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Aquatic Plant Diversity of Lakes in Somwarapete Taluk, Kodagu, Karnataka

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The principal objective of the present research is to record data regarding the aquatic plants of Somwarapete taluk of Kodagu district. Three major lakes were selected for the study for a period of one year, i.e., June 2020–July 2021. A total of 43 species were recorded, belonging to 28 families and 41 genera. The most dominant families were found to be Araceae, Hydrocharitaceae, Asteraceae, and Amranthaceae. After initial identification, the plants were classified according to their habitats, life spans, and IUCN status. Jaccard's index and Sorenson's index were used to learn about the similarity coefficient between the sample sites. We divided plants in accordance with their IUCN status and found them to be endangered, threatened, and under the category of least concern. The work was undertaken because no documented data is available for the aquatic macrophytes of Somwarapete taluk.

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1. INTRODUCTION

Western ghats are one of the global hotspots of biodiversity with a high population status [1]. The stretch of western ghats runs for approximately 1600 km with area coverage of about 1,64,000 Km^2. The altitude ranges from 300-2700 mtrasl [2].

Lakes play a major role in human lives by contributing to restoring the water table [3]. Wetlands are the most diverse yet most threatened ecosystems in the world [4]. The aquatic systems are an integral property of rural people's life activities and are much more sensitive to eutrophication due to anthropogenic activities. In the present scenario, lakes are under the threat of qualitative and quantitative pollutants from different sources [5].

Aquatic plants are a significant source of food, fodder, and herbal medicine for people living near water bodies [6]. Wetlands play a significant role in achieving Sustainable Development Goals [SDG] in ecosystems and their biodiversity. However, this goal is curtailed by the threats faced by the wetland ecosystem due to human intervention [7]. Moreover, wetlands also face issues with factors like eutrophication, sedimentation, encroachment, pollution, and climate change [8].

In accordance to all this strict planning sustainable development has been a major concern in recent times. It is very much important to have a depository of information on aquatic macrophytes. For example, no written documentation is available on the aquatic floristics of Somwarapete taluk. Hence, this study was undertaken to understand the plant diversity of the area, and 3 major lakes were selected as the study area for the same.

2. MATERIALS AND METHODS

2.1 Study Area

Kodagu district is situated on the eastern and western slopes of the Western Ghats, carpeted with lush green forests, plantations, and cultivated valleys. Geographically, it lies on the southwestern border of Karnataka State and geologically it is situated in the southwestern art of the Western Dharwar Craton [WDC]. Kodagu district is considered as the smallest district in Karnataka state and covers an area of 4,102 Sq.km. The district is bounded by latitudes 110 56' – 120 52' N and longitudes 720 22'-760 12'E. The study area lies between North latitude 120 19'17'' and 120 43' 36'' and East longitude 750 22' 29'' and 760 19' 15'' Somwarapete is one of the taluks of Kodagu district with an area of 4102 square kilometers.The area of research carried out lies at a latitude of 12.5943°N and 75.8505°E (Fig. 1).

Three lakes were studied in this area (Fig. 2).

Fig. 1. Map of Kodagu district
[Source: Google images]

Fig. 2. Lake 1 - Tavarekere, Lake 2- Dodda kere, Lake 3 - Honnamana Kere
[Image source: Google maps]

2.2 Methods of Data Collection

All lakes were visited regularly during the period of study. Aquatic plants were collected and photographed [Canon EOS 1500D] in their natural habitat. Collected plants were brought to the laboratory for identification using standard references like Flora of Udupi [9], Flora of Madras [10], and Flora of Hassan [11].

2.3 Analysis of Collected Data

From the collected specimens, information like habitat, family name, life span, and IUCN category are tabulated for further analysis.

Collected plants are pressed under newspapers for herbarium preparation. These plants were then classified based on their life span, family, and morphological characteristics. They were also divided into different categories according to their habitats i.e. free floating, submerged, emergent, and rooted macrophytes.

Jaccard's Similarity Index [JSI] was applied and analyzed [12].

