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Diversity of freshwater macrophytic vegetation of six rivers of south West Bengal

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Abstract: Eighty–four species of macrophytes belonging to 73 genera and 34 families were recorded from the riverine beds of six major rivers (Dwarkeswar, Kansai, Keleghai, Rupnarayan, Shilabati and Subarnarekha) of South West Bengal from March 2001 to February 2002. Physicochemical parameters of water and soil of different study sites were estimated. Seasonal distributional patterns of different categories of vegetation (terrestrial, semiaquatic and aquatic) were studied along with the seasonal fluctuation of major ecological variables. Result on similarity indices showed that river Rupnarayan considerably differs from other rivers in terms of species composition and abundance of macrophytes.

Resumen: Ochenta y cuatro especies de macrofitas pertenecientes a 73 géneros y 34 familias fueron registradas en los lechos ribereños de seis ríos principales (Dwarkeswar, Kansai, Keleghai, Rupnarayan, Shilabati y Subarnarekha) del sur de Bengala Occidental, entre marzo de 2001 y febrero de 2002. Se estimaron los parámetros fisicoquímicos del agua y el suelo en diferentes sitios de estudio. Se estudiaron los patrones estacionales de distribución de diferentes categorías de vegetación (terrestre, semiacuática y acuática) junto con la fluctuación estacional de las variables ecológicas principales. Los resultados de los índices de similitud mostraron que el río Rupnarayan difiere considerablemente de los otros ríos en términos de la composición de especies y la abundancia de macrofitas.

Resumo: Oitenta e quatro espécies de macrófitas pertencentes a 73 géneros e 34 famílias foram registados em leitos ribeirinhos de seis maiores rios (Dwarkeswar, Kansai, Kaleghai, Rupnarayan, Shilabati e Subarnarekha) do sudoeste de Bengala entre Março de 20001 e Fevereiro de 2002. Os parâmetros físico–químicos da água e do solo das diferentes estações de estudo foram estimados. Os padrões de distribuição sazonal das diferentes categorias de vegetação (terrestre, semi–aquática e aquática) foram estudados ao longo da flutuação sazonal das principais variáveis ecológicas. Os resultados dos índices de semelhança mostraram que o rio Rupnarayan difere consideravelmente dos outros rios em termos da composição das espécies e abundância das macrófitas.

Key words: Freshwater macrophyte, physico chemical parameters, river, similarity index.

Introduction

Aquatic and semiaquatic macrophytes play an important role in maintaining the riverine ecosystem. Although several studies have been done on macrophytic diversity in different lentic fresh water bodies of India (Billore & Vyas 1981; Dey & Kar 1989; Kar & Barbhuiya 2001; Unni 1971), in riverine or lotic system, such works are very scanty (Chavan & Sabnis 1961; Gopal 1990; Gopal & Chamanlal 1991; Gopal & Zutshi 1998). The growth, propagation and abundance of aquatic and semiaquatic macrophytes along with other hydrophilic terrestrial vegetations during different seasons help enhancement of biodiversity and influence their distribution pattern . The present paper elucidates the species composition and seasonal distribution of various macrophytic vegetations growing on river beds of six fresh water rivers of South West Bengal, India, highlighting soil and water qualities of these aquatic environments.

Materials and methods

The present investigation has been conducted during March 2001–February 2002 in 19 sampling sites (S1–S19) covering six rivers of South West Bengal of which 6 on Dwarkeswar, 3 on Kansai, 2 on Keleghai, 2 on Rupnarayan, 3 on Shilabati and 3 on Subarnarekha river (Fig. 1).

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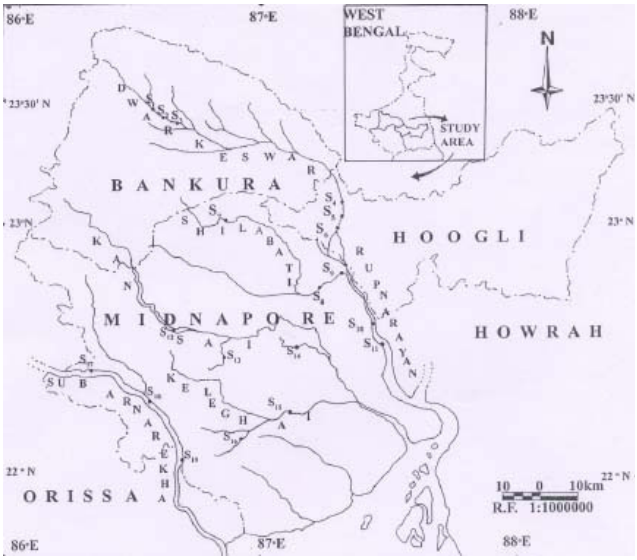

