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Macrophytic species composition of five wetlands of Sonitpur district of Assam, India

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ABSTRACT

The Sonitpur district is situated between 26^0 30'N to 27^0 02'N Latitudes and 92^0 17'E to 93^0 47'E Longitudes in the northern bank of river Brahmaputra covering an area of 5255.2 km^2 (492145 ha) that accounts for 6.27% of the geographical area of the state. The five wetlands of Sonitpur district of Assam, India, were surveyed for their floristic compositions during the period of 2009 to 2011. The aquatic macrophytic species of these areas were documented. 213 plant species were recorded under 141 genera and 55 families from the wetlands. Family Poaceae contains maximum number of species followed by Cyperaceae and Asteraceae. Moist soil species (Ms) were found to be dominating habits followed by rooted emergent hydrophytes (Reh) and ecotone species (Eco). The most common life forms included geophytes (geo) hydrophytes (hydro) and chamaephytes (chamae).

Key words: Wetlands, macrophytes, dominant, habit, life forms.

INTRODUCTION

Wetlands are defined as lands transitional between terrestrial and aquatic eco-systems where the water table is usually at or near the surface or the land is covered by shallow water [1]. Wetlands are the most productive ecosystem of the world and provide direct and indirect services to mankind and rest of the organisms. However, irrespective of their obvious positive contributions, wetlands are the first among the victims of modern development and degrading with times [2]. India, with its varied topography and climatic regimes harbours a wide variety of wetland habitats. The majority of the inland wetlands are directly or indirectly dependent on the major rivers like Ganga, Brahmaputra etc. India has recently taken commendable initiatives towards the conservation and management of wetlands and rational utilization of their resources. But unfortunately proper documentations as well as inventory wetland studies has not been done in some regions of India, particularly, in the north eastern part of India, where wetlands cover a sizable portion of the entire landscape and perform myriad of functions from the time immemorial. Wetlands are now considered as one of the most threatened ecosystems of the world. Tremendous pressure is exerted on these ecosystems globally, mainly due to the need to find more land for cultivation of crops [3, 4, 5, 6, 7, 8, 9]. Wetlands in India are also increasingly degrading and deteriorating its natural characteristics due to several anthropogenic factors like exponential growth of human population, large scale changes in land use and land covers, industrialisation, urbanisation, unsustainable way of grazing and fishing activities etc.

The state of Assam ($24^0$8´N -$28^0$2´N and $89^0$42´E – 96^0E) falls in the tropical climate belt in the north eastern region of India. The most part of the state has humid, subtropical climatic conditions with heavy rainfall. The state is also known for its rich biodiversity and cultural diversity. In Assam 5097 wetlands (>2.25 ha) and 6081 small wetlands (<2.25 ha) have been identified which encompass 764372 ha that is around 9.74 % of the total geographic area of the state. Of these River/stream types of wetland encompasses 637164 ha accounting majority 84 % of the wetlands followed by lake/pond (51257ha), waterlogged (47141ha) and ox-bow lakes (14173ha).Besides 2833 ha area under man made wetland is also mapped. The climatic condition of Sonitpur district is sub-tropical humid to wet humid during summer and mild cool with foggy condition during winter. Both south-west and northeast monsoons bring rain to this region. Total wetland area in the district is 83427 ha that includes 980 small wetlands (<2.25 ha).

River/stream occupies 94.52% of wetlands. The other major wetland type is Waterlogged - natural (2.22%) and Ox-bow lakes (1.04%). There are 23 Tank/pond types of wetlands covering 84 ha. Sonitpur is the leading district covering 83427 ha of wetland areas which accounts for 10.9% of the total wetlands areas of the state [10]. Aquatic plant species are dependent on the hydrological regime and geological conditions. In Assam, wetlands are largely regulated by rivers, rivulets and streams, therefore most of the wetlands of the state are found in the close proximity of the rivers and vice versa. But due to the modification of hydrology of rivers mainly due to dykes have severely affected the dynamics of many wetland ecosystems in this part of the country.