Sj=a/[a+b+c]

Where, Sj=Jaccard's similarity coefficient
a=Number of species in sites A and B.
b=Number of species absent in A but present in B
c=Number of species present in A but absent in C.

The above plant data was also analyzed by **Sorenson's Similarity coefficient** [SSc] [13].

Sc=2a/[2a+b+c]

Where, Sc=Sorenson's Similarity coefficient.

a=Number of species in sites A and B.
b=Number of species absent in A but present in B.
c=Number of species present in A but absent in C.

3. RESULTS AND DISCUSSION

A total of 43 species of aquatic macrophytes have been reported from three study areas. 43 species are represented by 41 genera belonging to 28 families. Out of these, 40 species were Angiosperms, 2 were Pteridophytes and 1 was an Algae (Fig. 3).

Amongst Angiosperms, 13 species were monocotyledons, belonging to 13 genera and 5 families. The dicots were 28 species belonging to 13 families. 23 out of 43 species are annuals and 20 are perennials (Fig. 7). The IUCN status of the plants is as follows, 1 Endangered, 2 Threatened, 39 Least Concerned, and 1 is Not Evaluated (Fig. 4).

Out of the 43 species, 41 are represented by single genera, and 2 are represented by 2 species each. Araceae was the most occurring family with 5 genera and 5 species, followed by Hydrocharitaceae and Asteraceae with 4 genera and 4 species each. Amaranthaceae is represented by 3 genera and 3 species. Potamogataceae is represented by 1 genus and 2 species, followed by Salviniaceae, Nympheaceae, and Poaceae with 2 genera and 2 species each. The rest of other species belong to families like Commelinaceae, Acanthaceae, Typhaceae, etc. (Table 1) (Fig. 5).

Lake 1 has the highest number of species [14], followed by lake 3 [4] and lake 2 with A total of 79% of plants confined to lake 1, followed by lake 3 with 41.8% and lake 2 with 39.5%. In lake 1 the monocots were 10 species, dicots 21 species, Algae 1 species, and Pteridophytes were 2 species. Lake 2 had 4 monocot species, 11 dicot

species, 1 Algal species, and 1 Pteridophyte species. Lake 3 had 4 species of monocots, 14 species of dicots, and 1 species of Algae (Fig. 6).

Lake 1 had exclusive plants like *Acemella uliginosa, Alternathera sessilis, Alternathera triandra, Amaranthus spinosus, Hydrilla sp., Lemna minor, Hygrophila auriculata, Elodea canadensis, Pennisetum polystachion.* Lake 2 had plants like, *Vallisneria spiralis, Pistia stratiotes, Oxalis corniculata, Najas graminea, Leucas aspera* .Lake 3 had plants like *Monochoria vaginalis, Nuphar lutea, Utricularia aurea, Nymphoides indica, Baldellia ranunculoides, Colocasia esculenta , Glyceria maxima* (Table 3).

A high number of Hydrocharitaceae were reported by Lakshman and Gathi, in their work on wetlands in Tamilnadu [15]. Badole et al. [2021] have reported a high number of Hydrocharitaceae followed by Poaceae, and Asteraceae with their work in the Gonidia district, Maharastra [6].

Macrophyte diversity will be influenced by the morphometry of the lake. External factors like the availability of light underwater act as a controlling factor in macrophyte growth [16].

On the calculation of Jaccard's Similarity Index, Lakes 2 and 3 showed a high degree of similarity with 44%, followed by Lakes 1 and 2 with 34% and Lakes 1 and 3 with 22% (Table 4). Sorenson's Similarity Index also similar results with lakes 2 and 3 with 61% similarity, followed by lakes 1 and 2 with 47% and lakes 1 and 3 with 36% (Table 5).

