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## RESEARCH ARTICLE

### PLANT DIVERSITY ALONG THE LOWER REACHES OF BHARATHAPUZHA RIVER, KERALA, INDIA

\*Vaheeda, K. K. and Uma, K.

Department of Botany, M.E.S. Asmabi College, P. Vemballur, Thrissur Dt. Kerala, India

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#### ABSTRACT

The present investigation deals with the aquatic macrophyte diversity and species composition along the lower reaches of the second longest river of Kerala, the Bharathapuzha River, also known as Nila. 110 plants of aquatic and shore vegetation belonging to three Pteridophyta and 38 Angiosperm families were enumerated. 23% of the vegetation analysed were grasses and sedges and 34% of plants were of medicinal importance. Aquatic and wetland plant communities are bioindicators of environmental quality. In the present study 25% of the plants recorded were exotic and invasive weeds indicating that the river ecosystem is being transgressed.

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#### INTRODUCTION

Biotic communities living along the shores of rivers are known as riparian. The riparian region, being an ecotone or interface between a water body and its shore, is a haven for a wide variety of terrestrial and aquatic organisms. This transitional region between water and land is ecologically distinctive. A fertile and dynamic environment with the bank habitat and the in stream habitat, has its own unique microclimate and characteristic species composition. It is vulnerable to attack of exotic and invasive floral and faunal species. The flora that dominates these areas includes the aquatic, semi aquatic and terrestrial plants, belonging to flowering as well as non flowering groups. They have a key role in primary productivity, nutrient cycling, and provide a heterogeneous habitat for a number of other organisms. The present investigation is an analysis of the macrophytic plant along the Bharathapuzha River. Literature pertaining to the flora of lentic waters is many, but those on lotic flora are few. Naskar (1990), Bachan (2003), Maya *et al.* (2003), Pradhan *et al.* (2005), Mehaboob and Simon (2006), Bamidele and Nyamali (2008), Paul and George (2010), Swapna *et al.* (2011), Datta *et al.* (2011) have studied riparian flora. Most of these works are devoted to tree species along the riverine ecosystem. The macrophytic flora along the lower reaches of Bharathapuzha River has not received any attention so far. The present investigation is an attempt to analyse the macrophytic diversity along this river.

\*Corresponding author: Vaheeda, K. K.

Department of Botany, M.E.S. Asmabi College, P. Vemballur,  
Thrissur Dt. Kerala, India

#### MATERIALS AND METHODS

##### Study area

Bharathapuzha is the second longest among the west flowing perennial rivers of the state being 209 km in length. 10 sites were selected along the Bharathapuzha River, the first seven sites chosen for this study i.e. Shornur, Njangattiri, Pattambi, Thrithala, Koodallur, Kumbidi, Perassannur are located in Palakkad District and the remaining sites Kuttippuram, Thirunnavaya and Chamravattam are located in Malappuram district, Kerala. The study area falls between 10<sup>o</sup>.75'-10<sup>o</sup>.87'N and 76<sup>o</sup> 26'-76<sup>o</sup> 97' - E. A survey was conducted and aquatic and wetland macrophytes were collected from the selected sites. Phyto-sociological parameters were analysed using quadrat method (Trivedi *et al.*, 1998). A total of hundred 1×1m sized quadrats were analysed from the 10 stations selected. The study was conducted during March to June 2011. Plants were identified with the help of standard floras, (Gamble and Fischer, 1915-1936; Cook, 1996; Sunil and Sivadasan, 2009). Simpson (1949) and Shannon-Weaver diversity index (1963) were calculated using software PRIMER (Polymouth Routines in Multivariate Ecological Research). Alien plants were listed following Reddy (2008).

#### RESULTS

A total of 110 macrophytes under 41 families were observed in the study area of which 29 families belonged dicotyledons, 9 to monocotyledons and three belonged to Pteridophyta (Table1). 81 were typical herbs. Shannon-Weiner index used