The first step in conservation of biodiversity is to assess the diversity of natural resources present and identify those, which are important and most irreplaceable [11]. Wetlands being dynamic and influenced by both natural and man-made activities, need frequent monitoring. Regular updation of the status of the wetlands is all the more significant in view of the accelerating pressure on the very existence of these resources due to developmental activities and population pressure being witnessed currently [2]. So far very few notable works on the ecology of the wetlands of Assam have been reported by earlier workers [12, 13, 14 15, 16, 17, 18 19]. At the same time, no remarkable study has been done yet about the wetlands of Sonitpur district of Assam. Therefore the aim of the present study is to document these invaluable biodiversity rich wetlands through assessing the macrophytic communities and the present habitat conditions prevailing there, so that planning for conservation and management of these wetlands could be taken.

MATERIALS AND METHODS

Study area:

The Sonitpur district is bounded on the east by Lakhimpur district, on the west by Darrang district of Assam respectively and on the north by Arunachal Pradesh and on the south by the river Brahmaputra and Nagaon district of Assam. Along the river Brahmaputra and between the central belt and the Brahmaputra, low land condition prevail some parts of which are chronically flood affected. Swampy areas are seen mainly in these areas which represent naturally depressed vast wetlands constituting a sizable area in this zone. There is a steady fall in the level of the district towards the Brahmaputra, thus the whole of the drainage of the district ultimately finds it way in to the Brahmaputra which flows along the southern boundary of the district. The following five wetlands as described below have been selected for the present study.

Boralimora: This wetland is located between the $26^0$40′46.99″N latitude and $93^0$3′16.09″E longitude. It is an almost closed riverine semi perennial wetland occupies an area of 8ha. The wetland receives water from the river Brahmaputra and Ghiladhari. The wetland is encroached on its two sides by human settlements.

Kauribeel: It is situated between $26^0$41′20.64″N latitude and $93^0$01′48.18″E longitude. It is an ox-bow type, open and perennial wetland covering an area of about 8 ha. This wetland is connected with the river Brahmaputra through another river Ghiladhari. After the construction of dykes on the river Brahmaputra and Ghiladhari the wetland area had been reduced considerably and new human settlements have been created by people evacuated from different nearby areas due to natural calamities.

Raumari: Raumari wetland is situated inside the 6th addition of the Kaziranga National Park and lies between $26^0$39′46.43″N latitude and $92^0$56′34.43″E longitude and covers about an area of 35 ha. It is a large floodplain ox-bow, open, perennial and unleased wetland without any noticeable human interference. The main feeder river is Brahmaputra and water from the rivers Ghiladhari and Gabharu also enters the wetland during summer.

Sitalmari: This is an ox-bow type, closed and perennial wetland situated between $26^0$40′15.70″N latitude and $92^0$59′02.30″E longitude. It covers an area about 10ha. The wetland is terminated by dykes and therefore there is no outlet in this wetland. The main feeder river of this wetland is Ghiladhari. Cultivation of seasonal crops around the wetland takes place throughout the year.

Sildubi: It lies between $26^0$39′55.20″N latitude and $92^0$58′50.70″E longitude on the southern side of the district and is adjacent to the Sitalmari wetland. These two wetlands are vertically separated by dykes and the outlet of Sitalmari is interrupted and the inlet of Sildubi is blocked. This construction of dykes has led to the splitting of this wetland into two. It is an ox-bow type, open and perennial wetland. This wetland is located on the bank of the river Brahmaputra and has direct connectivity with the river. It has an area of about 15ha.

An intensive field survey was made during the summer and winter seasons throughout the year in the period of 2010-2013. The coordinates (Latitude and Longitude) of five wetlands of the district have been taken with the help of GPS **(**Model Garmin etrex). The study was conducted in two ecologically different zones of wetlands viz; water

spread and ecotone zone. The macrophyte species found in the study sites were collected and necessary procedure and precautions were followed to prepare herbarium sheets of collected specimens. The plant species were pressed between the absorbents under varying degree of pressure at regular intervals. Dried specimens were poisoned by Kew mixture (115 gm of mercuric chloride dissolved in 4.5 liter of ethyl alcohol). After the specimens were poisoned, they were dried and affixed on herbarium sheets (28cm x 42 cm ± 1 cm) by using tread and fevicol glue. Each and every herbarium sheet was numbered and labeled.