Fig. 1. Map showing the study sites (S_1–S_{19}) along major rivers of South West Bengal; River Dwarkeswar: S_1–Rajagram, S_2–Ktherdanga, S_3–Ekteswar, S_4–Chandur, S_5–Kalipur, S_6–Dingdubi More; River Shilabati: S_7–Garbeta, S_8–Ghatal, S_9–Bandar, River Rupnarayan: S_{10}–Natunbazar, S_{11}–Denan; River Kansai: S_{12}–Midnapore, S_{13}–Gokulpur, S_{14}–Khirai; River Keleghai: S_{15}–Dehati, S_{16}–Khakurda; River Subarnarekha: S_{17}–Gopiballavpur, S_{18}–Rohini, S_{19}–sonakonia.

Macrophytes were collected from the main flow of water to the top of the banks of the river–the length of which from main riverine course vary from 50 meters to 100 meters based on water volume. Investigations were made at monthly interval through three seasons viz. Pre monsoon (PrM; March–June), Monsoon (M; July–October), and Post monsoon (PoM; November–February). All the macrophytic vegetations were grouped into three categories viz. aquatic (A), semiaquatic (SA) and terrestrial (T). The last category often intermingles with aquatic and semiaquatic vegetation during short duration of a year. Coefficient of similarity among different categories viz. aquatic (A), semiaquatic (SA) and terrestrial (T) plants of six rivers was calculated using the Sorensen Similarity Index (SSI) –

$$SSI = \frac{2C}{A+B} \times 100$$

where, C = Common species from two sites
A = Total number of species from 1st site
B = Total number of species from 2nd site.

Major water quality parameters (pH, temperature, dissolved oxygen, light penetration, conductivity, hardness, COD, BOD etc.) and soil parameters (texture, organic carbon, pH etc.) have been analyzed by following standard methods (APHA 1995; Jackson 1971; Trivedy & Goel 1984).

Table 1. Seasonal and habitat wise occurrence of plant species in six rivers.

River	Terrestrial species	Aquatic species	Semi aquatic species	Total
Dwarkeswar				
M	31	7	13	51
PoM	6	0	3	9
PrM	0	0	0	0
PoM-M	11	3	0	14
PrM-M	3	1	0	4
PrM-M-PoM	0	0	1	1
Total	51	11	17	79
Shilabati				
M	29	6	14	49
PoM	6	0	3	9
PrM	0	0	0	0
PoM-M	12	2	0	14
PrM-M	4	1	0	5
PrM-M-PoM	0	0	1	1
Total	51	9	18	78
Rupnarayan				
M	9	3	8	20
PoM	4	0	2	6
PrM	0	0	0	0
PoM-M	5	2	0	7
PrM-M	2	0	0	2
PrM-M-PoM	0	0	1	1
Total	20	5	11	36
Kansai				
M	29	7	14	50
PoM	5	0	3	8
PrM	0	0	0	0
PoM-M	12	3	0	15
PrM-M	5	1	0	6
PrM-M-PoM	0	0	1	1
Total	51	11	18	80
Keleghai				
M	21	6	10	37
PoM	5	0	3	8
PrM	0	0	0	0
PoM-M	10	1	0	11
PrM-M	1	0	0	1
PrM-M-PoM	0	0	1	1
Total	37	7	14	58
Subarnarekha				
M	28	7	14	49
PoM	7	0	3	10
PrM	0	0	0	0
PoM-M	9	2	0	11
PrM-M	8	1	0	9
PrM-M-PoM	0	0	1	1
Total	52	10	18	80

The physicochemical parameters recorded from each of the study sites were averaged monthly for each river and ultimately presented seasonally.

Identification of plants were made in consultation with standard literatures, monographs and relevant floras.

