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Diversity of Aquatic Macrophyte Flora Abundance in Meghadrigedda Reservoir at Visakhapatnam, Andhra Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Meghadrigedda reservoir is located in the Gajuwaka municipality of Visakhapatam district in Andhra Pradesh, India. The research was conducted at six distinct sites in the reservoir catchment region from April 2023 to March 2024, throughout pre-monsoon, monsoon, and post-monsoon periods. The current analysis indicated the presence of 52 weed species belonging to twenty orders, 33 families, and four classes. The present investigation compiled a list of hydrophytes, including their class, order, family, genus, species, and common name. The mentioned species under free floating, submerged species, and emergent weeds were found mostly around the mouths of the reservoir's main tributaries, in shallow areas with depths of about 7 feet. Among the 21 orders of aquatic weeds recorded, emergent weeds accounted for 52.38% (11 species), followed by submerged weeds 42.85% (09) and free floating weeds 21.81%. In 30 families, emergent weeds accounted for

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the most (66.66%), followed by submerged weeds (30.00%) and free floating weeds (20.00%). Emergent weeds dominate with 36 species, accounting for 69.23% of the total species, followed by submerged weeds with 10 (19.23%) and free floating weeds with 6 (11.53%). According to the IUCN (2014), there are 52 different species of hydrophytes. The status of these 42 aquatic weed species is least worried; 9 are not evaluated (NE), and one species is vulnerable (VU). The common name, habitat and IUCN (2024) status of the macrophytes has also been noted in the present paper.

Keywords: Free floating; submerged; emergent; emergent weeds; hydrophytes.

1. INTRODUCTION

In the natural environment, herbivorous and omnivorous fish might find edible plants for consumption. Aquatic plants can provide a nutritious food for fish in aquariums or backyard ponds. *Ipomoea aquatica*, an aquatic weed, might be managed in an environmentally benign way by including it into fish diet. Fish feed is critical to the long-term viability of aquaculture production. However, fish nutrition is crucial since feed is the most costly component of the aquaculture system, accounting for around 60% of total production costs [1,2,3]. The young grass carp prefer duckweeds such as Lemna, Spirodela, Wolffia, and Azolla until they reach a greater size and can consume macrophytes. Aquatic weeds are potential fish and animal feed components that are extensively spread across Indian water bodies. The higher nutritional content of aquatic weeds has lately enabled fish meal to be largely or entirely substituted [4,5]. Naseem et al. [6] found that aquatic weed meal has 11 to 32% crude protein, 2.9 to 16.81% crude fat, 8 to 31% crude ash, and a very high amino acid, mineral, and vitamin content, depending on the components employed.

Nearly 50 aquatic weed species are known to be used as direct or indirect diet for both herbivorous and omnivorous fish [7,8,9]. Water hyacinth (*Eichhornia crassipes*) is potentially useful in many tropical places throughout the world. It's a toxic aquatic plant that grows quickly in aquatic medium [10]. Recent studies also suggest that macrophytes play a central role in shallow reservoirs which can have two possible stable equilibrium: a clear-water state that is dominated by aquatic macrophytes and a turbid-water state that is dominated by phytoplankton [11]. Aquatic plants are an essential component of an aquatic environment. They may provide a valuable source of food for humans and a nutritious diet for water birds and animals, building the groundwork for aquatic wildlife conservation techniques. They can also be used as an energy source [12]. Researchers such as Wetzel [13], Majid [12], Meshram [14], Ambasht [15], Raut, and Pejawer [16] studied macrophytes in diverse water bodies across India. Macrophytes act as a connection between sediment, water, and the atmosphere in reservoirs, lakes, and rivers. Plants' most recognized function is as primary producers. However, macrophytes have a role in ecosystem processes like as biomineralization, transpiration, sedimentation, elemental cycling, material transformation, and the release of biogenic trace gases into the atmosphere [17]. The Meghadrigedda Reservoir hosts a varied diversity of macrophytes over many substrata, which have been documented for the first time. The current study is aimed at assessing the distinctive temporal variation in macrophyte varieties in the Meghadrigedda reservoir, along with their potential use as bioindicators.

2. MATERIALS AND METHODS

2.1 Study Area

Meghadrigedda is a non-perennial river that flows east and rises in the Eastern Ghats in Nandikonda Hills. It flows towards Rajaourajapeta village in Visakhapatnam district's S. Kota mandal, then swings south up to Karuvapuvanipalem village, where it passes in a south-east direction before joining the Bay of Bengal at Ramapuvanipalem. The reservoir area is bounded by three administrative mandals of Visakhapatnam district, namely Sabbavaram, Pendurthi, K.Kotapadu, and Kothavalasa mandal of Vizianagaram district, with geographic coordinates ranging from 170 42' to 170 57' north and 830 00' to 830 17' east. The three primary ephemeral rivers that flow into the reservoir are Naravagedda (by Anantapuram and Chintapatla villages), Meghadrigedda (via Pinagadi, Rampuram, and Pedagadi villages), and Borramgedda (via Kothavalasa, Pendurthi, Fig. 1).

