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Investigation Of Emergent Aquatic Macrophytes In Jalna District Of Maharashtra.

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Abstract:

Aquatic macrophytes, often referred to as hydrophytes, encompass a wide range of macroscopic plants that thrive either fully or partially in water-based ecosystems. However, their populations are significantly impacted by factors such as eutrophication, sewage discharge, and industrial contaminants. Moreover, seasonal changes can lead to a marked reduction in the diversity of these aquatic plants. Consequently, it is essential to establish baseline data to assess these effects and maintain the health of aquatic ecosystems.

A thorough survey was carried out to evaluate the presence of emergent macrophyte populations in the waterways of the study region, with careful documentation of the findings. The results indicate that the Jalna district is home to a rich variety of emergent macrophytes, with a total of 89 species identified. The district is particularly notable for its substantial representation of the Cyperaceae family, which comprises 35 species. Following this, the Poaceae family includes 8 species, while the Nymphaeaceae family has 5 species, and the Typhaceae family contains 4 species. Additionally, the Convolvulaceae and Graminaeae families each feature 3 species, and the Acanthaceae, Alismataceae, Amaranthaceae, Commelinaceae, Fabaceae, Plantaginaceae, and Polygonaceae families each have 2 species. Furthermore, one species was recorded from each of the following families: Apiaceae, Aponogetonaceae, Asteraceae, Boraginaceae, Brassicaceae, Cannaceae, Euphorbiaceae, Iridaceae, Juncaceae, Lythraceae, Marsileaceae, Pontederiaceae, Scrophulariaceae, Taccaceae, and Verbenaceae.

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

Introduction:

Aquatic plants are essential components of aquatic ecosystems, serving as a source of food and habitat for fish, wildlife, and various aquatic organisms. These plants have evolved a range of adaptive strategies that allow them to respond effectively to environmental changes and flourish in diverse aquatic environments, including freshwater bodies, rivers, wetlands, swamps, seasonally flooded areas, as well as brackish and marine environments (Mironova, 2014; Rajmankova, 2011; Wetzel, 2001).

From a taxonomic standpoint, aquatic macrophyte vegetation encompasses several groups, including green macroalgae (Chlorophyta, such as Cladophora spp.), charophytes (Charophyceae, including Chara and Nitella spp.), and higher aquatic plants, which consist of both vascular plants (Tracheophyta) and bryophytes (de Nie, 1987; Srivastava et al., 2008). Some studies suggest that macroalgae from the Rhodophyta and Xanthophyta groups may also be categorized as aquatic macrophytes (Chambers et al., 2008). In aquatic ecosystems, vascular plants are notably less diverse and abundant than their terrestrial relatives, accounting for only about 1% of the total vascular flora. It is estimated that aquatic tracheophytes include 33 orders and 88 families, totaling around 2,614 species across 412 plant genera (Chambers et al., 2008). The majority of these aquatic vascular plants are angiosperms (Magnoliopsida), although the aquatic flora also features members from the classes Polypodiopsida and Lycopodiopsida (Chambers et al., 2008; Wetzel, 2001).

From a conventional viewpoint, it is commonly accepted that aquatic vascular plants evolved from terrestrial species that subsequently adapted to aquatic environments (Cook, 1999). Nevertheless, recent studies indicate that some groups of aquatic angiosperms may have developed directly in water (Du and Wang, 2016). The aquatic ecosystem comprises both plant and animal life that interact to maintain ecological balance. Among these, aquatic weeds represent a significant portion of global aquatic ecosystems. These undesirable plants flourish in various water bodies, including ponds, lakes, reservoirs, and even oceans. Aquatic macrophytes, which include large forms of aquatic vegetation such as macroalgae, mosses, ferns, and angiosperms, play crucial roles within their habitats. The diversity, density, and types of macrophytes found in freshwater ecosystems are important indicators of the health of these water bodies.

In addition, aquatic vegetation can influence water quality. Macrophytes are essential to the aquatic ecosystem, offering habitat and sustenance for aquatic organisms. Among the biological strategies for managing eutrophication, emergent and submerged macrophytes have proven to be the most effective. There are various methods to utilize the potential of these aquatic plants, such as phytoremediation, which has led to their reclassification as 'aquatic plants' rather than 'aquatic weeds.'

