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PHYTOSOCIOLOGY OF FRESHWATER MACROPHYTES FOUND IN MORANG DISTRICT, EASTERN NEPAL

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In total, 38 species of aquatic macrophytes were collected from lentic (Betana pond and Bhattapokhari) and lotic (Singhia river) freshwater bodies of Morang district, eastern Nepal during January-December, 2009. Macrophytes of Singhia river had 20.5% similarity with Betana pond, and 21% with Bhattapokhari. However, Betana pond and Bhattapokhari had no species'similarity. Growth form categories were in the order: hyperhydates(29%) > tenagophytes(26%) > helophytes = vittates (18.5%) > pleustophytes(8%). *Blyxa japonica* dominated Betana pond with biomass range between 89.2 and 89.2-135 g/m^2 and IVI range between 52 and 99.2; *Eichhornia crassipes* dominated Bhattapokhari with biomass range between 650.7 and 1120.5 g/m^2 and IVI range between 95.5 and 192.8; and *Panicum psilopodium* dominated the shallow water zone in the Singhia river with biomass range between 30.1 and 42 g/m^2 and IVI range between 42.8 and 55.7.

Key words: Biomass, importance value index (IVI), growth forms

Aquatic macrophytes influence the structural and functional aspects of freshwater ecosystems mainly through the species composition, nutrient cycling and productivity (Canfield 1984; Adoni and Yadav 1985). In Nepal, although there are many reports on aquatic flora, community level studies on aquatic macrophytes are in infancy (Shrestha, 1997, 2000; Burlakoti and Karmacharya 2004 Upadhyay 2008). This report pertains to seasonal changes in floristic composition, growth forms, frequency, density, coverage, biomass and importance value index (IVI) of aquatic macrophytes occurring in two lentic (Betana pond and Bhattapokhari) and one lotic (Singhia river) freshwater bodies in the Terai plain of Morang district, eastern Nepal.

MATERIALS AND METHODS

Among the study sites, Singhia river and Bhattapokhari (a derelict depression spreaded in 1.5 ha area with annual variation in water depth between 0.5-1.0 m) are located at lat N 26^0 20', long E 87^0 16'; and altitude 72 m, msl; whereas Betana pond (an Ox-bow pond spread in 5.5 ha area with annual variation in water depth between 1-1.5 m) is located at lat N 26^0 39', long E 87^0 25', and altitude 115 m, msl. Both Bhattapohhari and Singhia river are surrounded by cultivated lands whereas Betana pond is surrounded by forests in east, north and west sides. Its southern side is situated adjacent to East-West Mahendra Highway. All the sites used to be flooded during the rainy season.

The study sites had alluvial soil and tropical monsoon climate with three distinct seasons *viz.* winter (November-February), summer (March-June) and rainy (July-October) in a year. The average annual rainfall was 1312 mm, average annual minimum and maximum temperatures 14.2^{0}C and 30.6^0 C, respectively.

Samplings of aquatic macrophytes were done by harvest method using a quadrat of 50×50 sq cm size in adequate numbers at monthly intervals from January to December, 2009. Collected samples were washed, brought to the laboratory and after proper sorting and processing samples were oven dried to a constant weight at 80^{0}C. The plant growth forms were identified as per the scheme of Cook (1996), whereas methods of Zobel *et al*.

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SN	Family/Name of plant	Growth form	Occurences I	II	III
	Macroalgae				
	Characeae				
1.	*Chara schweinitzii* A. Braun	Vittates	-	+	-
	Pteridophytes				
	Azollaceae				
2.	*Azolla imbricata* (Roxb.) Nakai	Pleustophytes	+	-	+
	Marsileaceae				
3.	*Marsilea crenata* Presl	Hyperhydates	+	-	+
	Angiospermae-Dicots				
	Acanthaceae				
4.	*Hygrophila polysperma* (Roxb.) T. Anders	Tenagophytes	-	-	+
	Amaranthaceae				
5.	*Alternanthera philoxeroides* Griseb	Hyperhydates	-	+	+
6.	*A. sessilis* (L.) DC.	Helophytes	-	-	+
	Apiaceae				
7.	*Oenanthe javanica* (Blume) DC.	Hyperhydates	-	-	+
	Asteraceae				
8.	*Eclipta prostrata* (L.) L.	Helophytes	-	-	+
9.	*Enydra fluctuans* Lourerio	Vittates	+	-	-
10.	*Gnaphalium polycaulon* Pers.	Helophytes	-	-	+
11.	*Sphaeranthus indicus* L.	Helophytes	-	-	+
	Ceratophyllaceae				
12.	*Ceratophyllum demersum* L.	Vittates	+	-	-
	Convolvulaceae				
13.	*Ipomoea carnea* Jacq. subsp. *fistulosa* (Mart. ex Choicy) D.F. Austin	Hyperhydates	-	+	+
	Onagraceae				
14.	*Ludwigia perennis* L.	Tenagophytes	-	-	+
	Polygonaceae				
15.	*Polygonum barbatum* (L.) Hara				
16.	*P. hydropiper* L.	Tenagophytes	-	-	+
17.	*P. lapathifolium* L.	Tenagophytes	-	-	+
18.	*Rumex dentatus* L.	Hyperhydates	-	-	+
	Ranunculaceae	Tenagophytes	-	-	+
19.	*Ranunculus scleratus* L.				
	Scrophulariaceae	Hyperhydates	-	-	+
20.	*Limnophila heterophylla* (Roxb.) Benth.				
21.	*Veronica anagallis -aquatica* L.	Vittates	+	-	-
	Angiospermae-Monocots	Tenagophytes	-	-	+
	Araceae				
22.	*Colocasia esculenta* (L.) Schott.				
23.	*Pistia stratioites* L.	Tenagophytes	-	-	+
	Commelinaceae	Pleustophytes	+	-	+
24.	*Commelina benghalensis* L				
	Cyperaceae	Helophytes	+	-	+
25.	*Cyperus compressus* L.				
26.	*C. difformis* L	Helophytes	-	-	+
27.	*Fimbristylis miliacea* (L.) Vahl	Tenagophytes	-	-	+
28.	*Schoenoplectus mucronatus* (L.) Palla	Tenagophytes	-	-	+

