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FLORISTIC STUDIES ON AQUATIC ANGIOSPERMS OF AKKULAM LAKE, THIRUVANANTHAPURAM

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Abstract

Aquatic angiosperms constitute an essential component of freshwater ecosystems, playing a crucial role in maintaining ecological balance, nutrient cycling, and providing habitat for aquatic fauna. The present study was undertaken to document and analyze the floristic diversity of aquatic angiosperms in Akkulam Lake, a prominent brackish water ecosystem located in Thiruvananthapuram district, Kerala. Systematic field surveys were carried out along different zones of the lake, including shallow margins, submerged regions, and marshy areas. The collected specimens were identified using standard floras and taxonomic keys. A total of 19 species of aquatic angiosperms belonging to 15 families were recorded, comprising free floating, submerged, and emergent life forms. The predominance of species such as *Eichhornia crassipes*, *Ipomoea aquatica* and *Nymphaea nouchali* indicates the eutrophic nature of the lake. The study highlights the ecological significance of aquatic macrophytes and their role as bioindicators of water quality. The findings provide baseline data for future ecological monitoring, conservation planning, and sustainable management of the Akkulam lake ecosystem.

Keywords: Aquatic angiosperms; hydrophytes, floristic diversity, wetland vegetation, Akkulam lake, emergent macrophytes, submerged plants; free floating species, eutrophication

INTRODUCTION

Aquatic angiosperms, also referred to as hydrophytes or aquatic macrophytes, are vascular plants that have adapted to grow in aquatic habitats either partially or completely submerged. They represent a specialized group of plants that play an important role in aquatic ecosystems by stabilizing sediments, regulating nutrient dynamics, enhancing oxygen levels, and serving as primary producers in food webs. Furthermore, they provide shelter and breeding grounds for a wide range of aquatic organisms, including fish, insects, and amphibians.

The study of aquatic angiosperms is particularly significant in freshwater and brackish ecosystems, as these plants serve as reliable bioindicators of ecological health. Excessive growth of certain macrophytes, often driven by eutrophication, can lead to ecological imbalance, while their decline may indicate pollution, habitat destruction, or hydrological changes. Thus, floristic surveys of aquatic angiosperms are essential for ecological monitoring and biodiversity conservation.

Akkulam Lake, situated in Thiruvananthapuram district of Kerala, is a brackish-water lake connected to Veli Lake and ultimately to the Arabian Sea through a narrow channel. The lake, surrounded by dense human settlements and subjected to multiple anthropogenic pressures, serves as a recreational center and a part of the backwater system of Kerala. Over the years, Akkulam Lake has been exposed to increased pollution load from urban runoff, sewage discharge, and encroachment, resulting in habitat modification and proliferation of invasive aquatic weeds.

Despite its ecological and socio-economic importance, floristic documentation of aquatic angiosperms in Akkulam Lake remains limited. Previous studies in Kerala have highlighted the diversity of aquatic plants in wetlands and rivers, but site-specific investigations of urban lakes like Akkulam are comparatively scarce. A comprehensive floristic study is necessary not only to catalog the aquatic angiosperm diversity but also to evaluate their ecological status and management implications.

The present investigation was therefore carried out with the objectives of:

1. Documenting the aquatic angiosperms occurring in Akkulam Lake
2. Analyzing their distribution across different aquatic habitats (floating, submerged, emergent)
3. Assessing their ecological significance and potential as bioindicators of lake health

This study is expected to provide baseline information on the aquatic flora of Akkulam Lake, contributing to the broader understanding of wetland biodiversity in Kerala and aiding in conservation and management strategies for sustainable utilization of lake ecosystems.

MATERIALS AND METHODS

Study area

The study was conducted in Akkulam Lake, located in Thiruvananthapuram district, Kerala (8°32′–8°34′ N latitude and 76°53′–76°55′ E longitude). It is a brackish-water lake that forms part of the Veli Akkulam backwater system and is connected to the Arabian Sea through a narrow channel. The lake receives inflow from the Killi and Amayizhanchan streams and is surrounded by marshy wetlands, residential areas, and recreational sites. The lake covers with varying depths and ecological zones such as shallow margins, open-water regions, and swampy banks.