Aquatic macrophytes are categorized into various groups, including planktonic algae, filamentous algae, surface-floating plants, emergent plants, submerged plants, and marginal plants. The presence of floating and emergent vegetation in lakes leads to gradual changes and promotes a nutrient-rich ecosystem (Sharma and Singhal, 1988). These aquatic plants are vital as they provide food, shade, and shelter for a diverse range of aquatic organisms. Additionally, they serve as a substrate for numerous micro and macro-fauna, which rely on the roots, stems, and leaves of both floating and submerged macrophytes for habitat and attachment.

Macrophytes are crucial components of aquatic ecosystems. They not only act as a food source for aquatic invertebrates but also play a significant role in the accumulation of heavy metals (Chung and Jeng, 1974). Certain aquatic plants, such as water hyacinth, water lettuce, and duckweeds, demonstrate considerable potential for phytoremediation (bioremediation) of polluted water due to their exceptional ability to remove toxic substances (Nirmal kumar et al., 2008). This area of research is expected to be explored further by modern scientists. The current study provides essential insights into the diversity of emergent macrophytes in the Beed district of Maharashtra, which will be valuable for the management and regulation of aquatic plant species.

Materials and methods:

Study area:

The investigation of macrophytes was conducted in the Jalna district, which is situated in the central region of Marathwada, Maharashtra State. This district lies between the latitudes of 19° 15’ and 20° 32’ North, and the longitudes of 75° 36’ and 76° 45’ East. The district extends 150 kilometers from north to south and 110 kilometers from east to west. Jalna district holds a prominent position on the Deccan plateau, with the majority of its area classified as plateau, except for the Ajanta and Satamala ranges and the river basins. The predominantly flat topography of the region facilitates a high population density. Jalna district is divided into eight tahsils, four subdivisions, and eight panchayat samitis, covering a total geographical area of 7,726 square kilometers, which accounts for 2.47% of the entire state area. The population is predominantly rural, with 98.07% residing in rural areas and only 1.93% in urban settings.

The district includes eight talukas: Jalna, Bhokardan, Jafrabad, Badnapur, Ambad, Ghansawangi, Partur, and Mantha. It is located in the eastern part of the Marathwada region and is bordered by Aurangabad district to the west, Jalgaon district to the north, Buldhana and Parbhani districts to the east, and Beed district to the south.

Climate:

The district experiences a dry and tropical climate characterized by extremely hot summers and mild winters, accompanied by a humid southwest monsoon season that brings moderate rainfall. The climate can be categorized into three primary seasons: a) the hot to warm humid monsoon season from June to September, b) the cool dry winter season from October to February, and c) the hot dry summer season from March to June. During the rainy season, temperatures range from 21 to 30°C, while winter temperatures significantly drop, ranging from 10 to 25°C. Nighttime temperatures typically range from 20 to 25°C, often accompanied by a refreshing breeze.

Rainfall patterns in the district reveal two distinct regions. The first region includes the Bhokardan, Jafrabad, and Jalna talukas, which receive approximately 700 mm of rainfall. The second region consists of the Ambad and Partur talukas, with an average rainfall of about 800 mm. Rainfall distribution is not uniform across the district; Jalna and Ambad talukas are known for their reliable rainfall, while Bhokardan and Jafrabad talukas experience moderate rainfall ranging from 625 to 700 mm. The average annual rainfall in the area is recorded at 725.80 mm, with around 83% occurring between June and September, making July the wettest month.

Generally, the air in the district is dry, except during the southwest monsoon when relative humidity increases. The summer months are the driest, with afternoon humidity levels typically between 20 and 25 percent. Winds are usually light to moderate, gaining strength in the latter part of the hot season and during the monsoon. During the hot season, winds predominantly come from the west and north, while during the southwest monsoon, they mainly originate from the southwest and northwest.

The district features an efficient drainage system characterized by dendritic patterns and well-developed valleys. There are two primary drainage systems: (1) the Godavari River and (2) the Purna and Dudhna Rivers. The Godavari River delineates the entire southern boundary of the district, particularly in the Ambad and Partur talukas. It is a significant river within the Deccan Plateau, with the entire Jalna district situated within its expansive basin. The direct tributaries of the Godavari include the Shivbhadra, Yellohadrs, Galhati, and Musa Rivers, all of which originate from the Ajanta and Ellora plateaus, flowing south and eastward to merge with the Godavari. While many smaller streams tend to dry up during the summer months, the major rivers maintain a perennial flow.