The plant specimens were identified with the help of Flora of Assam, Vol. 1-4 [20]; Flora of Assam, Vol.-5 [21]; Flora of British India, Vol. 1-7 [22]; Aquatic Angiosperms, Botanical Monograph [23]; A Mannual of Aquatic Plants [24]; Tropical Grasses [25] and also in the Herbarium of the department of Botany, Gauhati University, Guwahati Assam.

RESULTS AND DISCUSSION

The total numbers of taxa recorded in the five wetlands of the present study were 213 species under 141 genera and 55 families. The most common families were Poaceae, Cyperaceae, Asteraceae, Polygonaceaae, Araceae and Hydrocharitaceae (Table-1). The highest species were recorded in Raumari wetland (135) followed by Kauribeel (111) wetland. The lowest was observed in Boralimora ((94) and Sildubi (94) followed by Sitalmari (95) wetland. The macrophytes of water spread region of the wetlands were classified into five habits or growth forms following Sharma [26] as i) free-floating hydrophytes (Ffh), ii) rooted hydrophytes with floating leaves (Rhfl), iii) submerged floating hydrophytes (Sfh), iv) rooted submerged hydrophytes (Rsh) and v) rooted emergent hydrophytes (Reh), besides ecotone species (Eco) and moist soil species (Ms) were also categorized in the present investigation. The dominant habits were moist soil species (72), rooted emergent hydrophytes (56), ecotone species (51) and free-floating hydrophytes (13). The rooted hydrophytes with floating leaves were found to be lowest with only six species followed by submerged floating hydrophytes (7) and rooted submerged hydrophytes (8). Likewise, macrophytes were further categorized into different life forms following Raunkiaer [27]. The most common life forms included geophytes (59) hydrophytes (56) and chamaephytes (55). The phanerophytes were found to be minimum (3) followed by hemicryptophytes (9).

Wetland wise, hydrophytes were recorded highest life forms followed by geophytes and chamaephytes. The highest value of hydrophytes was recorded in Raumari wetland (47) followed by Sildubi (40), Sitalmari and Kauribeel wetland (35). The highest value for geophytes was recorded in Raumari wetland (32) followed by Kauribeel wetland (26). The chamaephytes have found to be highest in Kauribeel and Raumari wetland with 29 numbers each. The lowest life forms were observed in the case of phanerophytes followed by hemicryptophytes. In Boralimora wetland no phanerophtes were observed whereas Kauribeel, Sitalmari and Sildubi wetland each of them have shown one number of phanerophytes (Fig.-1).

Likewise, the moist soil species was recorded as highest in Raumari wetland (46) followed by Kauribeel (39) and Sitalmari wetland (30). The highest number of rooted emergent hydrophytes was recorded in Raumari (34) followed by Sitalmari (26) and Boralimora wetland (25). Similarly, the free-floating (10) rooted submerged (8) and submerged floating hydrophytes (7) were found to be highest in Raumari wetland. In Kauribeel wetland, rooted hydrophytes with floating leaves (6) was recorded as highest growth forms (Fig.-2)

Table 1: Floristic composition of five wetlands of Sonitpur district

[1= Boralimora, 2=Raumari, 3=Kauribeel, 4=Sitalmari, 5=Sildubi,√= present, X=absent, chamae = chamaephytes, geo= geophytes, hydro= hydrophytes, helo= helophytes, hemi= hemicryptophytes, phanero= phanerophytes, Eco= ecotone species, Reh= rooted emergent hydrophytes, Ms= moist soil species, ffh=free floating hydrophytes, sfh=submerged floating hydrophytes, Rsh=rooted submerged hydrophytes, Rhfl=rooted hydrophytes with floating leaves, p= perennial A=annual].