Results and discussion

All total 84 macrophytic species belonging to 73 genera and 34 families were observed during the study period. Among these, 55 terrestrial plants species belonging to 48 genera and 25 families, 11 aquatic plant species belonging to 9 genera and 8 families and 18 semiaquatic plant species belonging to 16 genera and 13 families have been found to occur in different rivers (Appendix 1). The numerical representation of seasonal and habitat–wise distribution of observed plant species in six rivers are shown in Table 1. Among 55 terrestrial plants, river Subarnarekha harbours maximum (52) and river Rupnarayan supports the minimum (20) species. All the 11 aquatic species have been found to occur in both Dwarkeswar and Kansai rivers while minimum number of species (5 species) have been recorded from Rupnarayan river. Out of 18 semiaquatic plants, all species inhabit Shilabati river and a minimum of 11 species inhabit Rupnarayan river. Twenty eight plant species (15 terrestrial, 3 aquatic and 10 semiaquatic) were common in all rivers. Thirty two plant species (21 terrestrial, 5 aquatic and 6 semiaquatic) were common in 5 rivers. Eighteen plant species (13 terrestrial, 2 aquatic and 3 semi aquatic) were common in 4 rivers. Five terrestrial plant species *(Euphorbia microphylla, Guazoma tomentosa, Lippia geminata, Nasturtium indicum, Pentapetis phoenicea,)* were common in 3 rivers. Two plant species [1 terrestrial (*Eupatorium adoratum),* 1 aquatic *(Aeschynomene aspera)*] were common in 2 rivers. Only one semiaquatic plant (*Marsilea quadridfolia*) was present in all rivers during all the seasons. A special mention can be made of *Parthenium*, whose luxuriant growth during post-monsoon months is supposed to inhibit the growth of other macrophytic species during pre-monsoon. The virtual absence of this plant in other periods may be attributed to the fact that most of the *Parthenium* plants were in the seedling stage on these sites or these plants are dried up during pre-monsoon.

Physicochemical parameters (Table 2) of water and soil displayed different characteristics among different rivers. Conductivity (340–2000 mhocm^{-1}), total dissolved solid (188–1242 mg/l), total suspended solid (100–998 mgl^{-1}) and chloride content (25.56–561 mg/l) at Rupnarayan river were found to be abnormally high in comparison to other rivers. In six rivers, pH of water varied from 6.4 to 7.8 and pH of soil varied from 6.1 to 7.7. Transparency, alkalinity, total–hardness, Ca–hardness, Mg–hardness, conductivity, total dissolved solid, total suspended solid ,dissolved oxygen, B.O.D, and total Kjeldahl nitrogen were found to be higher in post-monsoon season in all the rivers except Rupnarayan river where this trend was observed during pre-monsoon season. However, six rivers exhibited differences with regard to soil texture and organic carbon content. The higher content of organic carbon was recorded during pre-monsoon and monsoon seasons. In comparison to pre–monsoon season, the range of organic carbon was from 0.76 to 6.5% in six rivers of which Subarnarekha river was with comparatively low organic carbon content (2.2%), whereas in Rupnarayan river the organic carbon content was higher (5.8%). Soil texture of these six rivers revealed that, except in river Rupnarayan (sand, silt and clay were 17.8%, 43.6% and 38% respectively) and in river Keleghai (sand, silt and clay were 33.6%, 33.5% and 32.6% respectively), all the river beds were sandy in nature . In this respect river Dwarkeswar (sand 92.6%, silt 7.0%, clay 1.3%) and river Subarnarekha (sand 89.5%, silt 8.6%, clay 1.9%) showed much similarity (Table 2)

Free flowing rivers represent one of the most dynamic systems among different aquatic ecosystems. Difference in landscape coupled with physical (current, waves, depth, density etc.) and chemical characteristics (pH, Dissolved oxygen, Total dissolved solid, Chemical oxygen demand etc.) create different types of fluvial environments (Celwell *et al*. 1999, Gregory *et al*. 1991; Malanson 1993). Species composition of aquatic vegetation changes from site to site in a riverine system in tune with the hydrodynamics and sediment characteristics (Cathleen *at al*. 2001), which has been corroborated by the present findings. Besides, dispersal patterns have been found to be important for having an idea about the floristic patterns along rivers, both for species (Staniferth & Cavers 1976) and communities (Nilsson *et al*. 1991; Schaneider & Sharitz 1988). Wide river sections with week current favour species with propagules having the ability to float for longer duration prior to becoming stranded, germinate and establish (Nilsson *et al*. 2002). In the river having high water current, the property of seed floating ability diminishes (Danvind & Nilson 1997). Dependence of seeds stranding on hydrolic factors such as turbulent waves was established

Table 2. Physicochemical characteristics of water and soil (mean of 3 seasons of six rivers).