The Purna River originates near Mehun, approximately 8 km northeast of the Satmala Hills. It is the most significant river following the Godavari and drains the entire regions of Jafrabad, Bhokardan, and parts of the Jalna district. Its tributaries include the Charna, Khelna, Jui, Dhamna, Anjan, Girja, Jivrakha, and Dudhna Rivers. The Dudhna River, the largest tributary of the Purna, is nearly as long as the main river itself. It has the longest course within the Jalna district, draining portions of Ambad, Jalna, and Partur talukas, along with its tributaries such as Baldi, Kundilikha, Kalyan, Lahuki, and Sukna.

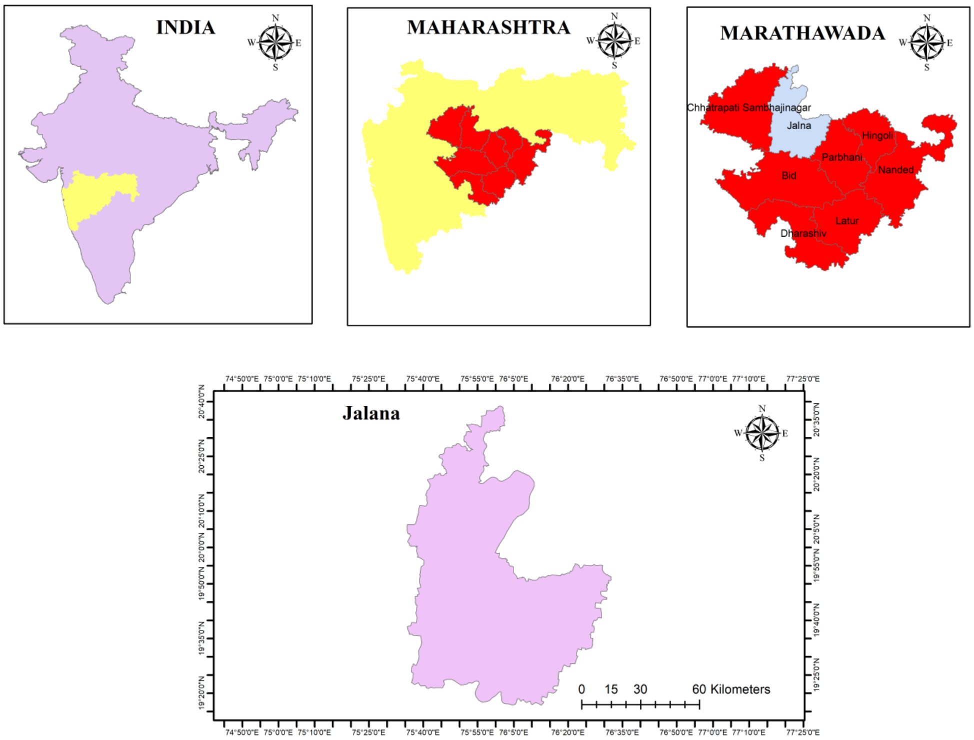

Figure 1: Map showing the location of the Jalna district within the study area.

Climate and Rainfall:

The district's climate is marked by hot summers and a general lack of moisture throughout the year, with the exception of the southwest monsoon season, which occurs from June to September. October and November represent the post-monsoon period. The winter season begins in late November, leading to a rapid decline in temperatures. December is the coldest month, with an average maximum temperature of 30.5°C and a minimum of 10.5°C (2015). Starting in early March, daily temperatures rise consistently, peaking in May, which is the hottest month, with an average maximum temperature of 41°C and a minimum of 24.6°C.

The southwest monsoon typically begins around the second week of June, resulting in a significant drop in temperature. However, the arrival of the monsoon has been increasingly delayed to the third or fourth week of June. Outside of the monsoon season, the district generally experiences dry air, with high relative humidity only during the southwest monsoon. The summer months are particularly arid, with afternoon relative humidity levels typically ranging from 20% to 25%. Winds are usually light to moderate, gaining strength during the latter part of the hot season and throughout the monsoon. During the hot season, winds predominantly come from the west and north, while during the southwest monsoon, they mainly originate from the southwest and northwest. For the remainder of the year, winds are primarily from the northeast and southeast, shifting to southwesterly and northwesterly in January and February. The average annual rainfall in the district ranges from approximately 600 mm to 750 mm, with instances of drought occurring when rainfall drops to between 400 mm and 450 mm.