		1	2	3	4	5	Life forms	families	Habits	Life spans
1	*Acalypha indica* L.	√	X	X	X	X	chamae	Euphorbiaceae	Eco	P
2	*Acrocephalus hispidus*(L.)Nicols.Et Siva	√	√	√	X	X	chamae	Lamiaceae	Reh	P
3	*Aeschnomene aspera* L.	X	√	X	X	X	chamae	Fabaceae	Reh	P
4	*A. indica* L.	√	X	X	X	X	chamae	Fabaceae	Reh	P
5	*Ageratum conyzoides* L.	√	√	X	X	X	chamae	Asteraceae	Eco	P
6	*Alocasia cucullata* Schott.	√	√	√	√	X	geo	Araceae	Ms	P
7	*A. indica* Schott.	√	X	√	√	X	geo	Araceae	Ms	A
8	*Alternanthera philoxeroides* (Mart.)	√	√	√	√	√	hydro	Amaranthaceae	Reh	P
9	*A. sessilis* (L.) R.Br.ex R&S	√	√	√	√	√	hydro	Amaranthaceae	Reh	P
10	*Amaranthus spinosus* (L.)	√	√	X	X	√	chamae	Amaranthaceae	Eco	P
11	*A. viridis* L.	√	X	√	X	X	chamae	Amaranthaceae	Eco	P
12	*Amorphophallus companulatus* BL.	X	X	√	X	X	geo	Araceae	Ms	P
13	*Anisomelis indica* (L.) O. Kuntze.	X	√	X	X	X	chamae	Lamiaceae	Eco	A
14	*A. ovata* R.Br.	X	X	√	√	X	chamae	Lamiaceae	Eco	A
15	*Aponogeton crispus* Thumb.	√	X	√	√	√	hydro	Aponogetonaceae	Reh	P