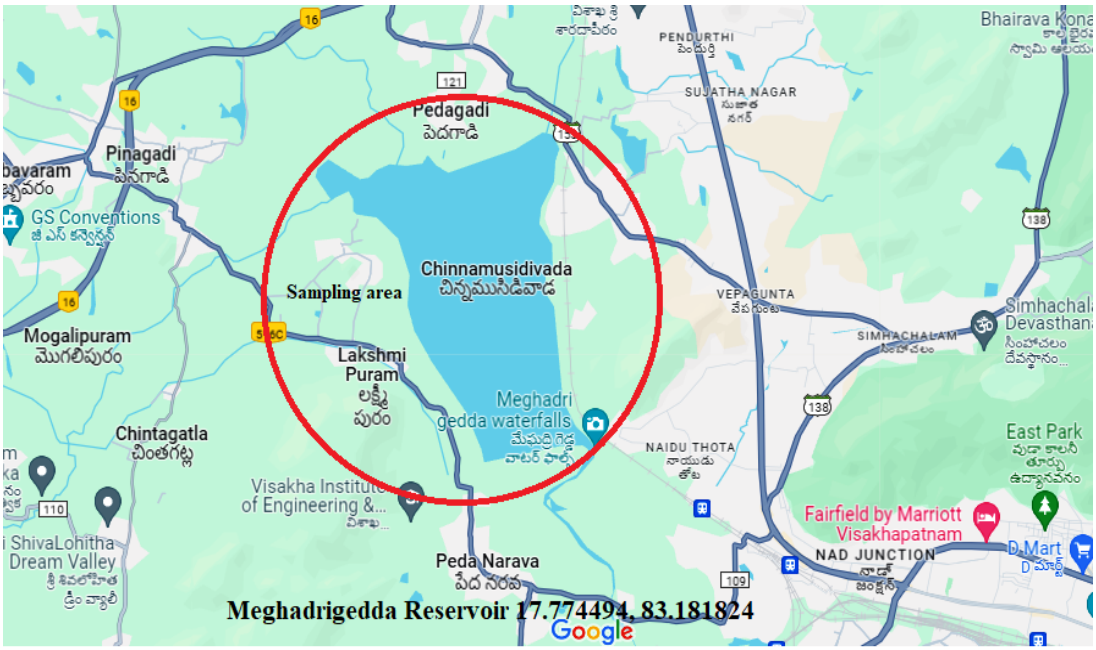

Fig. 1. Map showing study location

Fig. 2. Samples collection at various locations around the Meghadrigedda Reservoir

2.2 Laboratory Analysis

The research was conducted at six distinct sites in the reservoir catchment region from April 2023 to March 2024, throughout pre-monsoon, monsoon, and post-monsoon periods (Fig 2). The macrophytes were gathered by hand and with nets, then transported to the laboratory, fixed in 10% formalin, and identified in the laboratory by using standard accessible

literature [18]. The identification of aquatic plants was done using standard books and monographs such as and Biswas and Calder [19], Naskar. [20] Stromberg, [21], Singh and Karthikeyan [22,23], Adesina [24].

3. RESULTS AND DISCUSSION

The results of the present study revealed that the occurrence of 52 weed species belong to twenty orders, 33 families and four classes. The listed species under free floating, Submerged species and emergent weeds were identified mostly around the mouths of the reservoir's main tributaries, in shallow places with depths about 7feet (Table 1, 2, 3). The similar study were represented by Rama Rao et al. [25] recorded forty-eight distinct aquatic macrophytes reported in four classes, twenty orders, and 26 families, including five free floating macrophytes, ten submerged, and thirty-three emergent weds in Lower Manair Dam. Thomaz et al. [26] investigated over 62 species, 25 families, and 42 genera of aquatic macrophytes in the Itaipu Reservoir. James et al. [27] identified 12 submersed, 3 floating, and 18 emergent aquatic plants to species level; some samples were only identified to genera, and none of the filamentous algae were identified to either genera or species in Arizona's Reservoirs. Patil et al. [28] explained on hydrophytes and amphibious plants occurred in Panchganga River in vicinity of Ichalkaranji city district Kolhapur, Maharashta. Bandita Kumari et al. [29] reported a total 60 species of hydrophytes belonging to 39 genera and 25 families were identified. Among these, Cyperaceae was the dominant family comprising 17 species in in Different Aquatic Habitats of Puri District, Odisha. Das et al. [30] reported 13 genera of water macrophytes belonging to 10 families, as well as 24 plant species (bank flora) belonging to 16 families in Krishnagar, West Bengal, India. Ayodhya et al. [31] reported to the 74 species of macrophytes foundduring the present study at Mula river flowingthrough the Pune City. The similar results were found in Meghadrigedda reservoir during the study period.

In the present investigation the number of classes, orders and families under three types of weeds were shown in Table 4. Fig. 3. the submerged and emergent weeds are highest contributed each six class and Free floating weeds contributed lowest for three classes in Meghadrigedda Reservoir. Recorded aquatic weeds under twenty one orders, the emergent weeds occupied highest 52.38% (11 species), followed by submerged weeds 42.85% (09) and free floating weeds 21.81 % (05). In 30 families which are the emergent weeds occupied highest 66.66%, followed by submerged weeds 30.00 % and free floating weeds 20.00%. Emergent weeds are dominant with 36 species which contributes 69.23% of the total species followed by submerged weeds with 10 (19.23%) and free floating weeds with 06 (11.53%).

In terms of the number and percentage composition of free floating, submerged, and emergent weeds across twenty-one orders, Arales was dominant with two species accounting for 33.66% of the total five species of free floating weeds, followed by Salviniales, Liliales, Aslimatales, and Myrtales, each with one species (16.66%). Out of ten recorded submerged weed species, Slanales contributed two (20%), followed by Salviniales, Myrtales, Charales, Ceratophyllales, Hydrocharitales, Najadales, Poales, and Polypodiales, each contributing one (10%) of the total population Table 5. Fig. 4.

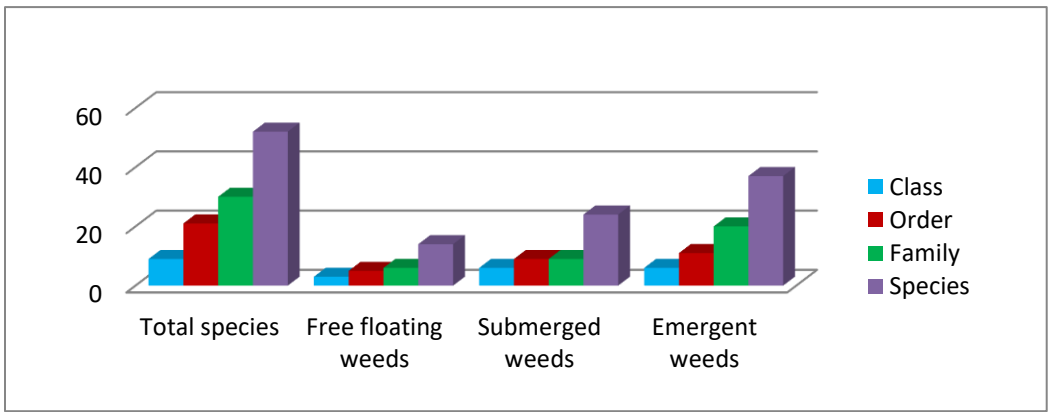

Fig. 3. Percentage composition of classes, orders, families and species

Recorded emergent weeds out of 36 species, Poales was dominant with five species which contributed 30.55%, followed by Caryophyllales 16.66%, Lamiales 13.88%, Asterales 11.11%, Commelinales 8.33%, Fabales 5.55%, and Myrtales, Amaranthaceae, Malphigiales, Boraginales, Sphigomondales which contributed each one species 2.77%. Recorded 52 species of aquatic weeds Poales were dominant with 12 (23.07%), followed by Caryophyllales with 6 species which contributed 11.53%, Lamiales with 5 species (9.61%), Asterales was dominant with 4 species (7.69%), Myrtales and Commelinales each with 3 (5.79%), Salviniales, Arales, Slanales, Fabales with 2 species, and liliales, Aslimatales, Charales, Ceratophyllales, Hydrocharitales, Najadales, Polypodiales, Amaranthaceae, Malphigiales, Boraginales, Sphigomondales contributed each one species (1.92%) Table 6. Fig. 5.