Survey Methodology:

Aquatic macrophytes from key waterways and water bodies within the Jalna district study area were systematically collected over three distinct seasons: rainy, winter, and summer. Seasonal surveys, which involved multiple visits, were conducted to collect data on both littoral and submerged vegetation, as outlined by Narayana and Somashekar (2002). Over a four-year period, from June 2018 to 2022, these surveys recorded aquatic plants, particularly macrophytes, through regular excursions at short intervals to gather and identify plant samples from the designated study locations. This paper focuses specifically on the emergent macrophytes present in the Jalna district.

A sufficient number of field excursions were undertaken to sample and document observations throughout the study duration, ensuring the collection of significant macrophyte species. The Aquatic Plant Sampling Protocols were meticulously adhered to during the sampling process. Samples were manually collected 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 cleaned to minimize mud content before being pressed between newspapers or placed in polyethylene bags, depending on availability and field conditions, for immediate identification. This methodology is consistent with techniques used in 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 sources, with additional confirmation from botanists when available.

Results and Discussion

Aquatic plants are species that inhabit various saltwater and freshwater environments, including small fish tanks, home aquariums, lakes, ponds, and oceans. These plants can exist above water, be fully submerged, or occupy an intermediate position; the key point is that they naturally flourish in wet habitats. Aquatic plants possess a variety of characteristics that enable their survival in these environments (Rascio, 2002).

Commonly referred to as 'submerged macrophytes,' these aquatic plants play a crucial role in their ecosystems. Although they may not be prominent in our everyday experiences, their significance cannot be overstated. They are vital components of aquatic ecosystems, contributing to the oxygen supply necessary for the metabolic processes of underwater animal species. Additionally, they serve as a food source for various aquatic animals; for example, turtles consume algae found on the surfaces of freshwater ponds. While some aquatic plants remain submerged, others float on the water's surface. Their stems and roots provide stability, allowing them to withstand strong currents, as seen with moss that adheres to rocks.

Aquatic plants primarily grow in water and exhibit a wide range of forms, with some resembling typical terrestrial plants and others appearing quite distinct. They are categorized into four main types: algae, floating plants, submerged plants, and emerged plants, with their classification based on the arrangement of their roots and leaves.

Aquatic plants serve purposes beyond merely enhancing the visual appeal of a fish tank or providing a secure habitat for frogs, although their contribution to the beauty of aquatic environments is certainly noteworthy. They play a crucial role in aquatic ecosystems by offering protection to fish, boosting oxygen levels in the water, filtering it to inhibit the growth of unwanted plants, and acting as a food source (Green et al., 2002; Bunkar et al., 2022). A variety of animals, including fish, birds, mammals, mollusks, and arthropods (such as insects and crustaceans), rely on aquatic plants for sustenance (Gross et al., 2001).

Aquatic plants are those that primarily thrive in water environments. They exhibit a wide range of forms, with some resembling typical terrestrial plants while others appear quite distinct. These plants are categorized into four main types: algae, floating plants, submerged plants, and emerged plants, with their classification based on the arrangement of their roots and leaves.

Aquatic plants offer numerous ecological advantages and play a vital role in enhancing the diversity and functionality of aquatic ecosystems (Carpenter and Lodge, 1986). These productive regions are typically shallow, maintain relatively stable water chemistry, and receive sufficient light to support the growth of aquatic life on the substrate (Dodds, 2002). Macrophytes, which include both plants and algae, create essential habitats for various aquatic organisms, serving as substrates for attached flora and fauna, spawning grounds for species, nurseries for juvenile fish and other organisms, and habitats for adult life stages. Furthermore, they constitute the foundation of the food web, acting as a direct food source or as detrital matter following their decay.

