Original Research Article

AQUATIC PLANT DIVERSITY OF LAKES IN SOMWARAPETE TALUK, KODAGU, KARNATAKA.

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 to28 families28 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. The Jaccard's index and Sorenson's index were used to learn about the similarity coefficient between the sample sites.We divided plants in accordance to 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.

Key words: Western ghats, Kodagu, Aquaticmacrophytes, Jaccards index, Sorenson's index.

INTRODUCTION:

Western ghats is one of the global hotspots of biodiversity with a high population status(Cinchotta *et al*.,2000). The stretch of western ghats runs for approximately 1600 km with aan area coverage of about 1,64,000km^2.The altitude ranges from 300-2700 mtr asl(Ray *et al*.,2016).

Lakes play a major role in human lives by contributing in restoring the water table(Aher *et al*.,2016). Wetlands are most diverse yet most threatened ecosystems in the world(Murphy *et al*.,2006).The aquatic systems are an integral property of rural people's life activities, Hencehence are much sensitive to eutrophication due to anthropogenic activities.In the present scenario lakes are under the threat of qualitative and quantitative pollutants from different sources(Xia *et a*l.,2016).

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Aquatic plants are a major source of food, fodder and herbal medicine for people living near the water bodies (Badole *et al.*,2021~~).Wetlands~~). Wetlands play a major role in ~~achiveing~~achieving the Sustainable Development Goals(SDG's) in ~~realtion~~relation to ecosystems and their biodiversity.However, this goal is curtailed by the threats faced by the wetland ecosystem due to human intervention (Gibbs, 2000). Moreover, wetlands also face issues by factors like eutrophication, sedimentation, encroachment, pollution and, climate change (Sharma *et al.*,2005).

In accordance ~~to~~ withall this strict planning ~~with a biodiversity friend~~biodiversity-friendly~~ly~~ development has to be a major concern of 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 being undertaken to understand the plant diversity of the area, and 3 major lakes were selected as study area for the same.

MATERIALS AND METHODS:

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 south-western border of Karnataka State and geologically it is situated in the south western part 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 taluk of Kodagu district with an area of 4102 square kilometer.The area of research carried out lies at a latitude of 12.5943°N and 75.8505°E (Fig 1)

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Fig 1: Map of Kodagu district (Source: Google images)

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

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

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(Bhat,2003), Flora of Madras(Gamble,1914, 2016) and Flora of Hassan(Saldanha, 2007).

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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 characters.They were also divided into different categories according to their habitats i.e. free floating, submerged, ~~emergents~~emergent and rooted macrophytes.

Jaccard's Similarity Index(JSI) was applied and ~~analysed~~analyzed(Jaccard, 1912)

Sj=a/(a+b+c)

Where, Sj=Jaccard's similarity coefficient

a=Number of species in site 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 analysed by **Sorenson's Similarity coefficient** (SSc)(Sorenson, 1948)

Sc=2a/(2a+b+c).

Where, Sc=Sorenson's Similarity coefficient.

a=Number of species in site 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.

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RESULTS AND DISCUSSION:

A total of 43 species of aquatic macropytes 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. 23out of 43 species are annuals and 20 are perenials(Fig 7).

Out of the 43 species, 23 were annuals and 20 were perennial plants(Fig -). The IUCN status of the plants are 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 with 2 species each.Araceae was the most ~~occuring~~occurring family with 5 genera and 5 species, followed by Hydrocharitaceae and Asteraceae with 4 genera and 4 species each. Amaranthaceae is represented with 3 genera and 3 species. Potamogataceae is represented with 1 genera and 2 species, followed by Salviniaceae, Nympheaceae and Poaceae with 2 genera and 2 species each. Rest other species belong to families like, Commelinaceae, Acanthaceae, Typhaceae etc(Table 1)(Fig 5).

Lake 1 has highest number of species (34), followed by lake 3 with (18) and lake 2 with (17). A total of 79% plants were confined to lake ~~1, followed~~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 ,~~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,*

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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,(2018) with their work on wetlands in Tamilnadu. Badole *et al*.,(2021) have reported high number of Hydrocharitaceae followed by Poaceae , Asteraceae with their work in Gonidia district, Maharastra.

Macrophyte diversity will be influenced by the morphometry of the lake. The external factors like availability of light underwater also acts as a controlling factor in macrophyte growth(Hudon *et al*.,2006).

On calculation of Jaccard's Similarity Index, lake 2 and 3 showed high degree of similarity with 44%, followed by lake 1 and 2 with 34% and lake 1 and 3 with 22% (Table 4). Sorenson's Similarity Index also similar result with lake 2 and 3 with 61% similarity, followed by lake 1 and 2 with 47% and lake 1 and 3 with 36% (Table5).

Table X. ???

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

Srl.no	Plant name	Lake 1	Lake 2	Lake 3

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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*	+	-	+
23.	*Najas graminea*	-	+	+

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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 2 : List of plants with their availabilty in each lake.