16	*Apluda mutica* Linn.	X	X	√	X	X	geo	Poaceae	Ms	P
17	*A. varia* Hack.	X	√	X	X	X	geo	Poaceae	Ms	P
18	*Artimisia embrosides*	X	√	X	X	X	chamae	Asteraceae	Eco	P
19	*Arundinella bengalensis* (Spreng.) Druce.	X	X	√	X	X	geo	Poaceae	Eco	P
20	*Arundu donax* L.	X	√	√	√	√	geo	Poaceae	Ms	P
21	*Asteracantha longifolia* Nees.	X	X	√	√	X	chamae	Acanthaceae	Ms	P
22	*Axonopus compressus* (Sw.)Beauv.	X	√	X	X	X	geo	Poaceae	Ms	P
23	*Azolla pinnata*	X	√	√	X	√	hydro	Azollaceae	Ffh	A
24	*Bergia capensis* L.	X	√	√	X	X	hydro	Elatinaceae	Ffh	P
25	*Borreria hispida* (L.) K.Schum.	X	X	X	√	X	chamae	Rubiaceae	Eco	A
26	*Blyxa aubertti* Rick.	X	√	√	X	X	helo	Hydrocharitaceae	Rsh	A
27	*Carex cruciata* Wah.	√	X	√	X	√	helo	Cyperaceae	Eco	A
28	*C. muricata* L.	X	X	√	√	X	helo	Cyperaceae	Ms	A
29	*C. tora* L.	X	√	√	X	X	chamae	Fabaceae	Eco	P
30	*Cenchrus cillaris L.*	√	√	X	√	X	geo	Poaceae	Ms	P
31	*Centella asiatica* (L.) Urb.	X	√	X	X	X	hemi	Araliaceae	Ms	A
32	*Ceratophyllum demersum* L.	X	√	√	√	√	hydro	Ceratophyllaceae	Sfh	P
33	*C. tuberculatum* Cham.	X	√	√	√	X	hydro	Ceratophyllaceae	Sfh	P
34	*Ceratopteris thalictroides* (L.) Brong.	X	√	X	√	√	geo	Pteridaceae	Ms	P
35	*Chenopodium album* L.	X	X	X	√	X	chamae	Amaranthaceae	Eco	P
36	*Chloris incompleta* L.	X	√	X	X	X	hemi	Poaceae	Ms	P
37	*Chromolaena odorata* (L.)King& H.Er.	X	√	X	X	X	hemi	Asteraceae	Eco	P
38	*Chrysopogon aciculatus* Trin.	√	√	√	X	X	geo	Poaceae	Ms	P
39	*C. gryllus* Trin.	X	√	X	X	X	geo	Poaceae	Ms	P
40	*Cleome gynandra* (L.) L.	X	X	X	X	√	chamae	Capparidaceae	Eco	A
41	*C. viscosa* L.	X	X	√	X	√	chamae	Capparidaceae	Eco	A
42	*Clerodendrum viscosum vent.*	X	√	√	X	√	chamae	Verbenaceae	Eco	P
43	*Colocasia esculanta* (L.) Schott.	√	√	√	√	√	helo	Araceae	Ms	P
44	*Commelina benghalensis* L.	√	√	√	√	√	hemi	Commelinaceae	Ms	P
45	*C. obliqua* Ham.	√	√	√	X	√	hemi	Commelinaceae	Ms	P
46	*Cotula hemisphaerica*Wall ex.Benth&H	X	√	X	X	X	hemi	Asteraceae	Ms	P
47	*Cuphea balsamina* Chem.et. Sahl.	X	√	X	X	X	chamae	Lythraceae	Eco	A
48	*Cynodon dactylon* (L.) Pers.	√	√	X	√	X	geo	Poaceae	Eco	A
49	*Cyperus compactus* Retz.	X	√	√	√	X	helo	Cyperaceae	Reh	A
50	*C. compressus* L.	X	√	√	√	X	helo	Cyperaceae	Reh	A
51	*C. cyperoides* (L.) Kuntze.	X	X	√	X	X	helo	Cyperaceae	Reh	A
52	*C. digitatus* Roxb.	√	X	√	X	√	helo	Cyperaceae	Reh	A
53	*C. elatus* L.	√	X	X	X	X	helo	Cyperaceae	Reh	A
54	*C. haspan* L.	X	X	√	X	√	helo	Cyperaceae	Reh	A
55	*C. iria* L.	X	X	X	√	√	helo	Cyperaceae	Reh	A
56	*C. pilosus* Vahl.	X	√	X	X	X	helo	Cyperaceae	Reh	A
57	*C. rotundus* L.	√	√	√	√	√	helo	Cyperaceae	Reh	A
58	*Dactylis glomerata* L.	X	√	X	X	X	geo	Poaceae	Ms	P
59	*Dactyloctenium aegyptium* Willd.	X	√	√	X	X	geo	Poaceae	Ms	P
60	*Dichrocephala integrifolia* (l.F)Kuntz.	X	X	√	X	X	chamae	Asteraceae	Ms	P
61	*Digitaria longiflora* (Retz.) Pers.	√	X	X	X	X	geo	Poaceae	Ms	A
62	*D. marginata* Link.	X	X	√	X	X	geo	Poaceae	Ms	A
63	*D. sanguinalis* (L.)	X	√	X	X	X	geo	Poaceae	Ms	A
64	*D. violascens* Link.	X	X	√	X	X	geo	Poaceae	Ms	A
65	*Diplazium esculantum* (Retz.) Sw.	√	√	√	√	√	hemi	Athyriaceae	Ms	A
66	*Dopatrium junceum* (Roxb.) Ham.	X	X	√	X	X	chamae	Scrophulariaceae	Eco	P
67	*Drymeria cordata* (L.) Willd. Ex R&S	√	X	X	X	X	hemi	Caryophyllaceae	Ms	A
68	*Echinochloa compressus*	√	X	X	X	X	geo	Poaceae	Reh	P
69	*E. crus galli*(L.) P. Breauv.	X	√	X	√	√	geo	Poaceae	Reh	P
70	*E. stagnina* (Rets) P. Beauv.	X	X	X	√	X	geo	Poaceae	Reh	P
71	*Eichhornia crassipes* Solms-Laub.	√	√	√	√	√	hydro	Pontederiaceae	Ffh	P
72	*Eleocharis atropurpurea* (Retz.) Presl.	X	X	√	X	X	helo	Cyperaceae	Reh	A
73	*Elodea Canadensis* Rich Mich.	X	X	√	X	X	hydro	Hydrocharitaceae	Rsh	P
74	*Eleusine indica* (L.) Gaertn.	√	√	X	X	X	geo	Poaceae	Ms	A
75	*Emelia sonchifolia* D.C.	X	√	X	X	X	chamae	Asteraceae	Eco	A
76	*Enhydra fluctuans* Laur.	X	√	√	X	√	hydro	Asteraceae	Ms	A
77	*Eragrostis atrovirens* (Desf.) Trin.	√	√	X	√	X	geo	Poaceae	Reh	A
78	*E. cilianensis* (All.) Lutati.	X	X	√	X	X	geo	Poaceae	Reh	A
79	*E. gangetica* (Roxb.)	X	X	√	X	X	geo	Poaceae	Reh	A
80	*E. tenella* (L.) P. Beauv.	√	√	√	X	X	geo	Poaceae	Reh	A
81	*E. uniloides* (Retz.)Nees ex steud.	X	√	√	√	X	geo	Poaceae	Reh	A
82	*E. oryzaetorum* Mart.	X	X	√	X	X	geo	Eriocaulaceae	Reh	A
83	*E. trilobum* Ham.	√	X	X	X	X	geo	Eriocaulaceae	Reh	A
84	*E. truncatum* Ham.	X	X	√	√	X	geo	Eriocaulaceae	Reh	A
85	*Festuca rubra* L.	X	X	√	X	X	geo	Poaceae	Ms	A
86	*Ficus heterophylla var. assamica*	X	X	√	X	X	phanero	Moraceae	Eco	P