Natural populations of emergent aquatic plants can be found in both permanent and temporary water bodies. Rushes (such as Juncus spp.) and sedges (including Carex spp. and Carex aquatilis) are types of emergent plants that feature grass-like leaves and can grow either as a single stem or in clusters. These stems are interconnected by robust, elongated rhizomes. A significant distinguishing feature between sedges and rushes is the shape of their stems; sedges generally possess a triangular stem, whereas rushes have a round stem filled with white pith. The presence of these plants is advantageous, as they help stabilize slopes and reduce erosion. The diversity of aquatic plant species is often underestimated. While the variety of vascular plants is somewhat restricted compared to that of algae, it remains significant (Radmer, 1996; Lee, 1989; Bold and Wynne, 1985).

The role of plants in the littoral zone is extensive, as they enhance the structure, function, and diversity of aquatic ecosystems, facilitate nutrient cycling, provide nourishment for aquatic organisms, and offer habitats for invertebrates and fish (Carpenter and Lodge, 1986; Ozimek et al., 1990; Madsen et al., 2001). Aquatic plants also help to anchor soft sediments, stabilize underwater slopes, filter suspended particles, and absorb nutrients from the water above (Barko et al., 1986; Doyle, 2000; Madsen et al., 2001).

The sampling locations within the primary water bodies and wetland areas exhibited a diverse range of emergent macrophyte species. Throughout the four-year study, a total of 89 emergent macrophyte species were identified from the littoral and sub-littoral zones of the chosen sampling sites in the district. This compiled list represents the emergent macrophytes recorded, though it is not comprehensive. A summary of the identified emergent macrophytes is presented in Table 1.

Table 1: List of Emergent Macrophytes recognized in key water bodies, their adjacent regions, and wetlands within the study area.

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.* (Cannaceae)	Kardal/ Indian shot
11.	*Chrozophora rottleri* (Ephorbiaceae)	Suryavarti
12.	*Coix aquatic* (Poaceae)	Adlay millet
13.	*Colocasia chamissonis* (Araceae)	Swamp taro
14.	*Colocasia esculenta* (Araceae)	Taro/ Elephant grass
15.	*Commelina benghalensis* (Commelinaceae)	Benghal dayflower
16.	*Commelina hasskarlii* (Commelinaceae)	Kamalini
17.	*Cynodon dictylon* (Poaceae)	Bermuda grass
18.	*Cyprus alopecuroide* (Cyperaceae)	Foxtail flat sedge
19.	*Cyperus difformis* (Cyperaceae)	Dila
20.	*Cyperus esculentus* (Cyperaceae)	Sedge
21.	*Cyperus exaltatus* (Cyperaceae)	Gaint sedge
22.	*Cyperus iria* (Cyperaceae)	Rice flatsedge
23.	*Cyperus longus* (Cyperaceae)	Sweet cyperus
24.	*Cyperus Pseudokyllingoides* (Cyperaceae)	Plant form
25.	*Cyperus rotundus* (Cyperaceae)	Nagarmotha
26.	*Cyperus sanguinolentus* (Cyperaceae)	Purple glume sedge
27.	*Cyperus scariosus* (Cyperaceae)	Cypriol
28.	*Cyperus squarrosus* (Cyperaceae)	Awned cyperus
29.	*Cyperus Senguinolentus* (Cyperaceae)	Flat sedge
30.	*Cyperus stoloniferus* (Cyperaceae)	Nut grass
31.	*Echinochloa colona* (Poaceae)	Marsh grass
32.	*Echinochloa stagnina* (Poaceae)	Banti (Marathi)
33.	*Eclipta prostate* (Asteraceae)	Ink plant
34.	*Eleocharis capitata* (Cyperaceae)	Knoblike spikerush
35.	*Eleocharis dulcis (tuberosa)* (Cyperaceae)	Chinese water chestnut
36.	*Eleocharis geniculata* (Cyperaceae)	Spikerush