	Hydrocharitaceae	Hyperhydates	-	-	+
29.	*Blyxa japonica* (Miq.) Maxim				
30.	*Hydrilla verticillata* (L. f.) Royle	Vittates	-	-	+
	Poaceae	Vittates	+	-	-
31.	*Cynodon dactylon* L.				
32.	*Hemarthria compressa* (L. f.) R. Br.	Helophytes	+	-	-
33.	*Panicum psilopodium* Trin.	Tenagophytes	-	-	+
34.	*Paspalum distichum* L.	Hyperhydates	-	-	+
35.	*Sacciolepis. interrupta* (Willd.) Stapf	Hyperhydates	-	-	+
	Pontederiaceae	Hyperhydates	-	-	+
36.	*Eichhorni a crassipes* (Mart.) Solms.				
	Potamogetonaceae	Pleustophytes	-	+	+
37.	*Potamogeton crispus* L.				
	Typhaceae	Vittates	-	+	+
38.	*Typha angustifolia* L.	Hyperhydates	-	+	-

Table 2: Seasonal occurrences, range of frequency, density, coverage, biomass and IVI of aquatic macrophytes in Betana pond, Bhattapokhari , and singhia river; W= winter, S= summer, and R= rainy; += presence, -= absence.*

Plants	Occurrences			Frequency	Density	Coverage	Biomass	IVI
	W	S	R	%	ind/m^2	%	g/m^2	
Singhia river								
Alternanthera philoxeroides	+	+	+	30-52.5	8-14	2.5-6.5	4.6-23.5	15.1-28
Azolla imbricata	-	+	-	0-50	0-103	0-2	0-3.1	0-42.5
Cyperus compressus	+	+	-	0-35	0-12.6	0-2.5	0-17.9	0-17.6
Eichhornia crassipes	+	+	+	26.6-60	5.3-28	2-6	9.3-11.2	10.8-45.8
Hemarthria compressa	+	+	+	20-30	3.9-9.3	1-2.7	1.9-45.2	8.9-15.0
Hydrilla verticillata	+	+	+	10-40	1.3-38.6	1-2.5	0.7-12.6	4.6-35.7
Hygrophila polysperma	+	-	-	0-30	0-18.6	0-3.5	0-12.1	0-23.1
Marsilea crenata	+	+	+	30-50	13.3-38.6	1.6-3.5	3.5-36.9	15.5-41
Panicum psilopodium	+	+	+	55-77.5	27.3-35.3	6.5-12.2	30.1-42	42.8-55.7
Paspalum distichum	-	-	+	0-20	0-16	0-2	0-24.8	0-18.5
Polygonum lapathifolium	-	+	+	0-30	0-10.6	0-2.5	0-43.5	0-17.8
Potamogeton crispus	+	+	-	0-50	0-13.3	0-2	0-3.9	0-20.4
Schoenoplectus mucronatus	+	+	-	0-45	0-4.5	0-4.5	0-19	0-29.4
Veronica anagallis-aquatica	+	+	-	0-45	0-21.9	0-3.2	0-26.9	0-26.9
Bhattapokhari								
Alternanthera philoxeroides	+	+	+	30-47.5	15.6-22.5	3.3-4.5	82.8-202.9	30.7-71
Chara schweinitzii	+	+	-	0-40	0-1203	0-2.5	0-60	0-118.1
Eichhornia crassipes	+	+	+	67.5-72.5	43.6-68	17.2-24.7	650.7-1120.5	95.5-192.8
Ipomoea carnea	-	+	+	0-10	0-2.6	0-3	0-86.3	0-18.9
Potamogeton crispus	+	+	-	0-27	0-61.6	0-3	0-10.1	0-31.5
Typha angustifolia	+	+	+	8.7	2.7-49.3	1.7-2.2	141.7-654	10.9-17.3
Betana pond								
Azolla imbricata	+	-	-	0-73.3	0-817.6	0-18.6	0-2.1	0-125
Blyxa japonica	+	+	+	65-72.5	46.7-66	20.2-22	89.2-135	52-99.2
Ceratophyllum demersum	+	+	+	65-67.5	34.1-56.8	15.7-18.2	30.9-40.2	44.9-86.3
Enydra fluctuans	+	+	+	26.2-32.5	30.4-40.9	6.7-7.5	12.5-19	22-44.5
Limnophila heterophylla	+	+	+	26.2-35	14.6-20.4	5.2-8.5	11.3-35.4	22.5-32.8
Pistia stratioites	+	+	+	25-37.5	16.8-76.8	4.5-10.3	12.1-18.9	27.3-60