James et al. [27] surveyed aquatic plants in 38 reservoirs throughout Arizona from an inventory of species and to determine species distribution and composition patterns. They identified 12 submersed, 3 floating, and 18 emergent aquatic plants to species level. Adesina, [24] studied an assessment of aquatic vegetation of Jebba Lake, Nigeria. Olsen, [32] and Spence, [33] represented aquatic plants and hydrospheric factor and the macrophytes vegetation of lochs, swamps and associated fens. Ambasht, [34], Billore, and Vyas, [35] were studied the macrophytes limnology, distribution and production of macrophytes in the Indian subcontinent. Kiran, et al. [36] Krull, [37], Madsen, and Chambers [38] were studied aquatic macrophytes in fish culture ponds, aquatic plant-invertebrate associations and the Interactions between water movement, sediment dynamics and submersed macrophytes.

The number and percentage composition of free floating, submerged and emergent weeds under 30 families, recorded 6 species of free floating weeds Araceae contributed highest with 28.57%, followed by Azollaceae, Pontederiaceae, Hydrocharitaceae, Onagraceae, 14.28%. Recorded ten species of submerged weeds Convolvulaceae family was dominant with two species (20%) followed by Hydrocharitaceae, Onagraceae, Characeae, Ceratophyllaceae, Marsileaceae, Potamogetonaceae, and Typhaceae, Pteridaceae contributed each with one (10%) species. Recorded 36 species of emergent weeds were dominated by Cyperaceae with contributed seven (19.44%) followed by Asteraceae with four (11.11%), Amaranthaceae and Commelinaceae each with three (8.33%), Fabaceae and Poaceae each with two (5.55%), Onagraceae, Typhaceae, Hythraceae, Euphorbiaceae, Eriocaulaceae, Molluginaceae, Boraginaceae Plantaginaceae, Polygonaceae, Vertebae, Orobanchaceae, Sphinogomonadaceae and Verbanaceae ach with one (2.77%) Table 7. The percentage contribution of Macrophytes shown in Fig 6.

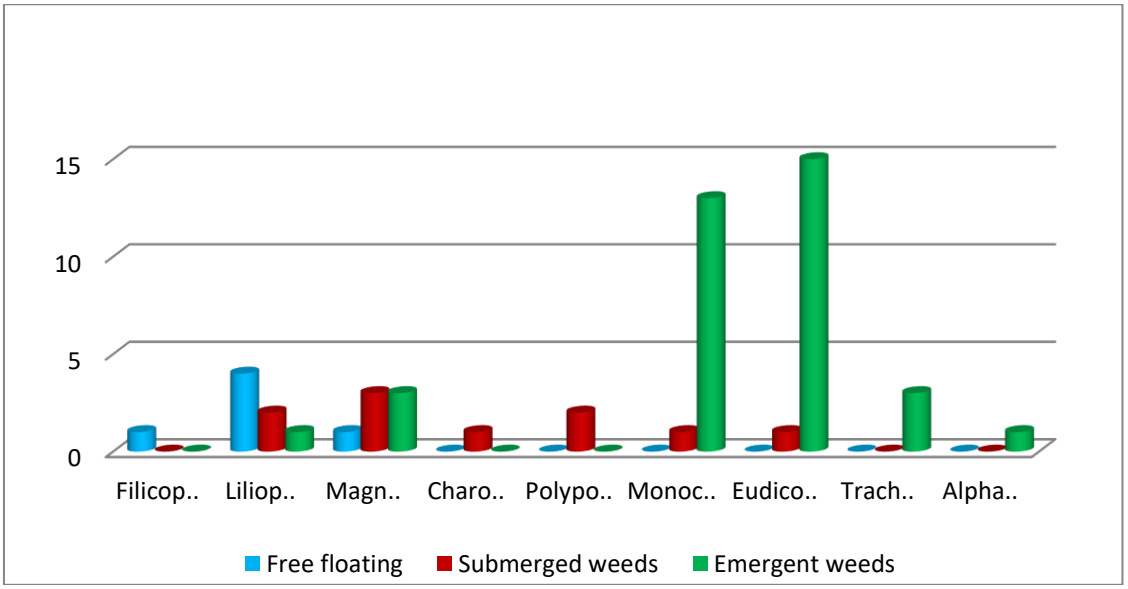

Fig. 4. Percentage contribution of Macrophytes in various classes

Table 1. Checklist of free floating weeds of their scientific name, common name, class, order, family, habitat and IUCN red list at Meghadrigedda Reservoir

S.No	Name of Species	Common name/s	Class	Order	Family	Habitat	IUCN (2024)
1	*Azolla filiculoides*	Water Fern	Polypodiopsida	Salviniales	Salviniaceae	It is most frequent in ponds, lakes, canals, ditches and slow flowing rivers.	NE
2	*Eichornia crassipes* (Mart.) Solms.	Water hyacinth	Liliopsida	Commelinales	Pontederiaceae	Shallow impermanent ponds, wetlands and marshes, slow-moving waterways, lakes, reservoirs, and rivers	NE
3	*Lemna perpusilla* Torrey	Duckweed	Liliopsida	Arales	Lemnaceae	It grows in paddy fields, ponds and other still water bodies.	LC
4	Ludwigia peploides	Floating primrose – willow	Magnoliopsida	Myrtales	Onagraceae	It is commonly found in wetlands, marshes, ponds, and slow-moving streams. It relishes shallow water with ample sunshine and nutrition.	LC
5	*Ottelia alismoides* (L.) Pers.	Duck-lettuce, waterplantain ottelia	Liliopsida	Hydrocharitales	Hydrocharitaceae	This species grows in shallow water edges and ponds and in rice field	LC
6	*Pistia stratiotes* L.	Tropical duck-weed, water lettuce	Liliopsida	Arales	Araceae	It is a free-floating weed and capable of forming dense mats on the surfaces of lakes, ponds, rivers and other water bodies.	LC

Table 2. Checklist of Submerged weeds of their scientific name, common name, class, order, family, habitat and IUCN red list at Meghadrigedda Reservoir