87	*Fimbristylis aestivalis* (Retz.)	√	√	√	√	X	helo	Cyperaceae	Ms	A
88	*F. dichotoma* Vahl.	X	X	√	X	√	helo	Cyperaceae	Ms	A
89	*F. miliacea* (L.) Vahl.	X	√	X	√	X	helo	Cyperaceae	Ms	P
90	*F. squarrosa* Vahl.	X	X	√	X	X	helo	Cyperaceae	Ms	A
91	*Floscopa rivularis*	X	X	√	X	X	chamae	Commelinaceae	Ms	A
92	*Fragaria indica* Andrews.	X	√	√	X	√	chamae	Rosaceae	Ms	A
93	*Fuirena umbellatea* Rottb.	X	X	√	X	X	helo	Cyperaceae	Ms	A
94	*Grangia maderaspatana* (L.)	X	√	X	X	X	chamae	Asteraceae	Ms	P
95	*Hedyotis corymbosa* (L.) Lamk.	√	X	X	X	X	chamae	Rubiaceae	Ms	P
96	*Heteropogon contortus* (L.) Beauv.ex.	√	√	√	√	√	geo	Poaceae	Eco	P
97	*Hydrilla verticillata* (l.F.) Royle.	√	√	√	√	√	hydro	Hydrocharitaceae	Rsh	P
98	*Hydrocharis cellulose* Buch-Ham.	X	√	X	X	√	hydro	Hydrocharitaceae	Reh	A
99	*Hydrocotyle sibthorpioides* Thumb.	√	√	√	√	√	hemi	Araliaceae	Ms	P
100	*Hydrolea zeylanica* Vahl.	√	X	√	√	√	hydro	Hydroleaceae	Reh	P
101	*Hygrophila polysperma* (Roxb.)T.	X	X	√	√	X	hydro	Acanthaceae	Reh	P
102	*Hygroryza aristata* Nees.	√	√	√	√	√	hydro	Poaceae	Reh	P
103	*Hymenachne acutigluma* (Steud.)Gillil.	√	√	√	√	X	hydro	Poaceae	Reh	P
104	*H. assamica* Hitch.	√	√	√	√	√	hydro	Poaceae	Reh	P
105	*Ipomoea aquatica* Forsk.	√	√	√	√	√	hydro	Convolvulaceae	Reh	A
106	*I. carnea Jacq.*	√	√	√	√	√	chamae	Convolvulaceae	Ms	A
107	*Imperata cylindrica* (L.) Beauv.	X	X	√	X	√	geo	Poaceae	Eco	A
108	*Ischaemum hirtum* Hack.	√	X	X	√	X	geo	Poaceae	Eco	A
109	*Isoetes coromandeliana*	√	X	X	X	X	hydro	Isoetaceae	Rsh	P
110	*Juncus articulatus* L.	X	√	X	X	X	geo	Juncaceae	Reh	A
111	*Jussieua repens* L.	√	X	√	√	√	hydro	Oenotheraceae	Ms	P
112	*J. suffruticosa* L.	X	√	√	X	X	hydro	Oenotheraceae	Ms	A
113	*Kyllinga brevifolia* Rottb.	√	√	√	X	√	helo	Cyperaceae	Ms	A
114	*K. monocephala* Rottb.	X	X	√	X	X	helo	Cyperaceae	Ms	A
115	*Lagenandra ovata*(L.) Thaw.	X	X	X	X	√	helo	Araceae	Eco	P
116	*Leersia hexendra* Sw.	X	X	√	√	X	geo	Poaceae	Ms	A
117	*Lemna oligorrhiza* Kurz.	√	√	√	√	√	hydro	Lemnaceae	Ffh	A
118	*L. polyrrhiza* L.	√	√	√	X	√	hydro	Lemnaceae	Ffh	A
119	*Leontodon autumanalis*	X	X	X	X	√	chamae	Asteraceae	Ms	P
120	*Leucus aspera* L.	√	√	√	√	√	chamae	Lamiaceae	Eco	P
121	*Limnophila chinensis* Osbeck.	X	X	√	X	√	hydro	Scrophulariaceae	Reh	P
122	*L. heterophyla* (Roxb.)	X	X	X	X	√	hydro	Scrophulariaceae	Reh	P
