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Hydrophytes of selected wetlands of Tirunelveli district Tamil Nadu, India

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Abstract
In the present study, an attempt has been made to highlight the Angiosperm diversity of hydrophytes recorded and documented in selected wetlands of Tirunelveli District of Tamil Nadu, South India. Qualitative floristic surveys were carried out during the year 2011-2014. Thirty seven (37) species of hydrophytes belonging to 21 families and 33 genera were documented. Families with maximum number of species include Lemnaceae, Poaceae and Scrophulariaceae (4 each), Nymphaceae and Hydrocharitaceae were represented by (3 each), Convolvulaceae, Cyperaceae, and Araceae were represented by 2 species each. Rapid eutrophication needs to be controlled through judicious removal of plants maintaining the species diversity and optimum productivity.

Keywords: angiosperm, hydrophytes, morpho-ecologic group, wetlands, Tirunelveli district

1. Introduction
Wetland is among the most productive ecosystems in the world [1]. Several works have been done on the aquatic macrophytes and phytosociology in different freshwater bodies of India [2-7]. In India the first comprehensive work on the wetland flora was produced [8]. In India very little attention used to be paid separately to aquatic plants. The state of our knowledge of the aquatic vegetation in the subcontinent, as a component of the aquatic ecosystems has been revealed and the lacunae, which need to be filled by future research, have been identified [9]. It was the first time drew attention to the importance of the aquatic plants. Studies on the aquatic and wetland vascular plants of India were done [10-15]. Macrophytes are common features of an aquatic ecosystem, which plays an important role in maintaining the ecosystem of wetlands [16-20]. The monographic work on aquatic angiosperms of India covered not less than 117 species representing 32 families [21]. The works on water plants and of on aquatic vascular plants of India are also very noteworthy contributions [22-23]. A total of 38 endophytic fungal strains were isolated from aquatic plants native to the Daepyeong wetland, and 27 strains were isolated from the Jilnal wetland [24]. The present study was an attempt to explore the Angiosperm diversity of hydrophytes wealth of selected wetlands of Tirunelveli district, Tamil Nadu India.

2. Materials and Methods
2.1 Study area
Tirunelveli district covers an area 6,823 sq.kms. It is in the south eastern part of Tamil Nadu and is triangular in shape. It lies between 08^0 08' and 09^0 23' of Northern latitudes and 77^0 09' and 77°54' of Eastern longitudes [25]. It is bounded by Virudhunagar District in the north, Kerala State in the west, Kanyakumari District and the Gulf of Mannar in the south, and Thoothukudi District in the east. The district comprises Tirunelveli, Cheranmahadevi and Tenkasi Revenue Divisions, 11 taluks, 19 Blocks, 425 Panchayats and 628 Revenue villages. (Figure: 1).