Survey and collection

Systematic field surveys were conducted during different seasons (pre-monsoon, monsoon, and post monsoon) from April 2019-August 2019 to document the diversity of aquatic angiosperms

Sampling was carried out at five representative sites of the lake, covering distinct habitats including:

- Shallow littoral zones
- Open water bodies
- Swampy and marshy margins
- Inflow points of streams
- Human-impacted areas (sewage influenced zones)

Plants were categorized based on their life forms: free-floating, submerged, rooted with floating leaves, and emergent species**.**

Collection and preservation

- Aquatic plant specimens were carefully collected using hand-picking, scooping nets, and in some cases, by wading into shallow regions
- Fresh specimens were pressed using blotting sheets and herbarium presses following standard herbarium techniques (Jain & Rao, 1977)
- Delicate aquatic plants were preserved in 4% formalin solution for microscopic examination and identification
- Each specimen was labeled with details of locality, habitat type, date of collection, and collector's name

Identification and classification

- Collected specimens were identified using standard floras and monographs such as:
  Gamble's *Flora of the Presidency of Madras* (1915–1935)
  Nayar et al., *Flora of Kerala* (2006 onwards)
  Cook, *Aquatic and Wetland Plants of India* (1996)
- Taxonomic classification was followed as per APG IV system (2016)

- Species richness, family wise distribution, and life form composition were recorded
- Diversity indices such as Shannon Wiener Diversity Index (H') and Simpson's Dominance Index (D) were calculated to assess community structure
- Photographic documentation was carried out to prepare a pictorial guide for aquatic angiosperms of Akkulam Lake

RESULTS

Systematic floristic surveys in Akkulam Lake led to the documentation of a rich diversity of aquatic angiosperms. A total of 19 species, 19 genera and 15 families were identified. The recorded species represented four major life forms: free floating hydrophytes, submerged hydrophytes, rooted with floating leaves, and emergent hydrophytes.

1. Enumeration of species

The identified aquatic angiosperms are enumerated below with their botanical name, family, and life form**.**

A. Free-floating species

1. *Eichhornia crassipes* (Mart.) Solms – Pontederiaceae (Free-floating)
2. *Pistia stratiotes* L. – Araceae (Free-floating)
3. *Salvinia molesta* D.S. Mitch. – Salviniaceae (Floating fern, free-floating)
4. *Azolla pinnata* R. Br. – Azollaceae (Floating fern, free-floating)
5. *Lemna minor* L. – Araceae (Free-floating duckweed)

B. Submerged species

6. *Hydrilla verticillata* (L.f.) Royle – Hydrocharitaceae (Submerged)
7. *Najas graminea* Delile – Hydrocharitaceae (Submerged)
8. *Ceratophyllum demersum* L. – Ceratophyllaceae (Submerged)
9. *Vallisneria spiralis* L. – Hydrocharitaceae (Submerged)

C. Rooted with Floating leaves

10. *Nymphaea nouchali* Burm.f. – Nymphaeaceae (Rooted with floating leaves)
11. *Nymphoides indicum* (L.) Kuntze – Menyanthaceae (Rooted with floating leaves)
12. *Nelumbo nucifera* Gaertn. – Nelumbonaceae (Rooted with floating leaves)

D. Emergent species

13. *Ipomoea aquatica* Forssk. – Convolvulaceae (Emergent, trailing)
14. *Typha angustata* Bory & Chaub. – Typhaceae (Emergent)
15. *Cyperus iria* L. – Cyperaceae (Emergent)
16. *Fimbristylis dichotoma* (L.) Vahl – Cyperaceae (Emergent)
17. *Phragmites karka* (Retz.) Trin. ex Steud. – Poaceae (Emergent)
18. *Ludwigia adscendens* (L.) Hara – Onagraceae (Emergent, floating stems)
19. *Alternanthera philoxeroides* (Mart.) Griseb. – Amaranthaceae (Emergent, invasive)

Table 1. Enumeration of Aquatic angiosperms in Akkulam lake

Sl. No	Species name	Family	Life form	Habitat zone
1	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Free-floating	Open water, eutrophic zones
2	*Pistia stratiotes* L.	Araceae	Free-floating	Shallow stagnant water
3	*Salvinia molesta* D.S. Mitch.	Salviniaceae	Free-floating	Margins, eutrophic waters
4	*Azolla pinnata* R. Br.	Azollaceae	Free-floating	Shaded water surfaces
5	*Lemna minor* L.	Araceae	Free-floating	Stagnant shallow water
6	*Hydrilla verticillata* (L.f.) Royle	Hydrocharitaceae	Submerged	Open water regions
7	*Najas graminea* Delile	Hydrocharitaceae	Submerged	Submerged littoral areas
8	*Ceratophyllum demersum* L.	Ceratophyllaceae	Submerged	Deeper zones
9	*Vallisneria spiralis* L.	Hydrocharitaceae	Submerged	Clear water patches
10	*Nymphaea nouchali* Burm.f.	Nymphaeaceae	Rooted with floating leaves	Shallow open waters
11	*Nymphoides indicum* (L.) Kuntze	Menyanthaceae	Rooted with floating leaves	Swampy margins
12	*Nelumbo nucifera* Gaertn.	Nelumbonaceae	Rooted with floating	Shallow marshy areas