37.	*Eleocharis plantagenera* (Cyperaceae)	Sedge
38.	*Fimbristylis alboviridis* (Cyperaceae)	Fimbristyle
39.	*Fimbrystyalis bisumbellata* (Cyperaceae)	Double umbel fimbri
40.	*Fimbrystylis complanata* (Cyperaceae)	Fimbry sedge
41.	*Fimbristylis dichotoma* (Cyperaceae)	Graminoid Fimbry
42.	*Fimbristylis ferruginea* (Cyperaceae)	Common ditch fimbry
43.	*Fimbristylis microcarya* (Cyperaceae)	Fringe rush
44.	*Fimbristylis polytrichoides* (Cyperaceae)	Rusty sedge
45.	*Fimbristylis schoenoides* (Cyperaceae)	Ditch fimbry
46.	*Fuirena cilaris* (Cyperaceae)	Vendranamalona
47.	*Fuirena trilobites* (Cyperaceae)	Three lobed umbrella sedge
48.	*Heliotropium supinum* (Boraginaceae)	Dwarf Heliotrope
49.	*Hygrophila schulis* (Acanthaceae)	Barleria
50.	*Iris pseudacorus* (Iridaceae)	Flag iris
51.	*Ipomoea aquatic* (Convolvulaceae)	Swamp Cabbage
52.	*Ipomoea Carnea* (Convolvulaceae)	Alpvardhini
53.	*Ipomoea fistulosa* (Convolvulaceae)	Beshram
54.	*Juncus effusus* (Juncaceae)	Soft brush
55.	*Jussiaea repens* (Onagraceae)	Primrose
56.	*Kyllinga bulbosa* (Cyperaceae)	Korapullu
57.	*Leersia hexandra* (Gramineae)	Rice cut-grass
58.	*Limnophila heterophilla* (Plantaginaceae)	Asian marshweed
59.	*Limnophila sessiliflora L.* (Plantaginaceae)	Asian marshweed
60.	*Marsilea quadrifolia* (Marsileaceae)	Water shamrock
61.	*Monochoria hastata* (Pontederiaceae)	Arrow Leaf pondweed
62.	*Nasturtium officinale* (Brassicaceae)	Watercress
63.	*Nuphar luteum* (Nymphaceae)	Yellow water lily
64.	*Nymphaea stellata* (Nymphaceae)	Indian Blue water lily
65.	*Nymphaea lotu* (Nymphaceae)	Egiptian Lily (as per color)
66.	*Nymphaea Victoria amazonica* (Nymphaceae)	Amazon waterlily
67.	*Panicum repens* (Gramineae)	Torpedo grass
68.	*Pennisetum pedicellatum* (Poaceae)	Deenanath grass
69.	*Polygonum glabrum* willd L. (Polygonaceae)	Knotweed
70.	*Polygonum hydropiper* (Polygonaceae)	Smart weed
71.	*Phragmites australis* (Poaceae)	Common reed
72.	*Phragmites karka* (Poaceae)	Perennial reed
73.	*Pycreus flvidus* (Cyperaceae)	Yellow flatsedge
74.	*Pycreus nervulosus* (Cyperaceae)	Low flatsedge
75.	*Pycreus pumilus* (Cyperaceae)	Dwarf sedge
76.	*Sagittaria latifolia* (Alismataceae)	Broadleaf arrowhead
77.	*Sagittaria trifolia (sinensis)* (Alismataceae)	Arrowhead
78.	*Scirpus acutus* (Cyperaceae)	Hardstem bulrush
79.	*Scirpus affinis* (Cyperaceae)	Club rush
80.	*Scirpus articulatus* (Cyperaceae)	Poppangorai
81.	*Scirpus californicus* (Cyperaceae)	Threesquare
82.	*Scirpus debilis* (Cyperaceae)	Weakstalk bulrush
83.	*Scirpus juncoides* (Cyperaceae)	Vivacious sedge
84.	*Scirpus littoralis* (Cyperaceae)	Baranagar motha
85.	*Scirpus mucronatus* (Cyperaceae)	Ricefield bulrush
86.	*Scirpus maritimus* (Cyperaceae)	Bayonet grass / saltmarsh
87.	*Scirpus roylei* (Cyperaceae)	Nees
88.	*Sparganium americanum* (Sparganiaceae)	Bur-reed
89.	*Tamarix ericoides* (Taccaceae)	Sharni/Jhao
90.	*Typha angustata* (Typhaceae)	Ram Ban / Pan Kanis
91.	*Typha latifolia* (Typhaceae)	Bulrudh / Cattail/ Reed-mace

92.	*Typha angustifolia L.* (Typhaceae)	Elephant Grass
93.	*Typha domingensis* (Typhaceae)	Southern cattail

The survey of macrophytes conducted in the specified study area aimed to assess vegetation in aquatic settings, which encompass water bodies, waterlogged areas, wetlands, and marshes. The primary objective of the survey was to identify ecological species from various families or groups and to investigate their diversity within the selected region. Over the years, numerous researchers have engaged in similar investigations, including Asri and Aftekhari (1999), Raizi (1996), Ghahreman and Attar (2003), Jalili et al. (2009), Zahed et al. (2013), and Naqinezhad and Hosseinzadeh (2014).