Table 1. List of families and genera with their species distribution

Srl. No	Categories	No. Of families
1	Families with 1 species	21
2	Families with 2 species	4
3	Families with 3 species	1
4	Families with 4 species	2
5	Families with 5 species	1
6	Genera with 1 species	40
7	Genera with 2 species	1

Table 2. List of plants with their availability in each lake [Lake 1 - Tavarekere, Lake 2- Dodda kere, Lake 3- Honnamma kere]

Srl. no	Plant name	Lake 1	Lake 2	Lake 3
1.	*Acemella uliginosa*	+	-	-
2.	*Alternathera sessilis*	+	-	-
3.	*Alternathera triandra*	+	-	-
4.	*Amaranthus spinosus*	+	-	-
5.	*Azolla pinnata*	+	+	-
6.	*Baldellia ranunculoides*	-	-	+
7.	*Bidens pilosa*	+	+	+
8.	*Ceratophyllum demersum*	+	+	-
9.	*Chara deliculata*	+	+	-
10.	*Colocasia esculenta*	-	+	+
11.	*Commelina erecta*	+	-	+
12.	*Eclipta prostrata*	+	+	-
13.	*Elodea canadensis*	+	-	-
14.	*Glyceria maxima*	+	-	+
15.	*Hydrilla* sp	+	-	-
16.	*Hygrophila auriculata*	+	-	-
17.	*Hymenocallis littoralis*	+	+	+
18.	*Hypericum elodea*	-	+	+
19.	*Ipomea aquatica*	-	+	+
20.	*Lemna minor*	+	-	-
21.	*Leucas aspera*	-	+	+
22.	*Monochoria vaginalis*	+	-	+

Srl. no	Plant name	Lake 1	Lake 2	Lake 3
23.	*Najas graminea*	-	+	+
24.	*Nelumbo nucifera*	+	-	+
25.	*Neptunia oleracea*	-	-	+
26.	*Nuphar lutea*	+	-	+
27.	*Nymphea nouchalli*	-	+	+
28.	*Oxalis corniculata*	+	+	+
29.	*Pennisetum polystachion*	+	-	-
30.	*Persicaria amphibica*	+	+	-
31.	*Pimpinella* sp	+	-	-
32.	*Pistia stratiotes*	+	+	-
33.	*Potamogeton gramineus*	+	-	-
34.	*Potamogeton natans*	+	-	-
35.	*Ranunculus reniforms*	-	+	+
36.	*Rotala* sp	+	-	-
37.	*Salvinia* sp	+	-	-
38.	*Spirodella* sp	+	-	-
39.	*Tridex procrumbens*	+	+	+
40.	*Typha domingensis*	+	-	-
41.	*Utricularia aurea*	+	-	+
42.	*Vallisneria spiralis*	+	+	-
43.	*Wolffia globosa*	+	-	-

Table 3. List of plants with family, habitat, lifespan, and IUCN status

Srl.No	Plant name	Family	Habitat	Lifespan	IUCN status
1.	*Acemella uliginosa*	Asteraceae	Emergents	Annual	LC
2.	*Alternathera sessilis*	Amaranthaceae	Emergent	Annual	LC
3.	*Alternathera triandra*	Amaranthaceae	Emergents	Perennial	LC
4.	*Amaranthus spinosus L.*	Amaranthaceae	Emergent	Annual	LC
5.	*Azolla pinnata*	Salviniaceae	Free floating	Annual	LC
6.	*Baldellia ranunculoides*	Allistamataceae	Rooted	Annual	Threatend
7.	*Bidens pilosa*	Asteraceae	Emergents	Perennial	LC
8.	*Ceratophyllum demersum*	Ceratophyllaceae	Free floating	Annual	LC
9.	*Chara deliculata*	Characeae	Submerged	Annual	LC
10.	*Colocasia esculenta*	Araceae	Emergents	Annual	LC
11.	*Commelina erecta*	Commelinaceae	Emergent	Perennial	LC
12.	*Eclipta prostrata*	Asteraceae	Emergents	Annual	LC
13.	*Elodea canadensis*	Hydrocharitaceae	Submerged	Perennial	LC
14.	*Glyceria maxima*	Poaceae	Emergents	Perennial	LC
15.	*Hydrilla* sp	Hydrocharitaceae	Submerged	Perennial	LC
16.	*Hygrophila auriculata*	Acanthaceae	Emergents	Annual	LC
17.	*Hymenocallis littoralis*	Amaryllidaceae	Free floating	Perennial	NE
18.	*Hypericum elodea*	Hypericaceae	Free floating	Perennial	LC
19.	*Ipomea aquatica*	Convolulaceae	Free floating	Perennial	LC
20.	*Lemna minor*	Araceae	Free floating	Annual	LC
21.	*Leucas aspera*	Lamiaceae	Emergent	Annual	LC
22.	*Monochoria vaginalis*	Pontederiaceae	Submerged	Annual	LC
23.	*Najas graminea*	Hydrocharitaceae	Submerged	Annual	LC
24.	*Nelumbo nucifera*	Nelumbonaceae	Free floating	Perennial	LC
25.	*Neptunia oleracea*	Fabaceae	Free floating	Perennial	LC
26.	*Nuphar lutea*	Nymphaceae	Free floating	Perennial	LC
27.	*Nymphoides indica*	Menyanthaceae	Free floating	Perennial	LC
28.	*Oxalis corniculata*	Geraniaceae	Rooted	Annual	LC
29.	*Pennisetum polystachion*	Poaceae	Emergent	Perennial	LC
30.	*Persicaria amphibica*	Polygonaceae	submerged	Perennial	LC