Parameters	Rivers					
Water	Dwarkeswar	Silabati	Rupnarayan	Kansai	Keleghai	Subarnarekha
Temperature (^{0}C)	28.0	27.8	27.3	28.1	28.0	27.1
pH	7.3	7.0	7.0	7.0	7.0	7.1
Transarency (Secchi Disc, cm)	25.1	18.8	10.9	25.1	19.3	37.3
Alkalinity (mg l^{-1} as $CaCO_3$)	101.1	96.4	94.5	76.9	88.5	78.4
Free carbondioxide (mg l^{-1})	1.9	1.8	2.5	2.4	2.1	2.1
Total hardness (mg l^{-1} as $CaCO_3$)	92.9	75.8	112.6	69.6	67.8	57.3
Ca–hardness (mg l^{-1} as $CaCO_3$)	62.9	51.4	74.2	45.2	46.7	36.9
Mg–hardness (mg l^{-1} as $CaCO_3$)	30.2	23.9	38.3	24.4	21.2	20.3
Conductivity (μ mho cm^{-1})	324.8	271.9	1082.4	215.9	221.7	218.8
Total dissolved solid (mg l^{-1})	163.3	133.1	613.5	114.7	108.7	113.2
Total suspended solid (mg l^{-1})	38.4	97.3	599.5	73.9	76.6	65.6
D.O. (mg l^{-1})	7.5	7.4	7.4	7.3	6.7	7.8
C.O.D. (mg l^{-1})	58.7	56.9	87.9	56.6	70.2	60.9
B.O.D. (mg l^{-1})	2.6	2.7	3.1	2.4	2.6	2.5
Total kjeldahl N (mg l^{-1})	2.9	3.5	2.7	2.6	3.1	2.3
Total phosphate P (mg l^{-1})	4.6	0.3	0.5	1.5	0.2	0.3
Chloride (mg l^{-1})	42.9	36.4	175.0	32.2	32.2	32.0
Salinity ($^0/_{00}$)	0.0	0.0	0.5	0.0	0.0	0.0
Soil						
Temperature	36.1	35.4	35.8	34.1	33.4	34.4
pH	7.0	6.9	6.8	6.7	6.7	6.9
Salinity ($^0/_{00}$)	0.0	0.0	0.1	0.0	0.0	0.0
Organic carbon (%)	2.9	4.4	4.5	3.8	4.6	2.2
Soil texture (%): Sand	92.6	74.2	17.8	53.8	33.6	89.5
Silt	7.0	16.6	43.6	23.9	33.5	806.0
Clay	1.3	9.8	38.0	22.3	32.6	1.9

Table 3. Similarity index in respect to all vegetation (result expressed in %)

	Dwarkeswar	Shilabati	Rupnarayan	Kansai	Keleghai	Subarnarekha
Dwarkeswar		94.3	57.4	99.4	83.2	95.6
Shilabati			63.1	97.5	80.9	94.9
Rupnarayan				60.3	57.4	62.0
Kansai					82.6	97.5
Keleghai						82.6
Subarnarekha						

Table 4. Similarity index in respect to Terrestrial plants (result expressed in %)

	Dwarkeswar	Shilabati	Rupnarayan	Kansai	Keleghai	Subarnarekha
Dwarkeswar		94.1	50.7	100.0	81.8	95.1
Shilabati			56.3	98.0	79.5	93.2
Rupnarayan				53.5	52.6	55.6
Kansai					81.8	97.1
Keleghai						80.9
Subarnarekha						

by Nepf (1999). In the present study, maximum occurrence of macrophytes in Subarnarekha river (52 species) in contrast to river Rupnarayan (20 species) also supports the above findings as the former river enjoys low current and wide flood plain while the latter is characterized by high current experiencing tidal influence.