Table 1. Total plants observed in all study area

Sl.No.	NAME OF PLANT	FAMILY	ORIGIN	HABIT
1	<i>Achyranthus aspera</i> L.*	Amaranthaceae		Herb
2	<i>Acrostichum aureum</i> L.	Polypodiaceae		Herb
3	<i>Aerva lanata</i> (L.) Juss.ex Schul*	Amaranthaceae		Herb
4	<i>Ageratum conyzoides</i> L.	Asteraceae	Trop. America	Herb
5	<i>Alloopteropsis semialata</i> (R.Br.) Hitch.	Poaceae		Herb
6	<i>Alternanthera sessilis</i> (L.) R.Br.ex.DC*	Amaranthaceae	Trop. America	Herb
7	<i>Alternanthera tenella</i> Moq.in DC.	Amaranthaceae	Trop. America	Herb
8	<i>Amaranthus spinosus</i> L.*	Amaranthaceae		Herb
9	<i>Ammania baccifera</i> L.	Lythraceae		Herb
10	<i>Andrographis paniculata</i> (Burm.f) Wall.ex Nees.*	Acanthaceae		Herb
11	<i>Apluda mutica</i> Linn.	Poaceae		Herb
12	<i>Asparagus racemosus</i> Willd.*	Liliaceae		Herb
13	<i>Barleria</i> sps.	Acanthaceae		Herb
14	<i>Blumea oxydonta</i> DC.in Wight	Asteraceae		Herb
15	<i>Boerhaavia diffusa</i> L.*	Nyctaginaceae		Herb
16	<i>Calotropis gigantea</i> (L.) R.*	Asclepiadaceae	Trop. Africa	Herb
17	<i>Cardiospermum halicacabum</i> L.*	Sapindaceae		Climbing herb
18	<i>Cassia tora</i> L.*	Fabaceae	Temp.S.Amer	Sub shrub
19	<i>Centrosema pubescens</i> Benth.*	Fabaceae		Slender climber
20	<i>Chromolaena odorata</i> (L.) King & Rorins;	Asteraceae	Trop. America	Shrub
21	<i>Cleome aspera</i> Koenig ex DC.	Capparidaceae		Annual Herb
22	<i>Cleome monophylla</i> L.	Capparidaceae	Trop. Africa	Erect herb
23	<i>Cleome viscosa</i> L.*	Capparidaceae	Trop. America	Erect herb
24	<i>Clitoria ternatea</i> L.*	Fabaceae		Climbing shrub
25	<i>Commelina benghalensis</i> L.	Commelinaceae		Herb
26	<i>Crotalaria retusa</i> L.*	Fabaceae	Trop. America	Sub shrub
27	<i>Crotalaria verrucosa</i> L.*	Fabaceae		Herb
28	<i>Croton bonplandium</i> Baill.	Euphorbiaceae	Temp.S.Amer	Shrub
29	<i>Cyanotis axillaris</i> (L.) D.Don.	Commelinaceae		Herb
30	<i>Cyanotis villosa</i> (Spreng.) Schult.	Commelinaceae		Herb
31	<i>Cyclea peltata</i> (Lam.) Hook. F & Thoms.*	Menispermaceae		Climber
32	<i>Cynodon dactylon</i> (L.) Pers.*	Poaceae		Herb
33	<i>Cyperus articulatus</i> L.	Cyperaceae		Herb
34	<i>Cyperus castaneus</i> Willd.	Cyperaceae		Herb
35	<i>Cyperus compressus</i> L.	Cyperaceae		Herb
36	<i>Cyperus difformis</i> L.	Cyperaceae	Trop. America	Herb
37	<i>Cyperus michelianus</i> (L.) Link. Enum.	Cyperaceae		Herb
38	<i>Datura stramonium</i> L.*	Solanaceae		Subshrub