Srl.No	Plant name	Family	Habitat	Lifespan	IUCN status
31.	*Pimpinella* sp	Apiaceae	Emergent	Annual	Endangerd
32.	*Pistia stratiotes*	Araceae	Free floating	Perennial	LC
33.	*Potamogeton gramineus*	Potamogetonaceae	Submerged	Perennial	LC
34.	*Potamogeton natans*	Potamogetonaceae	Submerged	Annual	LC
35.	*Ranunculus reniforms*	Dilleniaceae	Emergents	Annual	LC
36.	*Rotala* sp	Lythraceae	Emergent	Annual	Threatend
37.	*Salvinia* sp	Salviniaceae	Free floating	Annual	LC
38.	*Spirodella* sp	Araceae	Free floating	Annual	LC
39.	*Tridex procrumbens*	Asteraceae	Emergent	Perennial	LC
40.	*Typha domingensis*	Typhaceae	Emergent	Perennial	LC
41.	*Utricularia aurea*	Lentibulariaceae	Free floating	Perennial	LC
42.	*Vallisneria spiralis*	Hydrocharitaceae	Submerged	Perennial	LC
43.	*Wolffia globosa*	Araceae	Free floating	Perennial	LC

Table 4. Jaccard's Similarity Index

I			
II	11/[11+7+17]=0.31		
III	10/[10+24+11]= 0.22	11/[11+7+7]=0.44	
Lakes	Lake I	Lake II	Lake III

Table 5. Sorenson's Similarity Index

I			
II	22/[22+7+17]=0.47		
III	20/[20+24+11]=0.36	22/[22+7+7]= 0.611	
Lakes	Lake I	Lake II	Lake III