			leaves	
13	*Ipomoea aquatica* Forssk.	Convolvulaceae	Emergent (trailing)	Margins, semi-aquatic
14	*Typha angustata* Bory & Chaub.	Typhaceae	Emergent	Swampy littoral zones
15	*Cyperus iria* L.	Cyperaceae	Emergent	Marshy margins
16	*Fimbristylis dichotoma* (L.) Vahl	Cyperaceae	Emergent	Swampy banks
17	*Phragmites karka* (Retz.) Trin. ex Steud.	Poaceae	Emergent	Littoral marshes
18	*Ludwigia adscendens* (L.) Hara	Onagraceae	Emergent (floating stems)	Stagnant shallow waters
19	*Alternanthera philoxeroides* (Mart.) Griseb.	Amaranthaceae	Emergent (invasive)	Polluted margins

2. Family wise distribution

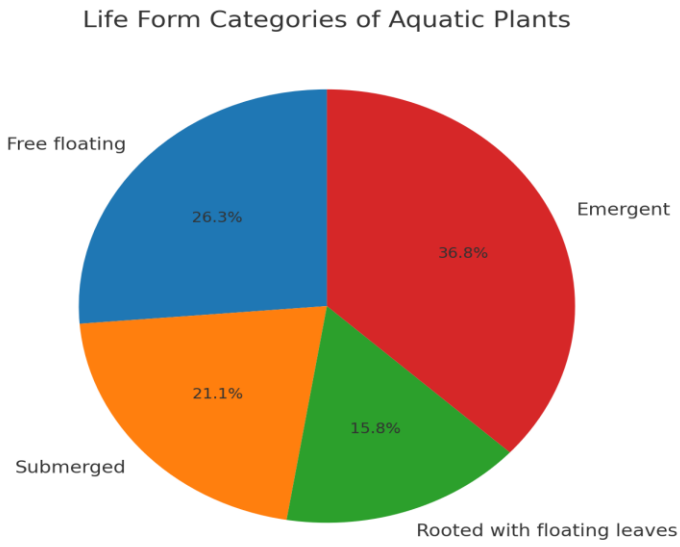
- Hydrocharitaceae – 3 species
- Cyperaceae – 2 species
- Nymphaeaceae, Poaceae, Onagraceae, Menyanthaceae, Pontederiaceae, Convolvulaceae, Typhaceae, Amaranthaceae **(** 1 species each), Araceae(2 Species)
- Others (ferns: Azollaceae, Salviniaceae, Ceratophyllaceae) – 1 species each
- Nelumbonaceae—one species

3. Life form composition

- Free-floating species – 5
- Submerged species – 4
- Rooted with floating leaves – 3
- Emergent species – 7

Table 2. Life form composition of aquatic angiosperms

Life form category	No. of species	Percentage (%)
Free floating	5	26.3 %
Submerged	4	21.1 %
Rooted with floating leaves	3	15.8 %
Emergent	7	36.8 %



4. Notable observations

- The lake was heavily infested with invasive species such as *Eichhornia crassipes* and *Alternanthera philoxeroides*, indicating nutrient enrichment and eutrophication.
- Native species like *Nymphaea nouchali* and *Vallisneria spiralis* were found restricted to relatively undisturbed zones.
- The presence of *Ipomoea aquatica* and *Typha angustata* in marshy zones reflects the semi aquatic nature of littoral areas.

DISCUSSION

The present floristic investigation on aquatic angiosperms of Akkulam Lake revealed a total of 19 species distributed across 15 families**,** representing diverse life forms such as free-floating, submerged, rooted with floating leaves, and emergent types. The predominance of emergent hydrophytes (36.8%) followed by free floating species (26.3%) indicates that the lake margins are heavily colonized by semi aquatic vegetation, which is typical of wetlands undergoing nutrient enrichment and anthropogenic influence. The widespread occurrence of invasive species such as *Eichhornia crassipes* and *Alternanthera philoxeroides* is of particular concern. Several studies have documented the rapid colonization of *Eichhornia crassipes* in freshwater ecosystems of Kerala, resulting in ecological imbalance and reduced biodiversity (Thomas et al., 2017). Similarly, *Alternanthera philoxeroides* has been recognized as a noxious aquatic weed in Indian wetlands, competing with native flora and altering habitat structure (Kumar & Joseph, 2018). The dominance of such invasive macrophytes in Akkulam Lake highlights the eutrophic condition of the system, primarily driven by sewage inflow, urban runoff, and organic matter accumulation.