Similarity indices, in respect of all vegetation types, terrestrial, aquatic and semi aquatic inhabiting the six rivers are represented separately in the Tables 3 – 6. Similarity indices revealed that in respect of vegetation covering six rivers, only in six cases percentages of similarity were above 90% (Dwarkeswar and Shilabati

Table 5. Similarity index in respect to Aquatic plants (result expressed in %)

	Dwarkeswar	Shilabati	Rupnarayan	Kansai	Keleghai	Subarnarekha
Dwarkeswar		90.0	62.5	100.0	77.8	95.2
Shilabati			71.4	90.0	75.0	94.7
Rupnarayan				62.5	50.0	66.7
Kansai					77.8	95.3
Keleghai						82.3
Subarnarekha						

Table 6. Similarity index in respect to Semiaquatic plants (result expressed in %)

	Dwarkeswar	Shilabati	Rupnarayan	Kansai	Keleghai	Subarnarekha
Dwarkeswar		97.1	71.4	97.1	90.3	97.1
Shilabati			61.1	100.0	87.5	100.0
Rupnarayan				75.9	72.0	75.9
Kansai					87.5	100.0
Keleghai						87.5
Subarnarekha						

94.3%; Dwarkeswar and Kansai 99.4%; Dwarkeswar and Subarnarekha 95.6%; Shilabati and Kansai 97.5%; Shilabati and Subarnarekha 94.9%; Kansai and Subarnarekha 97.5%). The percentages of similarity were below 60% only in two cases [Dwarkeswar and Rupnarayan (57.4%) and Rupnarayan and Keleghai (57.4%)]. The aquatic plants from Dwarkeswar and Kansai river showed 100% similarity (Table 5).The same trend (100% similarity) was found among semiaquatic plants of Kansai and Shilabati; Shilabati and Subarnarekha; Kansai and Subarnarekha (Table 6). The results highlight the differences in vegetation patterns in response to different ecological conditions of the riverine tracts. During monsoon, due to heavy precipitation, much of the river belts become water saturated conducive for the plant species to grow and propagate. This seasonal flourishing of plant biomass ultimately leads to enrich the soil and water of rivers during post-monsoon months through the process of decomposition.

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Appendix 1: List of plant species observed in sampling sites covering six rivers of south West Bengal during the study period; code: PrM = Pre Monsoon, M= Monsoon, PoM = Post Monsoon; present +, absent -.

Family and Species	Dwarkeswar			Silabati			Rupnarayan			Kansai			Keleghai			Subarnarekha		
	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
Terrestrial																		
Amarantaceae																		
Aerva aspera	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-	+	-
Amarantus spinosus	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-	+	-
Celosia argentea	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Gomphrena decumbens	-	+	+	-	+	+	-	-	-	-	+	+	-	+	+	-	+	+
Asteraceae																		
Eupatorium odoratum	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+
Grangea maderaspatana	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+
Mikania scandens	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+
Parthenium hysterophorus	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+
Tridax procumbens	-	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-	+
Vernonia cinerea	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-	+	-
Boraginaceae																		
Heliotropium curassavicum	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+
Heliotropium indicum	-	+	+	-	+	+	-	-	-	-	+	+	-	+	+	-	+	+
Heliotropium supinum	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+
Brassicaceae																		
Nasturtium indicum	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-
Capparidaceae																		
Cleome viscosa	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Chenopodiaceae																		
Chenopodium ambrosoides	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-	+	-
Convolvulaceae																		
Evolvulus nummularius	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Euphorbiaceae																		
Acalypha indica	+	+	-	+	+	-	-	-	-	+	+	-	-	-	-	+	+	-
Croton bonplandianum	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Euphorbia hirta	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+
Euphorbia microphylla	-	-	-	-	+	+	-	-	-	-	+	+	-	+	+	-	-	-
Phyllanthus simplex	-	+	-	-	+	-	-	-	-	+	+	-	-	-	-	+	+	-
Phyla nodiflora	-	+	-	-	+	-	-	-	-	+	+	-	-	-	-	+	+	-
Jatropha curcas	-	-	-	-	+	-	-	+	-	-	+	-	-	-	-	+	+	-
Jatropha gossypifolia	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	+	+	-

Contd.....

Appendix 1: Contd..