S.No	Name of Species	Common Name/s	Class	Order	Family	Habitat	IUCN (2024)
1	*Aponogeton natans* L.f	Floating lace Plant, Drifting Sword Plant	Liliopsida	Najadales	Aponogetonaceae	It grows in seasonal and permanent still or flowing waters, rice fields and marshy places.	LC
2	*Chara globularis J. L.T*	Muskgrass, stonewort, muskwort	Charophyceae	Charales	Characeae	It may be found in both fresh and brackish water. It may be found in both oligotrophic and eutrophic waters, including lakes and rivers. It grows on a sand, clay, mud, or marl substrate.	NE
3	*Ceratophyllum demersum* L.	Rigid Hornwort , Coontail, Hornwort	Magnoliopsida	Nymphaeales	Ceratophyllaceae	Less saline parts of sea inlets, ponds, slow-flowing streams	LC
4	*Hydrilla verticillata* (L. f.) Royle	Florida-elodea, Indian Stargrass, Water-thyme	Liliopsida	Hydrocharitales	Hydrocharitaceae	Rrivers and ponds. This species is hardy and tolerant to heavy metals.	LC
5	*Ipomoea aquatica* Forsk (Rooted)	*Water spinach*	Magnoliopsida	Solanales	Convolvulaceae	Found in marshy habitats and ditches, muddy stream banks, ponds, lakes, rice paddies and waste areas.	LC

S.No	Name of Species	Common Name/s	Class	Order	Family	Habitat	IUCN (2024)
6	*Ipomoea carnea* jacq	Pink morning glory	Magnoliopsida	Solanales	Convolvulaceae	Grows in dense concentrations along riverbeds, riverbanks, canals, and other soggy locations. It has gotten naturalized along canals, drains, and roadside.	NE
7	*Marsilea quadrifolia*	Water Shamrock	Polypodiopsida	Salviniales	Marsileaceae	It grows in still waters such as ponds, rice fields and ditches.	LC
8	*Najas minor* L.	Slender Naiad	Liliopsida	Hydrocharitales	Hydrocharitaceae	Ponds, lakes, rivers, streams, ditches and paddy fields.	LC
9	*Potamogeton pectinata* L.	Fennel Pondweed	Liliopsida	Najadales	Potamogetonaceae	Typical of eutrophic or brackish waters lakes, reservoirs, rivers, streams, canals, ditches, pond	LC
10	*Vallisneria spiralis* L.	Tapegrass	Liliopsida	Hydrocharitales	Hydrocharitaceae	Estuarine habitats, lakes, rivers, waterlogged swamps with open water, man-made reservoirs,	LC

Table 3. Checklist of emergent weeds of their Scientific name, common name, class, order, family, habitat and IUCN red list at Meghadrigedda Reservoir

S.No	Name of Species	Common Name/s	Class	Order	Family	Habitat	IUCN 2024
1	*Alternanthera sessilis (L).R.Br.ex*	Sessilis joyweed	Eudicots	Amaranthacea	Amaranthaceae	Aquatic and wetland environments.It may spread to branchish water and estuary environments along the shore.	LC
2	*Alternanthera philoxeroides*	Dwarf copper leaf	Eudicots	Caryophyllales	Amaranthaceae	Aquatic and wetland plants.	LC
3	*Ammannia baccifera L.*	Blistering ammania	Eudicots	Caryophyllales	Lythraceae	It is an annual herbaceous plant that may be found in swamps, rice paddies, and freshwater.	LC
4	*Aeschynomene indica L.*	India joint-vetch	Eudicots	Fabales	Fabaceae	Grows in field margins, ditches, grasslands,trail sides and river margins.	LC
5	*Bacopa monnieri (L.) wettestin*	Water hyssop	Eudicots	Lamiales	Scrophulariaceae	Forms dense mats in marshy places,the banks of pools and along stream and ditches.	LC
6	*Commelina benghaleasis L.*	Bengal day flower	Monocots	Commelinales	Commelinaceae	A widespread weed often found in ditches, wet fields and places	LC
7	*Commelina hasskarlii C.comm.cyrt.*	Carolina dayflower	Monocots	Commelinales	Commelinaceae	Commonly found in fields.swamps, yards, waste places, along roadsides, rarely in the forests.	LC
8	*Cyperus rotundus L.*	Nut - grass	Monocots	Poales	Cyperaceae	It dwells in a wide variety of wetland environments, including seasonally wet grasslands, swamps, ditches, pond and lake margins, springs, stream and river banks..	LC

S.No	Name of Species	Common Name/s	Class	Order	Family	Habitat	IUCN 2024
9	*Cyperus difformis L.*	Small flower umbrella sedge	Monocots	Poales	Cyperaceae	The plant generally flourishes in flooded or extremely moist soils.It may be found in small pools, rivers, canals, streams, open wet places, and grassy marshes.	LC
10	*Cynodon dactylon (L)Pets.*	Devils grass	Monocots	Poales	Poaceae	Water courses, wetlands	LC
11	*Cyathocline purpurea (Buch-Ham.ex D.Din)Oktze*	Purple bane	Eudicots	Asterales	Asteraceae	It is found growing in water logged soilssubjected to seasonal inundation and along waterways.	LC
12	*Chrozophora rottleri (Geisel)A.juss.ex.spr*	Suryavarti	Eudicots	Malpighiales	Euphorbiaceae	Paddy fields and reservoir banks	NE
13	*Dopatrium junceum*	Rushikesh dopatrium	Eudicots	Caryophyllales	Scrophulariaceae	It grows in post- monsoon pools, rice fields and perennially wet places below 1,800m	LC
14	*Eclipta alba*	False Daisy, bhringraj	Eudicots	Asterales	Asteraceae	Grows commonly in moist places as a weed in warm temperate to tropical areas worldwide	LC
15	*Eleocharis geniculata (L.)*	Canada spikesedge	Monocots	Poales	Cyperaceae	It is an annual plant that forms clusters and is gregarious in shallow water. It is particularly common in fallow rice fields, brackish water along the coast, and damp sandy places.	LC
16	*Eleocharis capitata R.Br.*	Spike -rush	Monocots	Poales	Cyperaceae	Wetlands,banks of pools and streams, terrestrial; freshwater	LC
17	*Eriocaulon cinereum R.Br*	Pipewort	Monocots	Poales	Eriocaulaceae	Damp shady place.rice fields, valleys, and damp soils from near sea level	NE
18	*Echinochloa colona (L.)link*	Wild grass	Monocots	Poales	Eriocaulaceae	Rice banks, pond shorelines, mangrove swamp inner borders, and ancient clearings are all examples of wetland ecosystems.	LC
19	*Fimbristylis miliacea*	Grass-like fimbristylis	Monocots	Poales	Poaceae	It is an annual or perennial herb growing in wet places, ponds, streams and at the edges of drying pools.	LC
20	*Gomphrena celosioides Mart.*	Gomphrena weed	Magnoliopsida	Caryophyllales	Amaranthacea	A common plant of roadsides, and sometimes invading pastures as a weed	NE
21	*Glinus lotoides L.*	Lotus sweetjuice	Magnoliopsida	Caryophyllales	Molluginaceae	Lake, marsh	NE
22	*Grangea maderaspatana*	Madras carpet	Magnoliopsida	Asterales	Asteraceae	The species occurs on the edges of ponds,canals and ditches, as well as rice fields,	LC
23	*Heliotropium supinum L.*	Dwarf heliotrope	Eudicots	Boraginales	Boraginaceae	Sandy and alluvial plains, waste ground, edges of cultivation.	LC
24	*Limnophila sessiliflora L.*	Asian marshweed	Tracheophyte	Lumiales	Plantaginaceae	Wetland habitats include the borders of ponds, marshes, rice fields, seasonally flooded habitats along streams, and low-lying wet places.	LC