Macrophytes are generally recognized as aquatic plants that are visible to the naked eye and can be easily identified by field specialists. These plants display considerable spatiotemporal variability in aquatic environments, which complicates assessments and raises the potential for errors when compared to terrestrial vegetation surveys (Allan et al., 2009). The scarcity of thorough studies on their quantification and sampling, coupled with various challenges such as depth fluctuations, boundary ambiguities, difficulties in identifying taxa within the same plant group, and low detection rates, contribute to these inaccuracies. As a result, the survey was structured into four distinct phases: the initial phase involved a pilot survey to establish the methodology and locations for the main survey; the second phase concentrated on documenting the macrophytes in the chosen aquatic areas; the third phase focused on data compilation; and the final phase included data manipulation and validation.

Macrophyte species are essential to numerous functions within aquatic ecosystems, such as biomineralization, transpiration, sedimentation, elemental cycling, material transformation, degradation, and the emission of biogenic trace gases. When applied correctly, these characteristics and processes associated with macrophytes can be effectively harnessed for the treatment of water and wastewater (Carpenter and Lodge, 1986). In their natural environments, the flora and fauna of aquatic ecosystems interact with each other, playing a vital role in sustaining ecological balance. Aquatic macrophytes include various types of vegetation, such as macroalgae, mosses, ferns, and angiosperms. This study specifically aimed to investigate macrophytes.

Table 2: Family-wise total of emergent macrophytes species in Jalana District.

Sr. No.	Family of emergent macrophytes	Number of Species
1.	Acanthaceae	1
2.	Alismataceae	3
3.	Amaranthaceae	2
4.	Apotomogetonaceae	1
5.	Araceae	2
6.	Asteraceae	1
7.	Boraginaceae	1
8.	Brassicaceae	1
9.	Cannaceae	1
10.	Commelinaceae	2
11.	Convolvulaceae	3
12.	Cyperaceae	44
13.	Ephorbiaceae	1
14.	Fabaceae	2
15.	Gramineae	2
16.	Iridaceae	1
17.	Juncaceae	1
18.	Lythraceae	1
19.	Marsileaceae	1
20.	Nymphaeaceae	4

21.	Onagraceae	1
22.	Plantaginaceae	2
23.	Poaceae	7
24.	Polygonaceae	2
25.	Pontederiaceae	1
26.	Scrophulariaceae	1
27.	Sparganiaceae	1
28.	Taccaceae	1
29.	Typhaceae	4
Total number of observed species		93 species

The study of emergent macrophytes in the Jalna district reveals that the Cyperaceae family is the most abundant, consisting of 41 species (refer to Table 2). Following Cyperaceae, the next most frequently observed families include Poaceae with 7 species, and both Nymphaeaceae and Typhaceae with 4 species each. Alismataceae and Convolvulaceae each contribute 3 species, while Amaranthaceae, Araceae, Commelinaceae, Fabaceae, Graminaeae, Plantaginaceae, and Polygonaceae each have 2 species represented. Additionally, one species from the families Acanthaceae, Aponogetonaceae, Asteraceae, Boraginaceae, Brassicaceae, Cannaceae, Euphorbiaceae, Iridaceae, Juncaceae, Lythraceae, Marsileaceae, Onagraceae, Pontederiaceae, Scrophulariaceae, Sparganiaceae, and Taccaceae was documented during the study. Previous research (Jadhav and Babare, 2025) has indicated that the emergent macrophyte flora in the Chhatrapati Sambhajinagar district is similarly dominated by the Cyperaceae family, suggesting its prevalence throughout the Marathwada region.