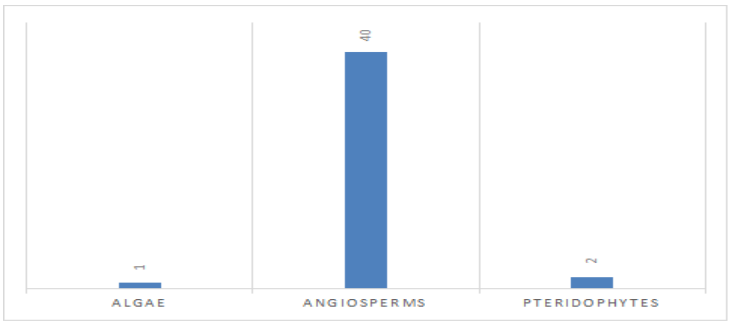

Fig. 3. Classified distribution of aquatic plants

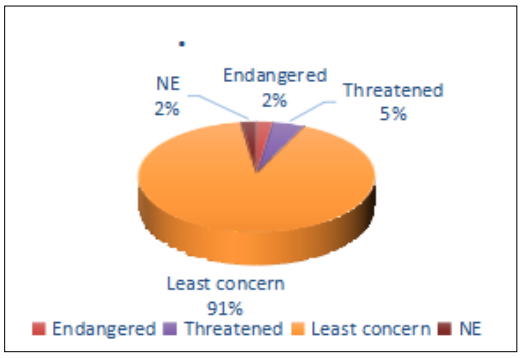

Fig. 4. Distribution of macrophytes according to their IUCN status

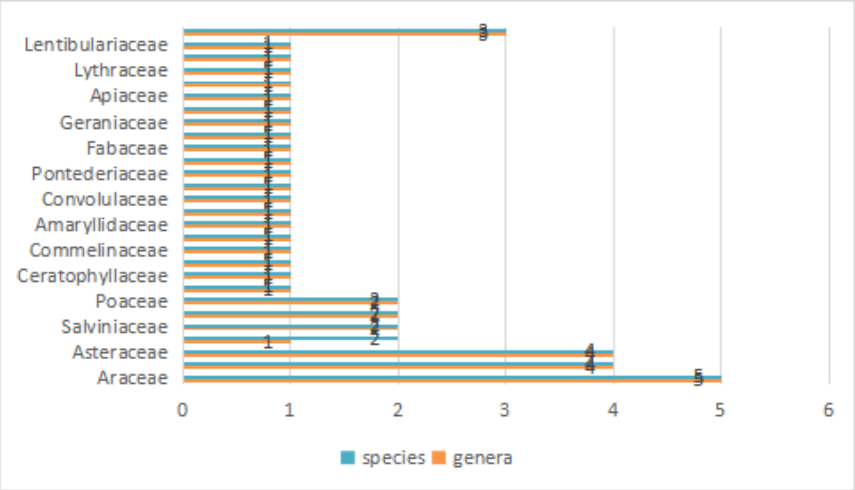

Fig. 5. Data on Families with the number of genera and species

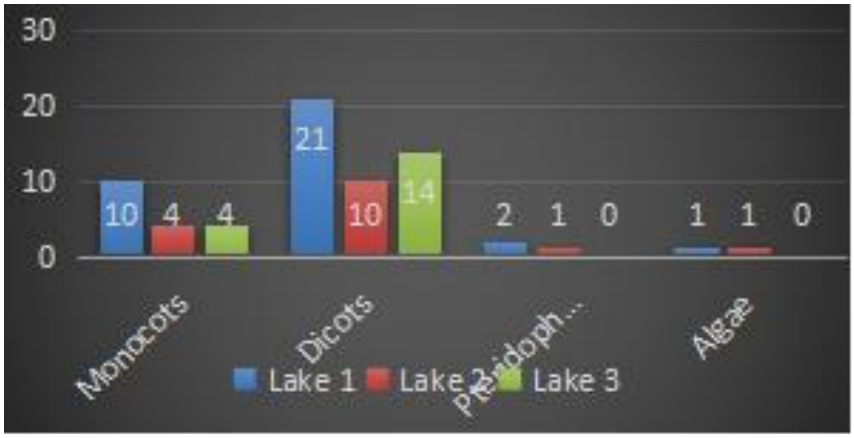

Fig. 6. Distribution of aquatic plants in each of the study area

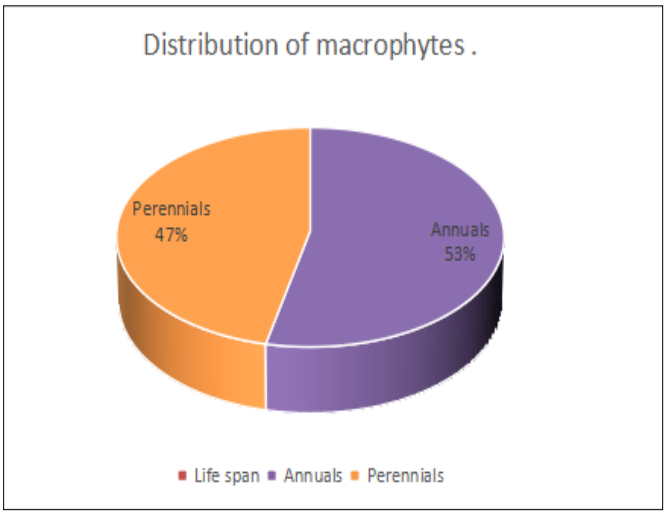

Fig . 7. Distribution of macrophytes according to their life span

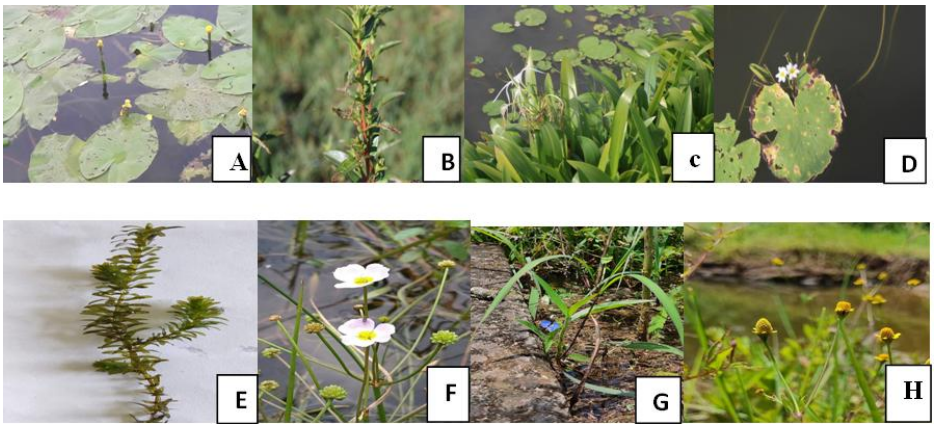

Fig. 8. Some macrophytes from the study area

A. Nuphar lutea, B. Hygrophila auriculata, C. Hymenocallis littoralis, D. Nymphoides indica, E. Elodea canadensis, F. Baldellia ranunculoides, G. Commelina erecta, H. Bidens pilosa

Macrophytes not only contribute as major primary producers, but they also take part in biomineralization, transpiration, cycling of nutrients, and sedimentation [17]. Studies have found that macrophytes enhance the stability of the shores of lakes [18]. They are the supporters of epiphytic algae, zooplanktons, and fishes [19]. They are also good bioindicators to understand the health of water body [20].

The population and variety of macrophytes mainly depend on factors like climate, substrate, hydrology, and nutrients [21]. The other factors that contribute include pH, water velocity, conductivity, gas saturation, light regime, and temperature [6,22].