S.No	Name of Species	Common Name/s	Class	Order	Family	Habitat	IUCN 2024
25	*Polygonum glabrum willd.*	Marsh buckwheat	Eudicots	Polygonales	Polygonaceae	Common, grows gregariously in marshy areas.plains	NE
26	*Phyla nodiflora (L) greene*	Turkey tangle frog fruit	Tracheophyte	Laminales	Verbenaceae	A marshy herb which grows in open and wet places near streams, ponds, paddy fields, ditches, backwaters, brackish water	LC
27	*Sesbania bispinosa (jacq.)w.t.wight*	Sesbania pea	Eudicots	Fabales	Fabaceae	It is not limited to wetlands; it may also be found in swamps, marshy wastelands, waterlogged regions, pond and river banks, rice fields, and periodically inundated areas.	LC
28	*Sopubia delphinifolia (L).G.Don*	Sopubia delphinifolia	Eudicots	Lamiales	Orabancheaae	Western India,as a root parasite.	VU
29	*Sphaeranthus indicus L.*	East Indian globe thistle	Eudicots	Asterales	Asteraceae	It is an annual that grows in moist places, often momentarily submerged.Common in and around irrigation canals.	LC
30	*Typha angustata Bory and chaub*	Reed mace, elephant grass	Monocots	Poales	Typhaceae	It occurs in shallow water of lakes, ponds, rivers, swamps and channels.	NE
31	*Sphsgneticola trilobata*	Yellow creeping Daisy	Alphaproteobacteria	Sphingomonadales	Sphingomonadeaae	A weed found in urban woodlands, waterways, lake margins, wetlands, roadsides, disturbed sites, waste areas, vacant lots, and coastal sand dunes in tropical and subtropical countries.	LC
32	*Cyperus javanicus*	Javanese flatsedge	Monocots	Poales	Cyperaceae	Asia to pacific. it is a perennial grows primarily in the seasonally dry tropical biome	LC
33	*Cyperus haspan*	Haspan flatsedge	Monocots	Poales	Cyperaceae	It is widely distributed in tropical and sub-tropical region in Africa, Madagascar, southern asia	LC
34	*Murdannia nodiflora*	Dove weed	Liliopsida	Commelina	Commelinaceae	Is a major weed of cotton and food crops on temporarily flooded hydromorphic soil	LC
35	*Phyla nudiflora*	Turkey tangle frog fruit	Tracheophyte	Lamiales	Verbenaceae	Wet location along the edges of ponds and ephemeral fresh water wetlands,sabal palmetto	LV
36	*Ludwigia octavalvis*	Mexican primrose willow	Eudicots	Myrtales	Onagraceae	It’s fast growth and matted roots will help stabilize	LC

Table 4. Number of classes, orders, families and species of Macrophytes at Meghadrigedda Reservoir

Classification	Total species	Free floating weeds		Submerged weeds		Emergent weeds	
Class	09	03	33.33	06	66.66	06	6666
Order	21	05	21.81	09	42.85	11	52.38
Family	30	06	20.00	09	30.00	20	66.66
Species	52	14		24		37	

Table 5. Number and Percentage contribution of Macrophytes in Nine classes

Class	Free floating		Submerged weeds		Emergent weeds	
	Total No.s	% contribution	Total No.s	% contribution	Total No.s	% contribution
Filicoposida	01	16.66	-	-	-	-
Liliopsida	04	66.66	02	20.00	01	2.77
Magnoliopsida	01	16.66	03	30.00	03	8.33
Charophyceae	-	-	01	10.00	-	-
Polypodiopsida	-	-	02	20.00	-	-
Monocots	-	-	01	10.00	13	36.11
Eudicots	-	-	01	10.00	15	41.66
Tracheophyte	-	-	-	-	03	8.33
Alpharoteobacteria	-	-	-	-	01	2.77
Total	06		10		36	

Table 6. Number and Percentage contribution of Macrophytes in Twenty one orders

Order	Free floating		Submerged weeds		Emergent weeds		Total	
	Total No.s	% contribution	Total No.s	% contribution	Total No.s	% contribution	Total No.s	% contribution
salviniales	01	16.66	01	10.00	-	-	02	3.84
liliales	01	16.66	-	-	-	-	01	1.92
Arales	02	33.66	-	-	-	-	02	3.84
Aslimatales	01	16.66	-	-	-	-	01	1.92
Myrtales	01	16.66	01	10.00	01	2.77	03	5.76
Charales	-	-	01	10.00	-	-	01	1.92
Ceratophyllales	-	-	01	10.00	-	-	01	1.92
Slanales	-	-	02	20.00	-	-	02	3.84
Hydrocharitales	-	-	01	10.00	-	-	01	1.92
Najadales	-	-	01	10.00	-	-	01	1.92
Poales	-	-	01	10.00	11	30.55	12	
Polypodiales	-	-	01	10.00	-	-	01	1.92
Amaranthaceae	-	-	-	-	01	2.77	01	1.92
Caryophyllales	-	-	-	-	06	16.66	06	
Fabales	-	-	-	-	02	5.55	02	3.84
Lamiales	-	-	-	-	05	13.88	05	11.53
Commelinales	-	-	-	-	03	8.33	03	5.76
Asterales	-	-	-	-	04	11.11	04	7.69
Malphigiales	-	-	-	-	01	2.77	01	1.92
Boraginales	-	-	-	-	01	2.77	01	1.92
Sphigomondales	-	-	-	-	01	2.77	01	1.92
Total	06		10		36		52	