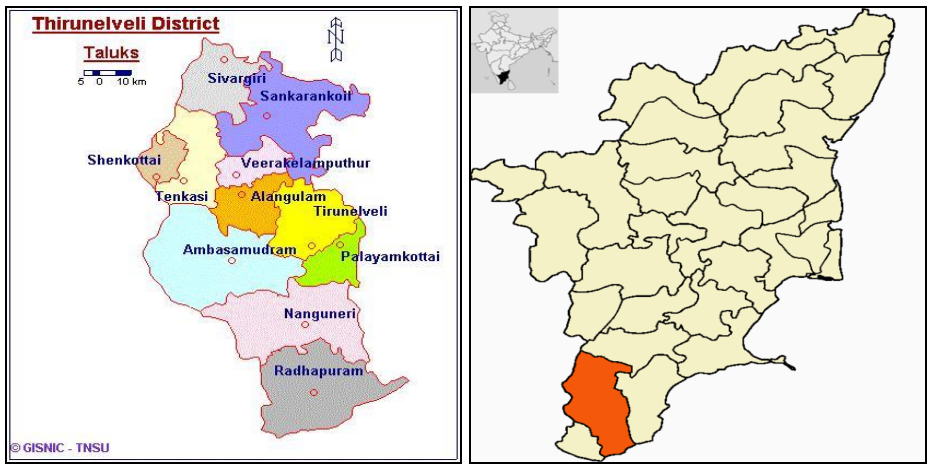

Fig 1: Study Area

The average annual rainfall is around 700 mm, 70% of which occurs during October – December. The fundamental characteristic of this climate is due to the large variability of rains from year to year. The high amount of rain is almost always cyclonic in origin. The total rainfall was 965.1, 753.97, 772.57 and 1346.59 mm for the year 2011, 2012, 2013 and 2014 respectively. The average rainfall for the rainy season was 220.77, 178.63, 133.77 and 283.95 for the year 2011, 2012, 2013 and 2014 respectively. The coolest month is January with a mean temperature of 25.3ºC and absolute minimum of 21ºC and absolute maximum of 33ºC. The hottest months are May and June with an average temperature of 36.3ºC with absolute minimum and maximum of 27ºC and 40ºC.

2.2 Methods

Twelve sampling stations were selected for present study and list of sampling stations were given in Table: 1 (Fig. 1, 2). An extensive floristic survey was conducted during the year 2011-2014. All the collected angiosperm hydrophytes were identified taxonomically with the help of available monographs, taxonomic revisions and floras [26-32]. Bentham and Hooker's Natural system of classification was followed to classify the species. Author citation and binomial of collected species were verified with International Plant Names Index (IPNI) [33].

Table 1: Names and location of selected wetlands in the Tirunelveli district

S. No	Name of the Wetland	Location		Tank Bund Level (M)	Max Water Level (M)	Water Storage Depth (M)	Irrigation Area (Acres)	Catchment Area (Sq Km)
		Village	Latitude / Longitude					
1.	Pirancheri	Gopalasamudram	08.65 N / 77.62 E	56.41	55.59	2.79	49.25	13.87
2.	Nambineri	Gopalasamudram	08.67 N / 77.63 E	50.94	50.02	3	114.78	3.37
3.	Senthimangalam	Sendimangalam	8.75 N / 77.70 E	36.65	35.73	1.21	54.18	36.13
4.	Izhandaikulam	Kandiaperi	08.74 N/ 77.69 E	42.89	41.97	0.91	30.42	0.3046
5.	Nanguneri	Nanguneri	08.50 N / 77.65 E	99.145	98.145	5.96	697.17	24.77
6.	Thamaraikulam	Kalakad	08.52 N / 77.54 E	132.49	130.99	3	136.785	4.863
7.	Puthukulam	Idaikal	08 76' N 77 28' E	44.37	43.32	0.88	34.25	0.3343
8.	Karungulam	Pappakudy	08.75 N /77.48 E	65.045	65.045	3.6	102.54	0.6439
9.	Vagaikulam	Vagaikulam	08.72 N /77.43 E	76.657	75.743	1.892	89.53	0.3635
10.	Valatthakulam	Alwarkurichi	08.78 N / 77.40 E	84.64	83.39	0.445	57.21	0.2475
11.	Shencottaikulam	Shencottai	08.97 N / 77.25 E	176.86	175.86	3.5	55.36	1.102
12.	Narayanaperi	Puliyankudi	09 11 N / 77 23 E	187.52	186.52	3.59	183.14	4.19

3. Results

A total of 37 species in 33 genera and 21 families were recorded. Maximum of 34 species were recorded from Narayanaperi wetland followed by Thamaraikulam (33), Piranjeri (32), Nambineri (30), Senthimangalam (28), Ezhanthakulam and Valaththakulam (26 each), Vaagaikulam (24), Nanguneri (22), Puthukulam and Shenkottai (21 each) and Karungulam (18 species). Families with maximum number of species include Lemnaceae, Poaceae and Scrophulariaceae (4 each), Nymphaceae and Hydrocharitaceae were represented by (3 each), and Convolvulaceae, Cyperaceae, and Araceae were represented by 2 species each. Acanthaceae, Amaranthaceae, Aponogetonaceae, Mimosaceae, Polygalaceae, Polygonaceae, Onagraceae, Lentibulariaceae, Elatinaceae, Ceratophyllaceae, Menianthaceae Pontederidaceae and Typhaceae were represented by only one species (Table 2).