Native species such as *Nymphaea nouchali* and *Vallisneria spiralis* were found restricted to relatively undisturbed zones of the lake. This aligns with the observations of Ramesh et al. (2019), who reported that sensitive aquatic taxa are often confined to less polluted pockets in impacted wetlands. The decline of native hydrophytes may serve as a biological indicator of deteriorating water quality, as suggested in other tropical freshwater studies (Joseph & Sabu, 2017).

Family wise distribution showed the dominance of Hydrocharitaceae (3 species), which is consistent with the findings of recent floristic surveys of Kerala wetlands. Studies conducted in Vembanad and Ashtamudi backwaters during 2017–2018 also reported Hydrocharitaceae as a prominent family due to the presence of *Hydrilla*, *Vallisneria*, and *Najas* species (Rajan et al., 2018). This pattern emphasizes the ecological adaptability of Hydrocharitaceae members in brackish as well as freshwater habitats.

The higher representation of emergent taxa such as *Typha angustata*, *Phragmites karka*, and sedges (*Cyperus* spp., *Fimbristylis* spp.) suggests the gradual terrestrialization of littoral zones. Similar observations were made by Mathew and Nair (2017) in their study of Kerala wetlands, where emergent vegetation expanded into marshy margins, often replacing submerged and floating forms. This process is typically associated with siltation, pollution, and encroachment.

Thus, the floristic composition of Akkulam Lake reflects a disturbed and eutrophic ecosystem**,** with invasive weeds outcompeting native hydrophytes, and emergent macrophytes proliferating in marshy margins. The findings underscore the urgent need for ecological restoration measures, including control of invasive species, sewage management, and conservation of native aquatic flora.

SUMMARY

The present study focused on the floristic assessment of aquatic angiosperms in Akkulam Lake, a brackish water ecosystem situated in Thiruvananthapuram, Kerala. Systematic field surveys and specimen identification revealed a total of 19 species belonging to 15 families and 19 genera, representing diverse life forms including free floating (5 species), submerged (4 species), rooted with floating leaves (3 species), and emergent types (7 species)**.**

The family Hydrocharitaceae was dominant, represented by three submerged taxa (*Hydrilla verticillata, Vallisneria spiralis,* and *Najas graminea*), while emergent hydrophytes such as *Typha angustata, Phragmites karka,* and members of Cyperaceae were abundant along marshy littoral zones. Native species like *Nymphaea nouchali* and *Nelumbo nucifera* were present but restricted to relatively undisturbed sites.

The lake was heavily infested with invasive weeds such as *Eichhornia crassipes* and *Alternanthera philoxeroides*, reflecting a state of eutrophication and ecological stress caused by sewage inflow, urban runoff, and habitat modification. The higher representation of emergent and invasive taxa indicates gradual terrestrialization of littoral zones and suppression of sensitive submerged and floating species.

This floristic survey provides baseline data on the aquatic angiosperm diversity of Akkulam Lake, which is essential for future ecological monitoring, wetland conservation, and management planning. The findings highlight the urgent need to control invasive macrophytes, restore native flora, and implement pollution mitigation strategies to sustain the ecological health of this important urban wetland.

CONCLUSION

The floristic assessment of Akkulam Lake revealed a diverse assemblage of 19 aquatic angiosperm species distributed across different life forms, with emergent macrophytes being dominant. The study highlights the dual character of the lake: on one hand, it supports native and ecologically important species such as *Nymphaea nouchali* and *Vallisneria spiralis*; on the other, it is severely impacted by invasive weeds like *Eichhornia crassipes* and *Alternanthera philoxeroides*, which indicate eutrophication and ecological imbalance.

The findings underscore the urgent need for conservation and management interventions, including:

1. Control of invasive species through mechanical removal and eco friendly biocontrol measures
2. Pollution mitigation**,** particularly sewage inflow and urban runoff management
3. Restoration of native aquatic flora**,** which can help improve water quality and ecological resilience

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