Table 7. Number and Percentage contribution of Macrophyte in Thirty families

Families	Free floating		Submerged weeds		Emergent weeds		Total	
	Total No.s	% contribution	Total No.s	% contribution	Total No.s	% contribution	Total No.s	% contribution
Azollaceae	01	14.28	-	-	-	-	01	1.92
Pontederiaceae	01	14.28	-	-	-	-	01	1.92
Araceae	02	28.57	-	-	-	-	02	3.84
Hydrocharitaceae	01	14.28	01	10.00	-	-	02	3.84
Onagraceae	01	14.28	01	10.00	01	2.7	03	5.76
Characeae	-	-	01	10.00	-	-	01	1.92
Ceratophyllaceae	-	-	01	10.00	-	-	01	1.92
Convolvulaceae	-	-	02	20.00	-	-	02	3.84
Marsileaceae	-	-	01	10.00	-	-	01	1.92
Potamogetonaceae	-	-	01	10.00	-	-	01	1.92
Typhaceae	-	-	01	10.00	01	2.77	02	3.84
Pteridaceae	-	-	01	10.00	-	-	01	1.92
Amaranthaceae	-	-	-	-	03	8.33	03	5.76
Hythraceae	-	-	-	-	01	2.77	01	1.92
Fabaceae	-	-	-	-	02	5.55	02	3.84
Scrophulariaceae	-	-	-	-	02	5.55	02	3.84
Commelinaceae	-	-	-	-	03	8.33	03	5.76
Cyperaceae	-	-	-	-	07	19.44	07	13.46
Poaceae	-	-	-	-	02	5.55	02	3.84
Asteraceae	-	-	-	-	04	11.11	04	7.69
Euphorbiaceae	-	-	-	-	01	2.77	01	1.92
Eriocaulaceae	-	-	-	-	01	2.77	01	1.92
Molluginaceae	-	-	-	-	01	2.77	01	1.92
Boraginaceae	-	-	-	-	01	2.77	01	1.92
Plantaginaceae	-	-	-	-	01	2.77	01	1.92
Polygonaceae	-	-	-	-	01	2.77	01	1.92
Vertebae	-	-	-	-	01	2.77	01	1.92
Orobanchaceae	-	-	-	-	01	2.77	01	1.92
Sphinogomonadace-ae	-	-	-	-	01	2.77	01	1.92
Verbanaceae	-	-	-	-	01	2.77	01	1.92
Total	06		10		36		52	

Table 8. Number and Percentage contribution of aquatic weeds to their IUCN Read list (2024) at Meghadrigedda Reservoir

IUCN (2024)	Free floating		Submerged weeds		Emergent weeds	
	Total No.s	% contribution	Total No.s	% contribution	Total No.s	% contribution
LC	4	7.62	8	15.38	30	57.69
NE	2	3.84	2	3.84	5	9.61
VU	-		-		1	1.92

The 52 recorded aquatic weed species have been classified into 30 families, with Cyperaceae comprising seven species, or 13.46% of the total. Asteraceae contributed four (7.69%) species. Onagraceae, Amaranthaceae, and Commelinaceae each produced three (5.76%) species. Araceae, Hydrocharitaceae, Convolvulaceae, Typhaceae, Fabaceae, Scrophulariaceae, and Poaceae all have two (3.84%) species. Azollaceae, Pontederiaceae, Characeae, Ceratophyllaceae, Marsileaceae, Potamogetonaceae, Pteridaceae, Hythraceae. Euphorbiaceae, Eriocaulaceae, Molluginaceae, Boraginaceae, Plantaginaceae, Polygonaceae, Vertebae, Orobanchaceae, Sphinogomonadaceae, and Verbanaceae all contributed one species (2.77%). The similar study was conducted by an assessment of macrophyte diversity of a freshwater reservoir of Bhadrawati Tehsil in Chandrapur district, by

Shashikant R.Sitre [39]. Gokhele, et al. [40] conducted a survey on flora of wet coastal and associated ecosystem to Maharastra.

In the present study the total of 52 species of hydrophytes according to IUCN (2024) status of these 42 species of aquatic weeds are least concerned, 9 are not evaluate (NE), 1 species is vulnerable (VU). The least concerned of free floating weeds contributed 7.62%, 3.84% species are not evaluated. The submerged weeds 15.38% are least concerned and 3.84% species are not evaluated. In the emergent weeds 57.69%) are least concerned, 9.61%) are not evaluated and1.92% is vulnerable Table 8. Fig. 7. The similar study was observed by Rama Rao et al. [25] reported a total of 48 species of hydrophytes belonging to 4 classes, 20 orders and 26 families were studied. According to IUCN (2013.2) of these 35 species of aquatic weeds are least concerned, 12 are not evaluate (NE), 1 species is vulnerable (VU). In the free floating weeds, three species are least concerned (6.25%), two (4.17%) species are not evaluated. In the submerged weeds, eight species (16.67%) are least concerned and two (4.17%) species are not evaluated. In the emergent weeds 24 species (50%) are least concerned, eight (16.67%) are not evaluated; one (2.03%) is vulnerable [41].