4. Discussion

Among five, morpho-ecologic groups, emergent anchored with 16 species dominated the wetlands followed by floating (10), floating leaved anchored (6), submerged anchored (4), and submerged with 1 species. Presence of *Ipomoea carnea*, *Pistia stratiotes, and Eichornia crassipes* indicated a clear sign of invasion of alien species in these lakes. Quantitative and qualitative floristic survey, constant monitoring and protection of lentic and lotic ecosystems are the need of the hour in order to save the native biota, to maintain the quality of drinking water, and disqualify the efforts of alien species to invade.

Free floating species like *Azolla*, *Lemna*, *Salvinia* and *Eichhornia*. Are commonly seen in the stagnant water bodies. They have rosetted aerial or floating leaves with are nchymatous petiole or stem and submerged roots. *Nelumbo* and *Nymphaea* were the rooted macrophytes with floating leaves present in the study area. The leaves come to the water surface forming long petioles. The aerial parts of these amphibious hydrophytes are with mesophytic characters and the submerged parts shows true hydrophytic characters. Many of these thrive well even after the substratum is considerably dried up e.g. *Typha*, *Hygrophila*. Pteridophytes viz. *Azolla pinnata, Marsellia* were abundant in Senthimangalam Tank and Kandiaperi - Ezhanthakulam Tank. Some of these plants like *Limnophila* sp. spread out its crown along the water surface to produce flowers. In *Vallisneria* the vegetative body will be always under water, but the flower stalk come up to the water surface and flowers will be opened at the surface of water to effect cross pollination. Plants like *Chara* and *Hydrilla* is restricted mostly under water. Rooted emergent viz. *Typha* and *Cyperus* were recorded throughout the year. *Isoetes coromandelina* and *Ceratopteris thalictroides* were recorded in Shenkottai Tank.

This aquatic vegetation retains the water in the pond for long period. The major services are carbon sequestration, flood control, groundwater recharge and nutrient removal. Besides they also have ornamental potential, medicinal uses, they provide a valuable source of food, especially for waterfowl, recycling of nutrients and attract the migratory birds. Some sacred flowers of aquatic plants also used in prayers.

Table 2: List of hydrophytes recorded in the selected wetlands of Tirunelveli District, Tamil Nadu