Family and Species	Dwarkeswar			Silabati			Rupnarayan			Kansai			Keleghai			Subarnarekha		
	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
Fabaceae																		
Alysicarpus monilifer	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Mimosa pudica	+	+	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+	-
Phaseolus trilobus	+	+	-	+	+	-	-	-	-	+	+	-	-	-	-	+	+	-
Lamiaceae																		
Leucas aspera	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Malvaceae																		
Sida cordifolia	-	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+
Meliaceae																		
Azadirachta indica	-	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+
Myrtaceae																		
Barringtonia acutangula	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Passifloraceae																		
Passiflora foetida	-	+	+	-	+	+	-	-	-	-	+	+	-	+	+	-	+	+
Poaceae																		
Digitaria sanguinalis	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Eragrostis cynosuroides	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Imperata cylindrica	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Oryza sativa	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Panicum flavescens	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Paspalidium sorobiculatum	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Saccharum officinarum	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Polygonaceae																		
Polygonum plebejum	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-	+	-
Portulacaceae																		
Trianthemum portulacastrum	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Rubiaceae																		
Oldenlandia corymbosa	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Oldenlandia biflora	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Sapindaceae																		
Cardiospermum helicacabum	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Scrophulariaceae																		
Scoparia dulcis	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-	+	-
Solanaceae																		
Physalis minima	-	+	+	-	+	+	-	-	-	-	+	+	-	+	+	-	-	-
Solanum torvum	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+
Solanum xanthocarpum	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+

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Appendix 1: Contd..

Family and Species	Dwarkeswar			Silabati			Rupnarayan			Kansai			Keleghai			Subarnarekha		
	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
Sterculiaceae																		
Pentapetes phoenicea	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	
Guazuma tomentosa	-	-	-	+	+	-	+	+	-	-	-	-	-	-	-	+	+	-
Tiliaceae																		
Corchorus acutangulus	-	+	-	-	-	-	-	-	-	-	+	-	-	+	-	-	+	-
Verbenaceae																		
Lippia alba	-	+	+	-	+	+	-	-	-	-	+	+	-	-	-	-	+	+
Lippia geminata	-	+	+	-	+	+	-	-	-	-	+	+	-	-	-	-	-	-
Violaceae																		
Ionidium suffruticosum	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-	+	-
AQUATIC																		
Amarantaceae																		
Tilanthera philexoroides	+	+	-	+	+	-	-	+	+	-	+	+	-	-	-	+	+	-
Apiaceae																		
Hydrocotyle asiatica	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-	+	-
Convolvulaceae																		
Ipomoea aquatica	-	+	-	-	-	-	-	-	-	-	+	-	-	+	-	-	+	-
Ipomoea carnea	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Fabaceae																		
Aeschynomene aspera	-	+	+	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-
Hydrocharitaceae																		
Hydrilla spiralis	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Onagraceae																		
Jussiaea repens	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Ludwigia parviflora	-	+	+	-	+	+	-	+	+	-	+	+	-	-	-	-	+	+
Polygonaceae																		
Polygonum hydropiper	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Polygonum orientale	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Pontederiaceae																		
Eichhornia crassipes	-	+	+	-	+	+	-	-	-	-	+	+	-	+	+	-	+	+

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Family and Species	Dwarkeswar			Silabati			Rupnarayan			Kansai			Keleghai			Subarnarekha		
	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
SEMI AQUATIC																		
Acanthaceae																		
Hygrophila polysperma	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Aizoaceae																		
Mollugo spergula	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-	+	-
Amarantaceae																		
Alternanthera paronychioides	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Alternanthera sessilis	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Alternanthera tenella	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Asteraceae																		
Xanthium strumarium	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+
Eclipta alba	-	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+
Chenopodiaceae																		
Chenopodium album	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-	+	-
Trianthema portulacastrum	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
Commelinaceae																		
Commelina bengalensis	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Convolvulaceae																		
Merremia emarginata	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Cyperaceae																		
Cyperus rotunbus	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Marsileaceae																		
Marsilea quadrifolia	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Portulacaceae																		
Portulaca oleracea	-	-	-	-	+	-	-	+	-	-	+	-	-	-	-	-	+	-
Rubiaceae																		
Dentella repens	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+
Scrophulariaceae																		
Bacopa monnieri	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-	+	-
Vandellia crustacea	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-
Sterculiaceae																		
Melochia corchorifolia	-	+	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-

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