Anthropogenic activities are heavily weighing in on aquatic ecosystems [23,24]. Macrophytes are threatened due to both anthropogenic and climatic factors, like physical destruction, physicochemical transformation, pollution, and Invasion of alien species [3,25]. Activities of urbanization and human recreation have led to decreasing in macrophytic diversity [26-33]. Therefore, proper monitoring, management, and control measures are required for the growth and conservation of macrophytes.

4. CONCLUSION

Aquatic macrophytes are a heterogeneous group of plants and algae that contributes significantly to the ecosystem. They play an important role in both structural and functional aspects of aquatic ecosystems by influencing the hydrobiological regime, food chain, and water quality of an aquatic ecosystem. The present study is a compilation of aquatic macrophytes from selected lakes of Somawarapete taluk of Kodagu district. The study was carried out to document the macrophytes which can be further as an authenticated baseline for further exploration and conservational studies of the local biodiversity.

Along the study it was found that the species variation is mainly due to the changing pH, Nitrogen and Phosphorous concentration of studied water bodies. Even factors like eutrophication and sewage disposal has played a major role in providing species diversity across these 3 lakes. A total of 43 species representing 29 families were recorded. The IUCN status and lifespans are also recorded. The study areas were clear without any invasive species. With this study, it is concluded that floristic aquatic diversity is a very important component in conserving the biodiversity of wetland.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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