S. No.	Botanical Name	Family Name	Morpho-Ecologic Group	Types of Wetlands											
				Piranjeri	Nambineri	Senthimangalam	Ezhanthakulam	Nanguneri	Thamaraikulam	Puthukulam	Karungulam	Vaagai kulam	Valatthakulam	Shenkottai	Narayanaperi
1.	*Alternanthera sessilis* (L.) R.Br. ex DC.	Amaranthaceae	Floating	+	-	-	-	-	+	-	-	+	-	+	+
2.	*Aponogeton natans* (L.) Engl. & K. Krause	Aponogetonaceae	Floating leaved anchored	+	+	+	+	+	+	+	+	+	+	+	+
3.	*Bacopa monnieri* (L.) Wettst.	Scrophulariaceae	Emergent anchored	+	+	+	+	+	+	+	+	+	+	+	+
4.	*Bergia capensis* L.	Elatinaceae	Emergent anchored	+	+	+	+	+	+	-	-	+	+	-	+
5.	*Ceratophyllum demersum* L.	Ceratophyllaceae	Floating	+	+	+	+	+	+	+	+	+	+	+	+
6.	*Chloris barbata* Sw.	Poaceae	Emergent anchored	+	+	+	+	+	+	+	+	+	+	+	+
7.	*Cynodon dactylon* (L.) Pers.	Poaceae	Emergent anchored	+	+	+	+	+	+	+	+	+	+	+	+
8.	*Cyperus rotundus* L.	Cyperaceae	Emergent anchored	+	-	-	+	+	+	-	-	-	-	-	+
9.	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	Emergent anchored	+	+	+	+	+	+	+	+	+	+	+	+
10.	*Echinochloa colona* (L.) Link	Poaceae	Emergent anchored	+	+	+	+	+	+	+	+	+	+	+	+
11.	*Eichornia crassipes* (Mart.) Solms	Pontederiaceae	Floating	+	+	+	+	+	+	+	+	+	+	+	+
12.	*Hydrilla verticillata* (L. f.) Royle	Hydrocharitaceae	Submerged anchored	+	+	+	+	+	+	+	+	+	+	+	+
13.	*Hygrophila auriculata* (Schumach.) Heine.	Acanthaceae	Emergent anchored	+	+	+	+	+	+	+	+	+	+	+	+
14.	Ipomoea aquatica Forssk.	Convolvulaceae	Floating leaved anchored	+	+	+	+	+	+	+	+	+	+	+	+
15.	*Ipomoea carnea* Jacq.	Convolvulaceae	Emergent anchored	-	-	+	-	-	-	-	-	-	-	+	+
16.	*Kyllinga bulbosa* P. Beauv.	Cyperaceae	Emergent anchored	+	+	-	-	+	+	-	-	+	+	-	+
17.	*Lemna gibba* L.	Lemnaceae	Floating	+	+	+	+	-	+	-	-	-	-	+	+
18.	*Lemna perpusilla* Torrey.	Lemnaceae	Floating	+	-	+	+	-	+	+	-	-	+	-	-
19.	*Limnophila heterophylla* Benth.	Scrophulariaceae	Emergent anchored	+	+	-	-	-	+	-	-	+	+	-	+
20.	*Limnophila indica* (L.) Druce.	Scrophulariaceae	Submerged anchored	+	+	+	-	-	+	-	-	+	-	-	+
21.	*Ludwigia perennis* L.	Onagraceae	Emergent anchored	-	-	+	-	-	+	-	-	-	-	-	+
22.	*Monochoria vaginalis* C. Presl	Araceae	Floating	+	+	+	+	+	+	+	+	+	+	+	+
23.	*Nelumbo nucifera* Gaertn.	Nymphaeaceae	Floating leaved anchored	+	+	+	+	+	+	+	+	+	+	+	+
24.	*Neptunia oleracea Lour*.	Mimosaceae	Floating	+	+	+	+	-	+	+	-	-	-	-	+
25.	*Nymphaea nouchali* Burm.f.	Nymphaeaceae	Floating leaved anchored	+	+	+	+	+	+	+	+	+	+	+	+
26.	*Nymphaea pubescens* Willd.	Nymphaeaceae	Floating leaved anchored	+	+	+	+	+	+	+	+	+	+	+	+
27.	*Nymphoides indica* (L.) Kuntze.	Mentianthaceae	Floating leaved anchored	+	+	+	+	-	-	-	-	-	-	-	-
28.	*Ottelia alismoides* (L.) Pers.	Hydrocharitaceae	Submerged anchored	+	+	+	+	-	+	-	-	+	+	-	-
29.	*Pistia stratiotes* L.	Araceae	Floating	+	+	+	+	+	+	+	+	+	+	+	+
30.	*Polygala javana* DC.	Polygalaceae	Emergent anchored	+	+	-	-	-	+	-	-	-	-	-	+
31.	*Polygonum glabrum* Willd.	Polygonaceae	Emergent anchored	-	-	-	-	-	+	-	-	-	+	-	+
32.	*Spirodela polyrhiza* (L.) Schl.	Lemnaceae	Floating	-	+	-	-	+	+	-	-	+	+	-	+
33.	*Striga angustifolia* (D. Don) Saldanha	Scrophulariaceae	Emergent anchored	+	+	+	-	-	+	+	-	-	-	-	+
34.	*Typha angustifolia* L.	Typhaceae	Emergent anchored	+	+	-	+	-	-	-	-	-	+	-	+
35.	*Utricularia bifida* L.	Lentibulariaceae	Submerged	-	-	-	-	-	-	-	-	-	-	-	+
36.	*Vallisneria natans* (Lour.) H. Hara	Hydrocharitaceae	Submerged anchored	+	+	+	+	+	+	+	+	-	+	+	+
37.	*Wolffia globosa* Roxb.	Lemnaceae	Floating	+	+	+	+	+	+	+	+	+	+	+	+