39	<i>Derris trifoliata</i> Lour.	Fabaceae		Climbing shrub
40	<i>Echinochloa colonum</i> (L.) Link & Enum.	Poaceae	Trop. America	Herb
41	<i>Eclipta prostrata</i> (L.) L.*	Asteraceae	Trop. America	Herb
42	<i>Eichhornia crassipes</i> (Mart.) Solms.	Pontederiaceae	Trop. America	Aquatic herb
43	<i>Eleusine indica</i> (L.) Gaertn.	Poaceae		Herb
44	<i>Eragrostis atrovirens</i> (Desf.) Trin.ex Steud.	Poaceae		Herb
45	<i>Eragrostis japonica</i> (Thunb.)	Poaceae		Herb
46	<i>Eragrostis tenella</i> (L.) P. Beauv.ex Roem & Schult	Poaceae		Herb
47	<i>Eragrostis unioloides</i> (Retz.) Nees ex Steud.	Poaceae		Herb
48	<i>Eragrostis viscosa</i> (Retz.) Trin.	Poaceae		Herb
49	<i>Fimbristylis aestivalis</i> (Retz.) Vahl. Enum.	Cyperaceae		Herb
50	<i>Fimbristylis argentea</i> (Rottb.) Vahl.	Cyperaceae		Herb
51	<i>Fimbristylis dichotoma</i> (L.) Vahl.	Cyperaceae		Herb
52	<i>Fimbristylis dipsacea</i> (Rottb.) Clarke in Hook.f.	Cyperaceae		Herb
53	<i>Fimbristylis miliacea</i> (L.) Vahl.	Cyperaceae		Herb
54	<i>Glinus oppositifolia</i> L.*	Molluginaceae		Prostrate Herb
55	<i>Gomphrena globosa</i> L.	Amaranthaceae		Herb
56	<i>Gomphrena serrata</i> L.	Amaranthaceae	Trop. America	Herb
57	<i>Hedyotis corymbosa</i> L.*	Rubiaceae		Herb
58	<i>Hedyotis travencorica</i> Bedd.	Rubiaceae		Herb
59	<i>Hedyotis puberula</i> (G.Don) R.Br.ex Arn.	Rubiaceae		Herb
60	<i>Heliotropium keralensis</i> Sivar. & Manilal *	Boraginaceae		Herb
61	<i>Hydrolea zeylanica</i> (L.) Vahl.	Hydrophyllaceae		Herb
62	<i>Hygrophila schulli</i> (Buch-Ham) M-R&Sm-Almeida*	Acanthaceae		Herb
63	<i>Hyptis suaveolens</i> (L.) Poit.	Lamiaceae	Trop. America	Herb
64	<i>Ichnocarpus frutescens</i> (L.) R.Br.*	Apocyanaceae		Climber
65	<i>Indoneesiella echioides</i> (L.) Sreem.	Acanthaceae		Erect herb
66	<i>Ipomea fistulosa</i> L.	Convolvulaceae		Shrub
67	<i>Ipomea hederifolia</i> L.	Convolvulaceae	Trop. America	Herb
68	<i>Ipomea aquatica</i> Forssk.	Convolvulaceae		Shrub
69	<i>Ipomea biloba</i> Forssk.	Convolvulaceae		Creeping herb
70	<i>Jatropha glandulifera</i> Roxb.*	Euphorbiaceae		Shrub
71	<i>Leucas aspera</i> (Willd.) Spreng.*	Lamiaceae		Herb
72	<i>Limncharis flavata</i> (L.) Buch.	Alismataceae		Herb
73	<i>Lindernia sessiliflora</i> (Benth.) Wetts.f.	Scrophulariaceae		Herb
74	<i>Lindernia rotundifolia</i> (L.) Mukerjee	Scrophulariaceae		Herb
75	<i>Ludwigia perennis</i> L.	Onagraceae	Trop. Africa	Herb

