)	Spike sedge
64.	*Kyllinga nemoralis* (Cyperaceae)	Shvetanirvisha
65.	*Leersia hexandra* (Gramineae)	Rice cut-grass
66.	*Limnophila heterophilla* (Plantaginaceae)	Asian marshweed
67.	*Limnophila sessiliflora L.* (Plantaginaceae)	Asian marshweed
68.	*Marsilea quadrifolia* (Marsileaceae)	Water shamrock
69.	*Monochoria hastata* (Pontederiaceae)	Arrow Leaf pondweed
70.	*Nasturtium officinale* (Brassicaceae)	Watercress
71.	*Nelumbo nucifera* (speciosa) (Nelumbonaceae)	Sacred Lotus
72.	*Nuphar luteum (*Nymphaceae)	Yellow water lily
73.	*Nymphaea lotus* (Nymphaceae)	Tiger lotus
74.	*Nymphaea rubra (*Nymphaceae)	Pink lotus
75.	*Nymphaea stellata* (Nymphaceae)	Indian Blue water lily
76.	*Nymphaea lotu* (Nymphaceae)	Egiptian Lily (as per color)
77.	*Nymphaea nouchali* (Nymphaceae)	Star lotus
78.	*Panicum repens* (Gramineae)	Torpedo grass
79.	*Pennisetum pedicellatum* (Poaceae)	Deenanath grass
80.	*Phyla nodiflora (Verbenaceae)*	Frogfruit
81.	*Polygonum glabrum* willd L. (Polygonaceae)	Knotweed
82.	*Polygonum hydropiper* (Polygonaceae)	Smart weed
83.	*Phragmites australis* (Poaceae)	Common reed
84.	*Phramites karka* (Poaceae)	Perennial reed
85.	*Pycreus flvidus* (Cyperaceae)	Yellow flatsedge
86.	*Pycreus nervulosus* (Cyperaceae)	Low flatsedge
87.	*Pycreus pumilus* (Cyperaceae)	Dwarf sedge
88.	*Saccharum spontianeum* (Poaceae)	Wild sugarcane
89.	*Sagittaria sagittifolia* (Alismataceae)	Arrowhead
90.	*Scirpus acutus* (Cyperaceae)	Hardstem bulrush
91.	*Scirpus affinis* (Cyperaceae)	Club rush
92.	*Scirpus articulatus* (Cyperaceae)	Poppangorai
93.	*Scirpus californicus* (Cyperaceae)	Threesquare
94.	*Scirpus debilis* (Cyperaceae)	Weakstalk bulrush
95.	*Scirpus juncoides* (Cyperaceae)	Vivacious sedge
96.	*Scirpus littoralis* (Cyperaceae)	Baranagar motha
97.	*Scirpus mucronatus* (Cyperaceae)	Ricefield bulrush
98.	*Scirpus maritimus* (Cyperaceae)	Bayonet grass / saltmarsh
99.	*Scirpus roylei* (Cyperaceae)	Nees
100.	*Sium sisarum* (Apiaceae)	Skirret
101.	*Tamarix ericoides* (Taccaceae)	Sharni/Jhao
102.	*Typha angustata* (Typhaceae)	Ram Ban / Pan Kanis
103.	*Typha latifolia* (Typhaceae)	Bulrudh / Cattail/ Reed-mace
104.	*Typha angustifolia L.* (Typhaceae)	Elephant Grass
105.	*Typha domingensis* (Typhaceae)	Southern cattail

Table 2: Total emergent macrophyte species observed, categorized by family, during the survey of the study area.

Sr. No.	Family of macrophyte	Number of Species
1	Acanthaceae	2
2	Alismataceae	4
3	Amaranthaceae	2
4	Apiaceae	1
5	Apotomogetonaceae	1
6	Araceae	2
7	Asteraceae	1
8	Boraginaceae	1
9	Brassicaceae	2
10	Cannaceae	1
11	Commelinaceae	2
12	Convolvulaceae	4
13	Cyperaceae	44
14	Ephorbiaceae	1
11	Fabaceae	2
12	Gramineae	3
13	Iridaceae	1
14	Juncaceae	1
15	Lythraceae	1
16	Marsileaceae	1
17	Nelumbonaceae	1
18	Nymphaeaceae	9
19	Onagraceae	1
20	Plantaginaceae	2
21	Poaceae	9
22	Polygonaceae	2
23	Pontederiaceae	1
24	Scrophulariaceae	1
25	Sparganiaceae	1
26	Taccaceae	1
27	Typhaceae	4
28	Verbenaceae	1
Total 28 Families		108 species

The district-wise analysis of emergent macrophytes reveals a similar trend in Chhatrapati Sambhajinagar district (Table 2), where the Cyperaceae family comprises 44 species, the Nymphaceae family includes 7 species, and the Poaceae family has 8 species. In total, species from 28 different families were recorded in Chhatrapati Sambhajinagar district.