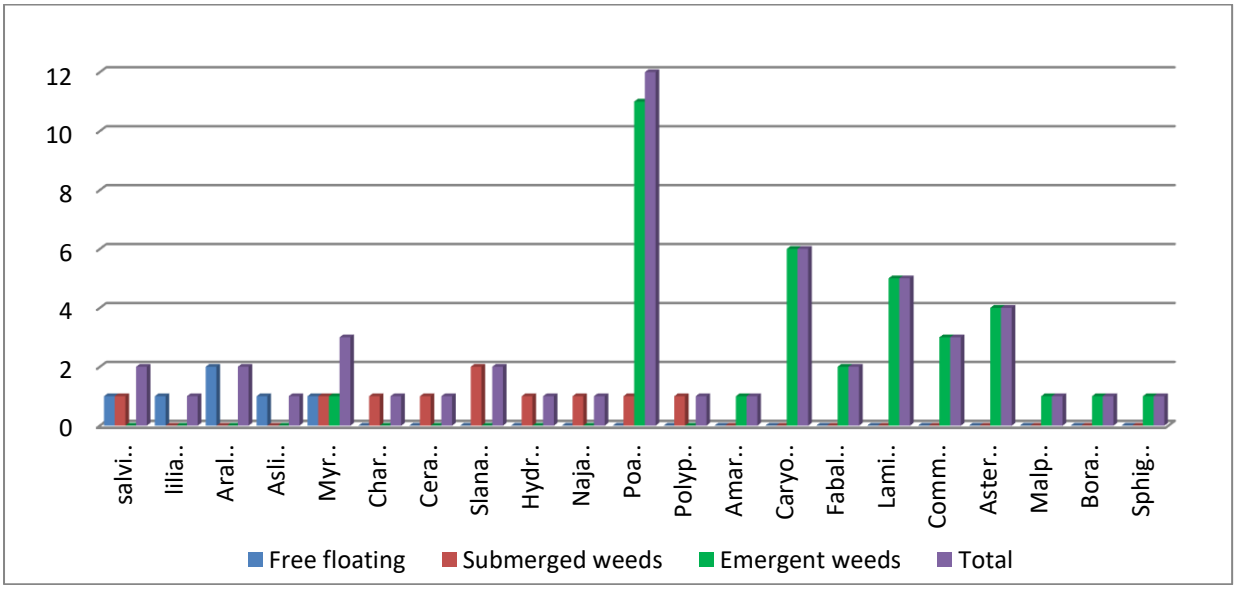

Fig 5. Percentage contribution of Macrophytes in Twenty one orders

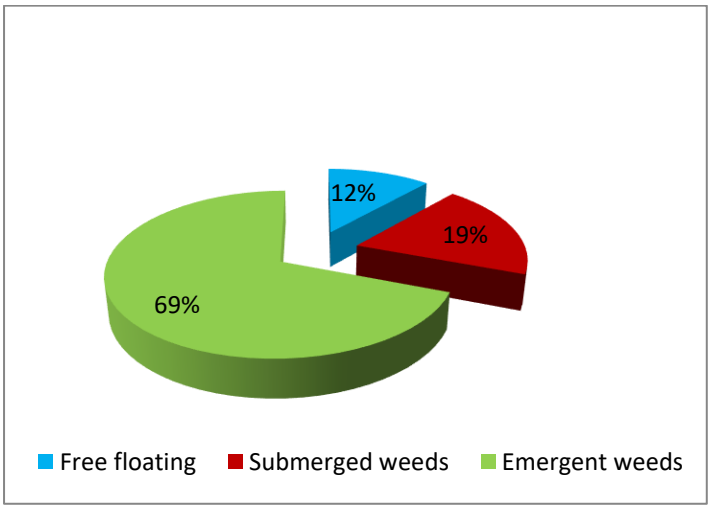

Fig. 6. Percentage contribution of Macrophytes

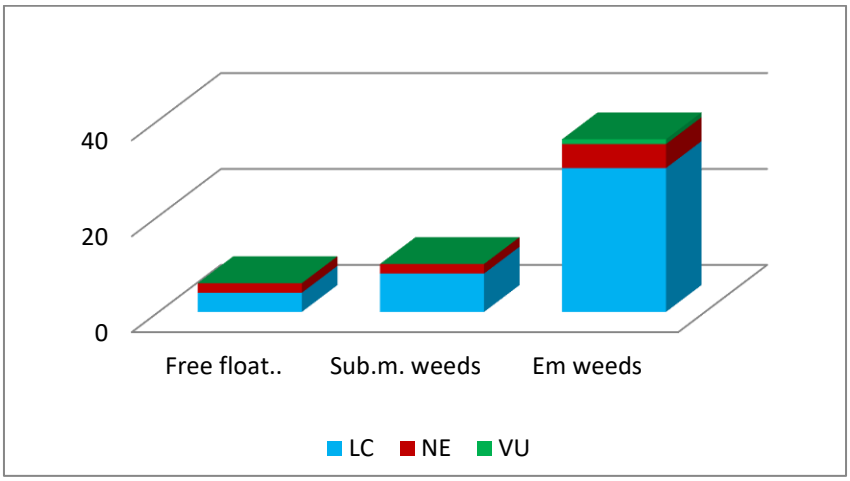

Fig. 7. IUCN Read list (2024)

4. CONCLUSION

The dominant weed species are *Ipomoea aquatic, Pistia aquatic, Marsilea quadrifolia, Ipomoea carnea, Typa domingenisis* were identified in Meghadrigedda Reservoir. The second dominance species are Commelina benghalensis, Ludwigia peploides, Ceratophyllum demersum, Alternanthera sessils and Cyprus rotundans. Very rare species are Ceratopteris thalictroides, Ludwigia adscendens, Eleocharis geniculate Phyla nodiflora (L) Green. As a consequence, exploiting and generating nutritious components from these plant products in the Reservoir is a fantastic choice for food and development, while also stimulating ecosystem restoration and encouraging an efficient and ecologically friendly feed formulation process. Despite this, the absence of defined laws and processes for employing aquatic plants in fish feed may be a barrier to both large-scale commercial deployment and market uptake.

ETHICAL APPROVAL

This study was conducted according to international ethical standards set by the Institutional Plant care and Use Committee

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Craig SR, Helfrich LA, Kuhn D, Schwarz MH. Understanding fish nutrition, feeds, and feeding. Virginia Tech. 2017;1-6.
2. Prabu E, Felix S, Felix N, Ahilan B, Ruby P. An overview on significance of fish nutrition in aquaculture industry. International Journal of Fisheries and Aquatic Studies. 2017;5(6):349-355.
3. Daniel N. A review on replacing fish meal in aqua feeds using plant protein sources. InternationalJournal of Fisheries and Aquatic Studies. 2018;6(2):164-179.
4. Ghosh T, Paul B, Chattopadhyay D, Mandal R. Duckweed (Lemna minor) as feedingredient for fingerlings of common carp (*Cyprinus carpio*); 2021.
5. Nandi SK, Suma AY, Rashid A, Kabir MA, Goh KW, Abdul Kari Z, Van Doan H, Zakaria NN, Khoo MI, Seong Wei L. The Potential of Fermented Water Spinach Meal as a Fish Meal Replacement and the Impacts on Growth Performance, Reproduction, Blood Biochemistry and Gut Morphology of Female Stinging Catfish (*Heteropneustes fossilis*). Life. 2023;13(1): 176.
6. Naseem S, Bhat SU, Gani A, Bhat FA. Perspectives on utilization of macrophytes as feedingredient for fish in future aquaculture. Reviews in Aquaculture. 2021;13(1):282-300.
7. Mandal S, Ghosh K. Utilization of fermented Pistia leaves in the diet of rohu, Labeo rohita(Hamilton): Effects on growth, digestibility and whole-body composition. Waste and BiomassValorization. 2019;10 (11):3331-42.
8. Akmal M, Hafeez-ur-Rehman M, Ullah S, Younus N, Khan KJ, Qayyum M. Nutritive value of aquaticplants of HeadBaloki on Ravi River, Pakistan. International Journal of Bio-science. 2014;4:115–122.