.....Continue

76	<i>Marselia quadrifolia</i> L.	Marsileaceae		Herb
77	<i>Mitracarpus verticillatus</i> (Schum.&Thonn.) Vice	Rubiaceae		Herb
78	<i>Mollugo pentaphylla</i> L.	Molluginaceae		Herb
79	<i>Naregamia alata</i> Wight & Arn.	Meliaceae		Herb
80	<i>Nymphoides indica</i> (L.) Kutze.	Menyanthaceae		Aquatic herb
81	<i>Ocimum sanctum</i> L.*	Lamiaceae		Herb
82	<i>Ocimum tenuiflorum</i> L.*	Lamiaceae		Herb
83	<i>Oldenlandia travencorica</i> (Bedd) O.Kutze.	Rubiaceae		Herb
84	<i>Panicum repens</i> L.	Poaceae		Herb
85	<i>Panicum paludosum</i> Roxb.	Poaceae		Herb
86	<i>Pennisetum polystachyum</i> (L.) Schult	Poaceae		Herb
87	<i>Phyllanthus amarus</i> Schum & Thonn *	Euphorbiaceae		Herb
88	<i>Physalis angulata</i> L.	Solanaceae	Trop. America	Herb
89	<i>Polygonum barbatum</i> L.	Polygonaceae		Herb
90	<i>Polygonum glabrum</i> Willd.	Polygonaceae		Herb
91	<i>Portulaca oleraceae</i> Linn.*	Portulacaceae	Trop. America	Herb
92	<i>Potamogeton nodosus</i> Poiret	Potamogetonaceae		Aquatic herb
93	<i>Pouzolzia indica</i> (L) Gaut.	Urticaceae		Herb
94	<i>Rungia laeta</i> Clarke in Hook.f.*	Acanthaceae		Shrub
95	<i>Saccharum spontaneum</i> L*	Poaceae		Herb
96	<i>Salvinia molesta</i> D.S.Mitch.	Salviniaceae	Brazil	Aquatic herb
97	<i>Scoparia dulcis</i> L. *	Scrophulariaceae	Trop. America	Herb
98	<i>Senna tora</i> L. (Roxb.)	Caesalpiniaceae	South America	Shrub
99	<i>Sesamum indicum</i> L. *	Pedaliaceae		Erect herb
100	<i>Sphaeranthus indicus</i> L. *	Asteraceae		Herb
101	<i>Smithia sensitiva</i> Ait.	Fabaceae		Herb
102	<i>Spermocoe verticillata</i> L.	Rubiaceae		Herb
103	<i>Spirodela polyrhiza</i> (L.) Schleid.	Lemnaceae		Herb
104	<i>Synedrella nodiflora</i> (L.) Gaerln.	Asteraceae	West Indies	Herb
105	<i>Trianthema portulacastrum</i> L. *	Aizoaceae		Herb
106	<i>Tridax procumbens</i> L.	Asteraceae	Trop.central America	Herb
107	<i>Typha angustifolia</i> L.	Typhaceae	Trop. America	Herb
108	<i>Vetiveria zizanioides</i> (L.) Nashin *	Poaceae		Herb
109	<i>Xanthium indicum</i> Koenig	Asteraceae	Trop. America	Herb
110	<i>Xenostegia tridentate</i> (L) Austin & Staples	Convolvulaceae		Prostrate herb

\*Medicinal plants

Table 2. Anova

		SUM OF SQUARES	DF	MEAN SQUARE	F	SIG.
No_Species	Between Groups	796.0302	9	88.4478	1.744917	0.090822
	Within Groups	4409.929	87	50.68883		
	Total	5205.959	96			
No Individuals	Between Groups	30368.06	9	3374.229	1.627707	0.119817
	Within Groups	180350.6	87	2072.995		
	Total	210718.7	96			
Sp_Richness	Between Groups	23.96014	9	2.662238	1.619185	0.122221
	Within Groups	143.044	87	1.644184		
	Total	167.0041	96			
Shannon	Between Groups	2.387035	9	0.265226	1.023083	0.428283
	Within Groups	22.55407	87	0.259242		
	Total	24.9411	96			
Simpson	Between Groups	0.022518	9	0.002502	0.698856	0.708214
	Within Groups	0.311472	87	0.00358		
	Total	0.33399	96			

to qualify species richness showed greater diversity in Pattambi with Shannon's diversity index of 3.605, least at Chamravattam (3.018) (Fig.1). ANOVA indicated no significant diversity between the sites ( $p=0.43$ ) (Table 2). Simpson Index in the study area for abundance of species ranged from 0.9451 to 0.9698. There was no significant difference between the stations studied (ANOVA =0.708214) (Table 2). Poaceae (15 sps.) and Cyperaceae (10 sps.) dominated the vegetation analysed. Amaranthaceae and Fabaceae with 7 species each were the next most common families found in the study area. 25 families had just one representative each (Table 1). True aquatic species were restricted to *Potamogeton nodosus* Poiret, *Nymphoides indica* (L.) O. Ktze., *Spirodela polyrhiza* (L.) Schleid. *Eichhornia crassipes* (Mart.) Solms. and *Salvinia molesta* D. S. Mitch. *Potamogeton nodosus* Poiret, a threatened species of Kerala, was also observed.

## DISCUSSION

Majority of the plants recorded in the present study were either moisture loving or wetland species as depicted by Cook (1996). The presence of wetland and terrestrial plants in the study area indicate a strong link between the two ecosystems and also points to the shrinking river basin, which is being dominated by sedges and grasses. The sedges and grasses contribute 23 % to the diversity of the flora along the banks of Bharathapuzha River. Sukumaran and Jeeva (2011) have also observed that the Cyperaceae and Poaceae are the dominant wetland flora of Kanyakumari district. *Saccharum spontaneum* L., *Cyanodon dactylon* (L) Pers. and *Cyperus compressus* L. were the major grasses recorded. Similar observation from the margin of River Ganga has been made by Krishnamoorthy *et al.* (1991). *Saccharum spontaneum* L. *Typha angustifolia* L.