(Lake 1 - Tavarekere: , Lake 2- Dodda kere, Lake 3- Honnamma kere.

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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	Threatened
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

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

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 4: Jaccard's Similarity Index.

I			
II	22/(22+7 +17)=0.4 7		
III	20/(20+2 4+11)=0.	22/(22+ 7+7)=	

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	36	0.611	
Lakes	Lake I	Lake II	Lake III

Table 5: Sorenson's Similarity Index.????

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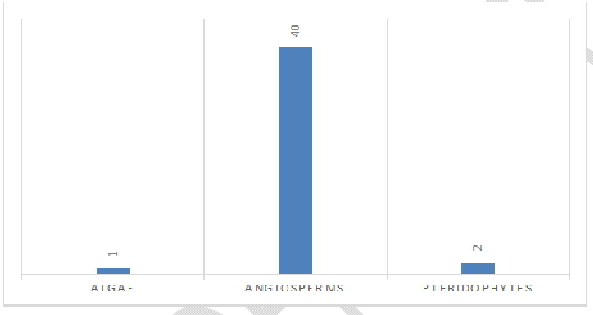

Fig 3 ; Distribution of aquatic plants

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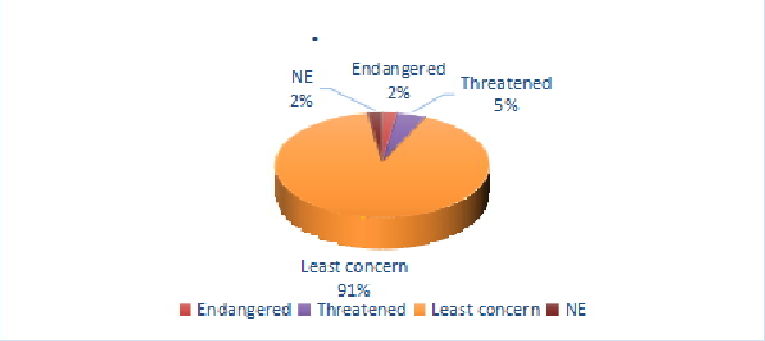

Fig 4; Distribution of macrophytes according to their IUCN status.

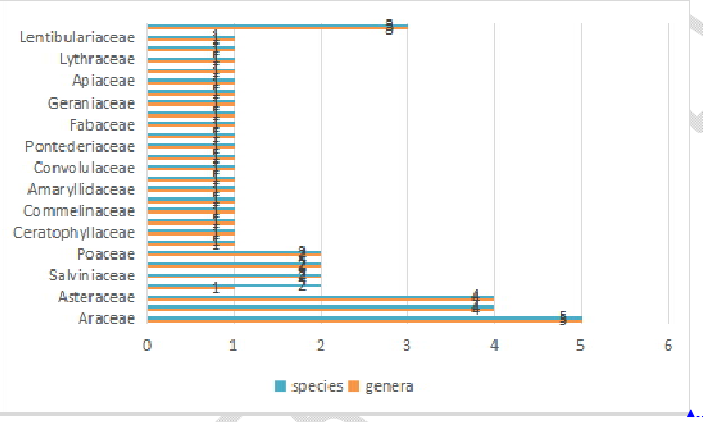

Fig 5 : Data on Families with number oF genera and species.

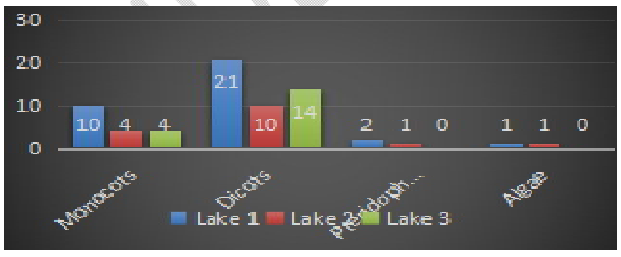

Fig 6; Distribution of aquatic plants in each of the study area.

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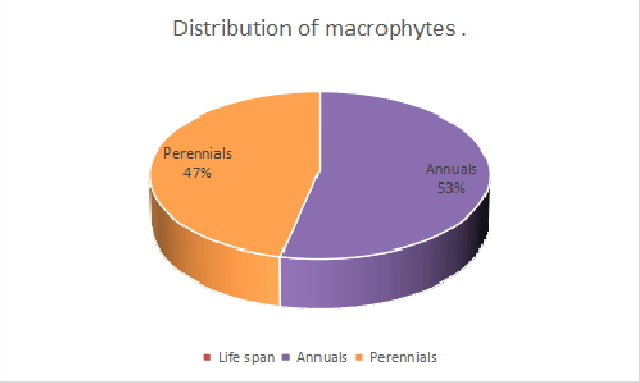
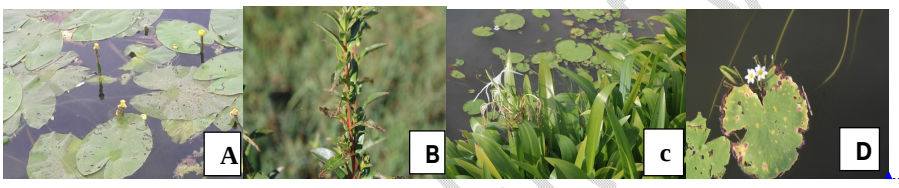


Fig;7; Distribution of macrophytes according to their life span.