123	*Lippia javanica* (Burm.f) Spreng.	X	X	√	√	√	chamae	Verbenaceae	Eco	P
124	*Ludwigia adscendens* (L.) Hara.	√	X	√	√	X	chamae	Onagraceae	Reh	P
125	*L. octavalvis* Jacq.	√	X	√	X	X	chamae	Onagraceae	Reh	P
126	*L. parviflora* Roxb.	√	X	X	X	X	chamae	Onagraceae	Reh	P
127	*Marsilea quadrifolia* L.	√	√	X	X	X	hydro	Marsileaceae	Rhfl	A
128	*Mikania mycrantha* Willd.	X	X	√	√	√	phanero	Asteraceae	Eco	A
129	*Mimosa pudica* L.	√	√	√	√	√	chamae	Mimosae	Eco	A
130	*Monocharia hastata* (L) solms-Laub.	√	√	√	√	√	hydro	Pontederiaceae	Reh	P
131	*M. vaginalis* (Burn f.)Presl.	X	X	√	X	X	hydro	Pontederiaceae	Reh	P
132	*Myriophyllum tuberculatum* Roxb.	√	√	√	√	√	hydro	Haloragaceae	Rsh	P
133	*Nasturtium officinale* R.Br.	√	√	√	X	X	chamae	Brassicaceae	Sfh	P
134	*Neptunia prostrata* (Lamk.)Ballion.	X	X	X	√	X	chamae	Fabaceae	Reh	P
135	*Nymphaea alba* L.	√	√	√	√	√	hydro	Nymphaeaceae	Rhfl	P
136	*N. nouchali* Burn.fsyn.	√	√	√	√	√	hydro	Nymphaeaceae	Rhfl	P
137	*N. stellata* Willd.	√	√	√	√	√	hydro	Nymphaeaceae	Rhfl	P
138	*Nymphoides cristata* (Roxb.)O.Kuntze.	√	√	X	√	X	hydro	Menyanthaceae	Ffh	A
139	*N. hydrophyllum*	X	X	√	X	X	hydro	Menyanthaceae	Ffh	A
140	*N. indicum* (L) O. Kuntze.	X	X	X	√	X	hydro	Menyanthaceae	Ffh	A
141	*Oenanthe javanica* (BL.) DC.	X	√	√	√	√	hydro	Araliaceae	Ms	P
142	*Ophiuros megaphyllus* Stapf.	X	X	X	√	X	geo	Poaceae	Eco	P
143	*Oplismenus burmannii* (Retz.)P.Beauv.	X	X	√	X	√	geo	Poaceae	Ms	A
144	*Oryza officinalis* Wall.	√	√	X	√	X	geo	Poaceae	Reh	A
145	*O. rufipogon* Griff.	√	√	X	X	X	geo	Poaceae	Reh	A
146	*Ottelia alismoides* (L.) Pers.	√	√	√	X	X	hydro	Hydrocharitaceae	Rsh	P
147	*Oxalis corniculata* L.	√	√	X	√	X	geo	Oxalidaceae	Ms	A
148	*O. corymbosa* D.C.	√	√	√	√	√	geo	Oxalidaceae	Ms	A
149	*Paederia scandens* (Lour.) Merr.	X	√	X	X	X	phanero	Rubiaceae	Eco	P
150	*Panicum brevifolium* L.	√	√	X	√	√	helo	Poaceae	Ms	A
151	*P. maximum* Jacq.	√	√	√	√	√	helo	Poaceae	Ms	A
152	*P. paludosum* Roxb.	X	X	√	X	X	geo	Poaceae	Ms	A
153	*P. repens* L.	√	X	X	X	X	geo	Poaceae	Ms	A
154	*Paspalidium flovidium* A.Camus	X	X	√	X	X	geo	Poaceae	Eco	A
155	*Paspalum compactum* Roth.	√	√	√	√	X	geo	Poaceae	Eco	A
156	*P. orbiculare* G.Forst.	X	X	X	√	√	geo	Poaceae	Eco	A
157	*P. scrobiculatum* L.	√	X	X	X	X	geo	Poaceae	Eco	A