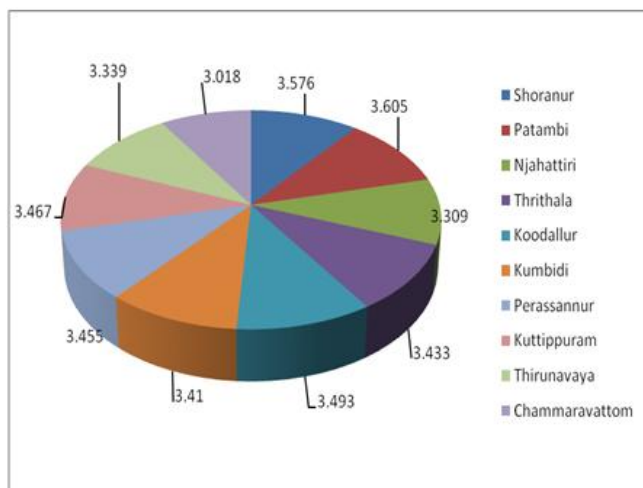


Fig. 1. Shannon's diversity index

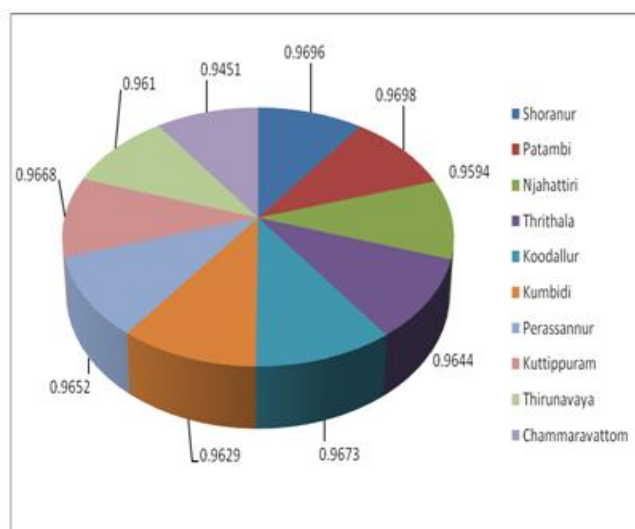


Fig. 2. Simpson's Diversity Index

and *Vetiveria zizanioides*(L.) Nashin, along the river bank have a valuable role in the protection of banks from erosion and also support aquatic organisms. Datta *et al.* (2011) have reported similar findings from Subansiri in North East India. These plants play a vital role in the primary productivity and nutrient cycling. 25 % of the plants recorded are alien to India (Table 1). The exotic invasive species *Eichhornia crassipes* (Mart) Solms, *Salvinia molesta* D. S. Mitch and various *Ipomoea* species are major threats this aquatic environment and would annihilate indigenous species. These weeds are the indication of disturbance in the vegetation of the area. The spread of these weeds from their native habitat is mainly due to anthropogenic interference. The invasion of weeds is the beginning of ecosystem degradation (Sujana and Sivaperumal, 2008). Bijukumar, (2000) while reviewing the impact of exotic fishes on aquatic biodiversity of India, states that the invasions of non-native species can reduce the state's biological diversity. 34% of the plants recorded from the study area have medicinal properties. Maya *et al.* (2003) discussed the economic importance 35 species of river vegetation of Kerala. The present study indicates that the species richness is less compared with that of sholas of Eravikulam, which are hotspots of the Western Ghats, where Jose *et al.* (1994) have recorded a high value of 4.86. The relatively low values of

species richness from the present study may be due to the river water being regulated most of the time by dams, leading to reduce flow and consequent dryness, especially during the time the study was conducted, viz. the pre monsoon period. According to Bijukumar (2001), the dams across the river have contributed to the present deterioration of the river by reducing the quantity and quality of water and altering the course of the river and by reducing its biodiversity.

## Summary and Conclusion

Wetland species and moisture loving plants accounted for majority of the flora rather than the truly aquatic species. The river being threatened by exotic invasive species and weeds, (25 %) and this will have a toll of the natural biodiversity. The diversity indices showed that all the stations under study have similar type of vegetation, and so no significant variance between the sites. The vegetation is disturbed by the advent of alien species and shows only moderate diversity and species richness, yet 34% of the plants recorded have medicinal importance.

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