9. Naseem S, Bhat SU, Gani A, Bhat FA. Perspectives on utilization of macrophytes as feedingredient for fish in future aquaculture. Reviews in Aquaculture. 2021;13(1):282-300.
10. Ganguly A, Chatterjee PK, Dey A. Studies on ethanol production from water hyacinth—Areview. Renewable and Sustainable Energy Reviews. 2012;16(1): 966-972.
11. Jeopesen E, Søndergaard, M, Søndergaard M, Christoffersen K. (Eds.) The Structuring Role of Submerged Macrophytes in Lakes. Ecological Series. 1998;131:423.
12. Majid FZ. Aquatic Weeds –Utility and Development, Agro Botanical Publishers, India; 1986.
13. Wetzel RG. Limnology, W.B. Saunders Company, Philadelphia. 1975;743.
14. Meshram, C. B. Macro invertebrate fauna of lake Wadali, Amaravati, Maharashtra., J. Aqua. Biol. 2003;18(2):47 – 50.
15. Ambasht RS. Macrophytes limnology in the Indian subcontinent. Ukaaz Publication, Hyderabad. 2005:58-174.
16. Raut Nayana S, Pejaver Madhuri. Survey of diversity of plankton attached to macrophytes from weed infested lakes. J. Aqua. Biol. 2005;20(1):1 - 7.
17. Carpenter S R, Lodge D. M, Effects of submersed macrophytes on ecosystem processes. Aquatic Bot. 1986;26:341-370.
18. Cook CDK. Aquatic and wetland plants in India Oxford University press. London; 1996.
19. Biswas K, Calder LC. Handbook of common water and marsh plants of India and Burma, xvii 216, Bishensingh Mahendra palsingh [Dehradun]; 1984.
20. Naskar, K.R. Aquatic and Semi-aquatic Plants of the Lower Ganga Delta. Daya Publishing House, New Delhi; 1990.
21. Stromberg JC. Instream flow models for mixed deciduous riparian vegetation within a semiaridregion. Regulated rivers: Research and Management. 1993;8:225-235.
22. Singh NP, Karthikegan S. Flora of Maharashtra-I. Dicotyledones. Botanical Survey of India; 2000.
23. Singh NP, Karthikegan S. Flora of Maharashtra-II. Dicotyledones. Botanical Survey of India. 2001.
24. Adesina GO, Akinyemiju OA, Olaleye VF. Assessment of aquatic vegetation of Jebba Lake, Nigeria. African Journal of Ecology. 2007;45:365-373.
25. Rama Rao. K.,Ramakrishna. N, Amravati. D. Checklist of the Aquatic Macrophyte Flora Abundence In Lower Manair Dam At Karimnagar Dt. Andhra Pradesh, India. IOSR Journal of Environmental Science, Toxicology and Food Technology. 2014;8 (5):11-20.
26. Thomaz SM, Bini LM, Souza MC, Kita KK, Camargo. Aquatic Macrophytes of Itaipu Reservoir, Brazil: Survey of Species and Ecological Considerations. Braz Arch Biol.Techn.1999;42:15-22.
27. James e. Fulmer, T. Robinson. Aquatic Plant Species Distributions and Associations in Arizona's Reservoirs. J. Aquat. Plant Manage. 2006;46:100-106.
28. Patil VG, Khabade S.A, Khade S.K. Study of hydrophytes and amphibious plants occurred in Panchganga River in vicinity of Ichalkaranji city district Kolhapur, Maharashta. Ecology and Fisheries. 2012; 5(2):63-66.
29. Bandita Kumari Dalasingh, Sagarika Parida, Dipankar Bhattacharyay, Gyanranjan Mahalik. Diversified Hydrophytes in Different Aquatic Habitats of Puri District, Odisha, India. Advances in Zoology and Botany. 2019;7(3):53-60.
30. Das SK, Biswas D, Roy S. A study of hydrophytes in some lentic water bodies in West Bengal, India. ECOPRINT. 2009;16: 9–13.
31. Ayodhya Kshirsagar, Venkat R Gunale. Diversity of aquatic macrophytes from River Mula Pune City, MS, India. Science Research Reporter. 2013;3(1):09-14.
32. Olsen, S. Aquatic plants and hydrospheric factor, I. Aquatic plants in Switzerland, Arizona. J. Sevensk. Botanisk Tidskriff. 1950;44:1-34.
33. Spence, D.H.N. The macrophytes vegetation of lochs, swamps and associated fens. The vegetation of Scotland (Ed.: J.H. Burnett). Edinburgh. 1964:306-425.
34. Ambasht RS. Macrophytes limnology in the Indian subcontinent. Ukaaz Publication, Hyderabad. 2005;58-174.
35. Billore DK, Vyas IN. Distribution and production of macrophytes in pichhola lake, Udaipur. Dnt J Ecol Env-sci. 1981;7: 45-54.
36. Kiran BR, Patel AN, Kumar Vijaya, Puttaiah ET. Aquatic macrophytes in fish culture ponds at Bhadra fish farm,

Karnataka. J. Aqua.Biol. 2006;21(2):27–30.
37. Krull JN. Aquatic plant-invertebrate associations and waterfowl. Journal of Wildlife Management. 1970;34:707-718.
38. Madsen JD, PA. Chambers WF. James, E.W. Koch, D.F. Westlake. The Interactions between water movement, sediment dynamics and submersed macrophytes. Hydrobiologia. 2001;444:71-84.
39. Shashikant R. Sitre. Assessment of Macrophyte Bio-Diversity of a Freshwater Reservoir of Bhadrawati Tehsil in Chandrapur District. Online International Interdisciplinary Research Journal. 2013;3(3).
40. Gokhele MV, Shsikh SS, Chavan NS. Floaral survey of wet coastal and associated ecosystem to Maharastra. Indian journal of Geomarine Sciences. 2011;40(5):725-730.
41. Muhammad Anamul Kabir, Shishir Kumar Nandi1, Afrina Yeasmin Suma and Nik Shahman NikAhmad Ariff. Aquatic Weeds as Functional Ingredients for Aquaculture Feed: Recent Advances, Challenges, Opportunities, New Product Development (NPD), and Sustainability. AgricultureReports. 2023;2(2):1-16.

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