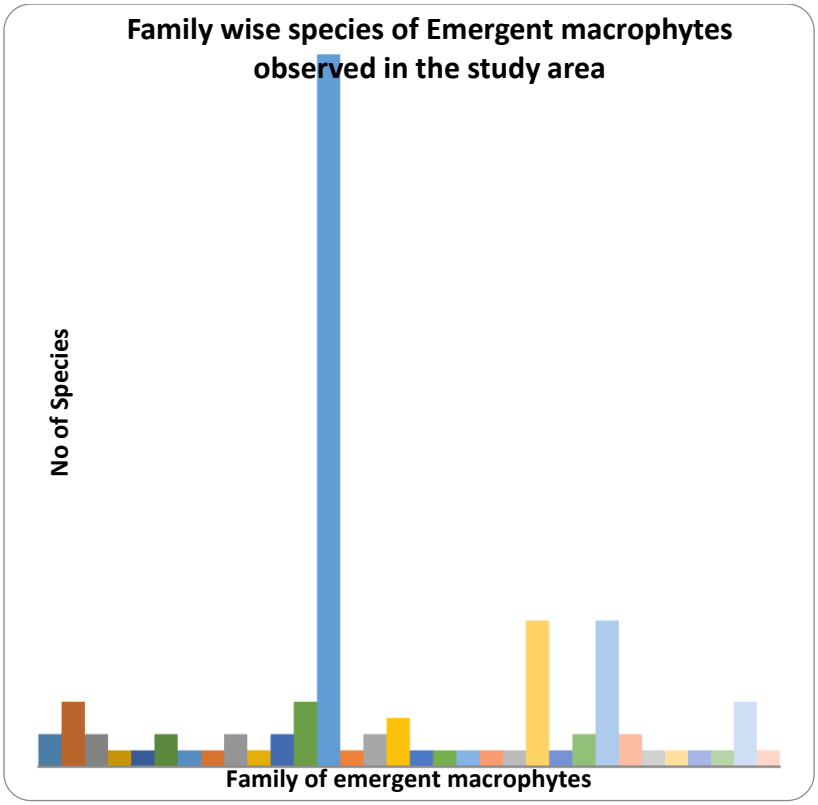

Fig. 2: Family wise species of Emergent macrophytes observed in study area

The survey of emergent macrophyte vegetation reveals that the Cypereaceae family is the most prevalent in the region, comprising 44 species, followed by Nymphaeaceae and Poaceae, each represented by 9 species. Analyzing diversity indices across these districts will enhance our understanding of their ecological conditions and functional characteristics. This research offers essential baseline data regarding the diversity of emergent aquatic macrophytes in the significant water bodies of the Chhatrapati Sambhajinagar district, which includes major water bodies, river systems, marshlands, and wetlands. The findings will be instrumental in managing plant growth, mitigating eutrophication, restoring aquatic ecosystems, and regulating plant species for effective pollution control through phytoremediation techniques.

The occurrences and distribution of emergent macrophyte species in the study area exhibit a significant level of diversity, playing a crucial role in regulating the climatic conditions of Chhatrapati Sambhajinagar district. These emergent macrophytes are characterized by a simpler structural complexity, as their intricate growth primarily occurs above the water's surface, making them less accessible to various aquatic organisms (Singadgaon and Chavan, 2017; 2018a; 2018b). Consequently, it is often suggested that these species create a uniform habitat (Daspute-Taur et al., 2018). The root structures of emergent macrophytes are known to affect the movement of solutes in the subsurface (Nikolakopoulou et al., 2018). Furthermore, it is believed that these macrophytes serve similar ecological functions across multiple trophic levels within ecosystems; however, there is currently a lack of scientific evidence to support this claim. Comprehensive scientific research is necessary to explore the role of emergent macrophytes in shaping littoral habitats (Stahr and Kaemingk, 2017).

Conclusions

Chhatrapati Sambhajinagar district boasts a rich diversity of emergent macrophytes, comprising 105 species. The district is predominantly represented by the Cyperaceae family, which includes 44 species, alongside 7 species from the Nymphaceae family and 8 species from the Poaceae family. Current research on aquatic macrophytes is vital for understanding the dynamics of aquatic ecosystems and may contribute to addressing issues related to eutrophication. Additionally, it could facilitate the implementation of phytoremediation strategies, particularly through the selective use of the identified macrophytes that are well-suited to the climatic conditions of the Chhatrapati Sambhajinagar district of Marathwada region.

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