Note: + (Present) - (Absent)

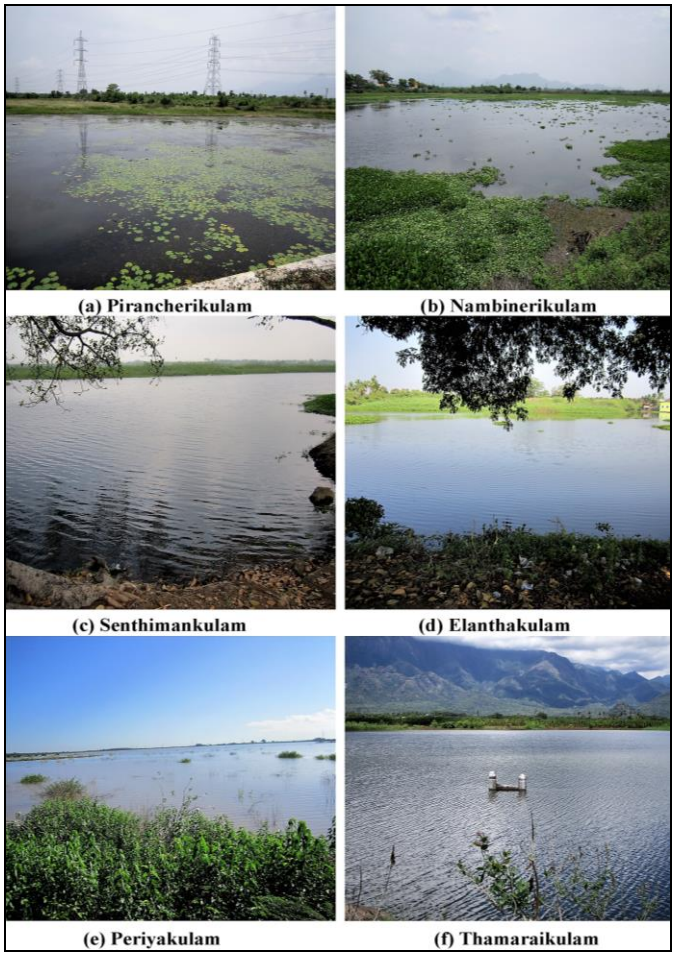

Fig 1: Overview of Selected wetlands in Tirunelveli District

Fig 2: Overview of Selected wetlands in Tirunelveli District

5. Conclusion

Major steps that need to be taken up in Tirunelveli District for sustaining wetlands for promotion of economic development and ecological welfare are enumerated in the following. Greater emphasis should be placed on promoting wetland awareness among local people, students of Schools, Colleges and Universities. Professionals and non-Government bodies also need to be trained in this regard. Occupational, environmental and health issues of wetland neighbours and users need to be studied in an integrated way so as to optimize human health and ecosystem. It is concluded that the quantitative and qualitative floristic survey, constant monitoring and protection of aquatic and semi-aquatic bodies are the need of the hour in order to save the aquatic flora and to maintain the wild progenitors of the wetland plants.

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