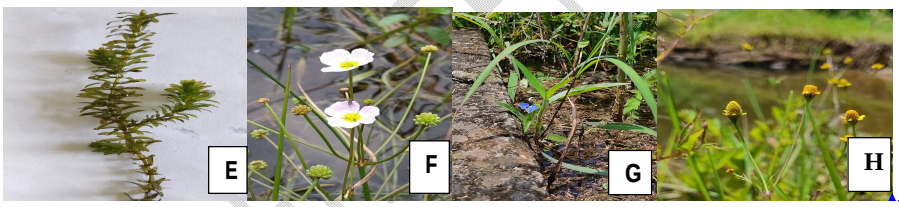


Fig 8; Some macrophytes from study area.

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

I continue to add a paragraph that summarizes the importance, usefulness and social relevance, contemporary of the study, specifically pointing out the Impact, Benefit and Social Projection, something like this (for example):

Aquatic plant diversity plays an important role in maintaining the ecological balance and biodiversity of aquatic ecosystems. The study of aquatic plant diversity is crucial for understanding the distribution, composition, and productivity of aquatic flora in different

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environments (Casana and Olivares, 2020; Guevara et al. 2012; Orlando and Franco, 2015; Rodriguez et al. 2015; Olivares and López, 2019).

The marine environment, together with the atmosphere, plays a fundamental role in regulating the temperature on the planet (Medina Contreras et al. 2018; Casana and Olivares, 2020). Among other environmental factors, the temperature conditions in the different regions of the Earth allow the existence of a great diversity of climates and a high variety of ecosystems and organisms (Olivares and Hernández, 2019). Temperature is a particularly important factor in life processes and in the distribution of species, which are greatly affected when their habitats are altered. Although throughout its 4.6 billion years, the Earth has undergone great variations in its climates (Olivares et al. 2018; Olivares, 2018; Olivares and Zingaretti, 2019), global warming is currently occurring much faster than expected. The results of the numerous scientific investigations that have been carried out in recent years (Olivares and Zingaretti, 2018), allow us to say that the activities generated by man are largely responsible for this increase in temperature, especially carbon dioxide emissions. Carbon results from the burning of fossil fuels, and other greenhouse gases into the atmosphere (Yang et al. 2011; Hayasaka et al. 2012).

The results of the study showed that the aquatic plant diversity of lakes in Somwarapete Taluk was high, with a total of 43 plant species belonging to 28 families identified in the study area. The most dominant families were Poaceae, Cyperaceae, and Araceae. The species richness and diversity of aquatic plants were positively correlated with water depth, dissolved oxygen, and pH. The results suggest that the presence of these factors contributes to the growth and distribution of aquatic plants in the lakes.

The soil analysis revealed that the lakes in Somwarapete Taluk had sandy loam soil with a neutral pH (Rey et al. 2022; Orlando et al. 2023). The soil was found to be rich in nitrogen, phosphorus, and potassium, which are essential nutrients for plant growth (Araya-Alman et al. 2020; Hernandez et al. 2020). The results suggest that the nutrient-rich soil contributes to the growth and distribution of aquatic plants in the lakes.

The climatic factors, including temperature (Guevara et al. 2013), rainfall (Rodriguez et al. 2013; Cortez et al. 2016; Orlando et al. 2017), and humidity (Orlando et al. 2013; Cortez et al. 2018),

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were found to have a significant impact on the aquatic plant diversity of the lakes. The study found that the species richness and diversity of aquatic plants were positively correlated with rainfall and humidity. However, there was no significant correlation between temperature and aquatic plant diversity.

In conclusion, the study showed that the aquatic plant diversity of lakes in Somwarapete Taluk is influenced by a combination of factors, including water depth, dissolved oxygen, pH, soil properties, and climatic factors. The results of the study suggest that the maintenance of a healthy aquatic ecosystem requires the management of these factors. The study provides valuable insights into the importance of aquatic plant diversity in maintaining the ecological balance and biodiversity of aquatic ecosystems in tropical environments.

CONCLUSION~~:~~

The present study is a compilation of aquatic macrophytes from selected lakes of Somawarapete taluk of Kodagu district. The study was carried out with an objective of documenting the macrophytes which can be further as ~~a~~an authenticated baseline for further exploration and conservational studies of the local biodiversity. A ~~totyal~~total of 43 species representing 29 families were recorded. The IUCN status, 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 wetlands.

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I suggest the authors update the bibliography, many of the citations are more than 15 years old, therefore I suggest adding recent references which address the issue in question. Suggested citations are for genuine scientific reasons that emphasize the current topic of study in context

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