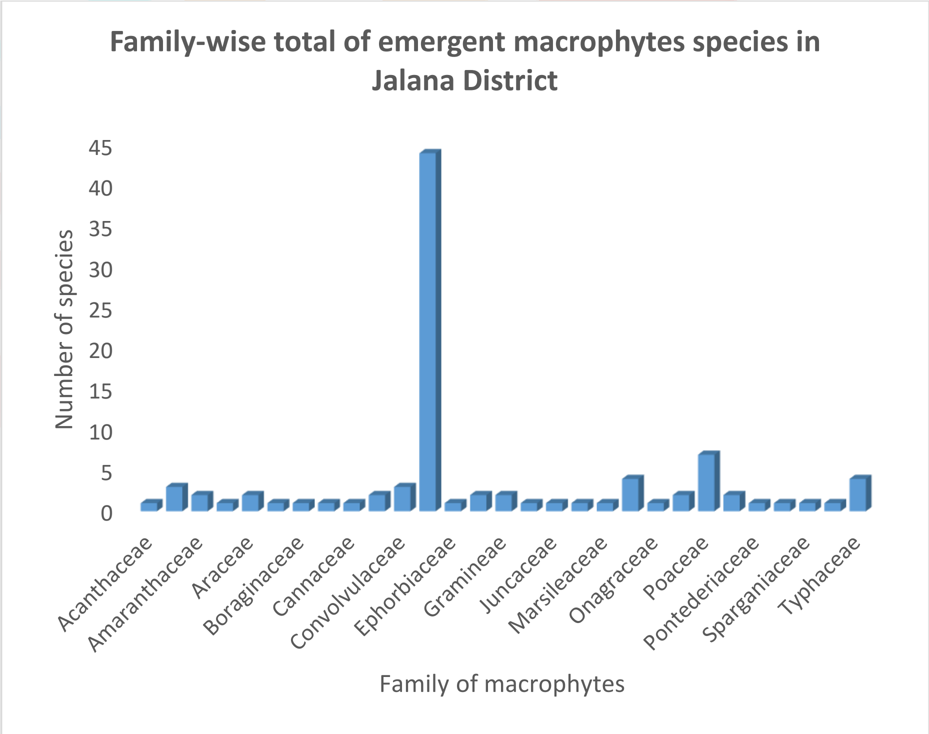

Figure 2: Species of emergent macrophytes categorized by family observed in the study area.

The investigation into emergent macrophyte vegetation in Jalna district indicates that the Cypereaceae family is the predominant group in this region. Analyzing diversity indices within these districts allows for a more comprehensive understanding of their ecological conditions and functional characteristics. This research offers essential baseline data concerning the diversity of emergent aquatic macrophytes in the significant water bodies of Jalna district, which includes important water bodies, river systems, marshes, and wetlands. The findings will be crucial for managing plant growth, tackling eutrophication, restoring aquatic ecosystems, and regulating plant species to improve pollution control through phytoremediation techniques.

The macrophytes are useful for the phytoremediation of metal contaminated wastewaters (Shingadgaon and Chavan, 2016; 2018; 2019). The occurrence and distribution of emergent macrophyte species in the study area reflect a significant diversity, which plays a vital role in regulating the climatic conditions of Jalna district, situated in the Marathawada region of Maharashtra. These emergent macrophytes generally display simpler structural complexity, as their 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 systems of emergent macrophytes are known to affect the movement of solutes in the subsurface. Furthermore, it is proposed that these macrophytes perform similar ecological functions across different trophic levels within ecosystems; however, there is currently a lack of scientific evidence to support this claim. Comprehensive scientific research is necessary to elucidate the role of emergent macrophytes in shaping littoral habitats (Stahr and Kaemingk, 2017).

Conclusions:

The Jalna district, located in the Marathwada region of Maharashtra, exhibits a remarkable variety of emergent macrophytes, encompassing 93 species across 29 families. The study reveals that Cyperaceae family is the most abundant, consisting of 41 species. Following Cyperaceae, the next most frequently observed families include Poaceae with 7 species, and both Nymphaeaceae and Typhaceae with 4 species each. Alismataceae and Convolvulaceae each contribute 3 species, while Amaranthaceae, Araceae, Commelinaceae, Fabaceae, Graminaeae, Plantaginaceae, and Polygonaceae each have 2 species represented. Additionally, one species from the families Acanthaceae, Aponogetonaceae, Asteraceae, Boraginaceae, Brassicaceae, Cannaceae, Euphorbiaceae, Iridaceae, Juncaceae, Lythraceae, Marsileaceae, Onagraceae, Pontederiaceae, Scrophulariaceae, Sparganiaceae, and Taccaceae was documented during the study.

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