* Only those plant species with IVI more than 15 have been included in the Table.

(1987) and Mueller-Dombois and Ellenberg (1974) were adopted for determining frequency, density, coverage, and importance value index (IVI) of the aquatic macrophytes.

RESULTS AND DISCUSSION

Thirty nine species of aquatic macrophytes (Macroalga-1, Pteridophytes-2, Dicots-18, and Monocots-18) were recorded from all the studied sites (Table 1). Growth form categories in these water bodies were in the order: hyperhydates (29%) > tenagophytes (26%) > helophytes= vittates (18.5%) > pleustophytes (8%). Emergents dominated Singhia river had Hel (7), Ten (10), Hyp (10), Vit (2), Pleu (3); that in Bhattapokhari Hyp, (3) Vit (2), Pleu (3); and Betana pond (submerged dominated) had Hyp (1), Vit (4), Pleus (2). Macrophytes of Singhia river had 20.5% similarity with Betana pond, and 21% with Bhattapokhari however, Betana pond and Bhattapokhari had no species' similarity. Increased species richness and diversity of emergents in the shallow water zone of Singhia river in contrast to Bhattapokhari and Betana pond was due to decrease of water depth. The decreasing trend in the number of emergents, submerged and free floating species with increasing water depth has been reported earlier by Van der Valk and Davis (1976).

Macrophytes of lentic water bodies (Bhattapokhari and Betana pond) occurred throughout the year except *Azolla imbricata, Chara schweinitzii* and *Potamogeton crispus;* which occurred only during winter and summer months. However, Singhia river had seasonality in species' occurrences except *Alternanthera philoxeroides, Eichhornia crassipes, Hemarthria compressa, Hydrilla verticillata, Marsilea crenata and Panicum psilopodium.* In the Singhia river, *Azolla imbricata, Cyperus compressus. Hygrophila polysperma, Potamogeton crispus, Schoenoplectus mucronatus* and *Veronica anagallis-aquatica* occurred during winter-summer seasons and *Paspalum distichum and Polygonum lapathifolium* during rainy season with IVI >15. Changes in species composition of riverine vegetation are in tune with the hydrodynamics and sediment characteristics (Cathleen *et al.* 2001). Wide river sections with weak current favour species with propagules having the ability to float for longer duration prior to their germination and establishment (Nilsson *et al.* 2002).

*P*hytosociological status (seasonal range of frequency, density, coverage, IVI, and biomass) of macrophytes sampled from Singhia river, Bhattapokhari and Betana pond are given in Table 2. Most dominant species occurring throughout the year were: Singhia river-*Panicum psilopodium* (IVI 42.8-55.5, biomass 30.1-42 g/m^2)*, Marsilea crenata* (IVI 15.5-41, biomass 3.5-36.9 g/m^2)*; Bhattapokhari-Eichhornia crassipes* (IVI 95.5-192.8, biomass 650.7-1120.5 g/m^2)*, Alternanthera philoxeroides (*IVI 30.7-72, biomass 82.8-202.9 g/m^2); *and Betana pond-Blyxa japonica* (IVI 52-99.2, biomass 89.2-135 g/m^2), *Ceratophyllum demersum (*IVI 44.9-86.3, biomass 30.9-40.2 g/m^2). *Alternanthera sessilis, Colocasia esculenta, Commelina benghalensis, Cynodon dactylon, Cyperus difformis Eclipta prostrata, Fimbristylis miliacea, Gnaphalium polycaulon, Ipomoea carnea, Ludwigia perennis, Oenanthe javanica, Polygonum barbatum, P. hydropiper, Pistia stratioites*, *Ranunculus scleratus, Rumex dentatus, Sacciolepis interrupta* and *Sphaeranthus indicus* had IVI < 15 in the Singhia river.

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