158	*Phalaris aquatica* Ait.	X	√	√	√	X	geo	Poaceae	Reh	A
159	*Phleum pratense* L.	X	X	√	X	√	geo	Poaceae	Reh	A
160	*Phragmites karka* (Retz.) Trin.ex Steud.	X	X	√	X	√	geo	Poaceae	Eco	A
161	*Pistia stratiotes* L.	√	√	√	√	√	hydro	Araceae	Ffh	A
162	*Poa annua* L.	X	X	X	√	X	geo	Poaceae	Ms	A
163	*Polycarpon tetraphyllum* L.	X	X	√	X	√	hydro	Caryophyllaceae	Ms	A
164	*Polygonum assamicum* Meissn.	√	X	√	X	X	chamae	Polygonaceae	Ms	A
165	*P. barbatum* L.	√	√	√	√	√	chamae	Polygonaceae	Eco	A
166	*P. glabrum* Willd.	√	√	√	√	√	chamae	Polygonaceae	Eco	A
167	*P. sinensis var. sinensis*	X	X	√	X	X	chamae	Polygonaceae	Ms	A
168	*P. hydro-piper* L.	√	X	√	X	√	chamae	Polygonaceae	Ms	A
169	*P. lapathifolium* (L.) S.F. Gray.	X	√	X	X	X	chamae	Polygonaceae	Ms	A
170	*P. plebejum* R.Br.	X	√	√	X	X	chamae	Polygonaceae	Eco	A
171	*Pontederia cordata* L.	X	X	√	√	√	hydro	Pontederiaceae	Rsh	A
172	*Potamogeton indicus* Roxb.	X	X	√	√	√	hydro	Potamogetonaceae	Rsh	P
173	*P. pectinatus* L.	X	X	√	X	X	hydro	Potamogetonaceae	Sfh	P
174	*Ranunculus aquatalis L.var.tricophylls*	X	X	√	X	√	hydro	Ranunculaceae	Reh	P
175	*R. scleretus* Linn.	X	X	X	√	√	hydro	Ranunculaceae	Reh	P
176	*Ricinus communis* L.	X	X	√	√	√	chamae	Euphorbiaceae	Eco	P
177	*Rotala rotundifolia* (Roxb.)Koehne.	X	√	X	X	√	chamae	Lythraceae	Eco	P
178	*Rumax maritimus* L.	√	X	√	√	√	chamae	Polygonaceae	Ms	A
179	*Saccharum spontaneum* L.	√	X	√	X	√	geo	Poaceae	Eco	A
180	*Sacciolepis indica* (L.) A.Shase.	√	X	X	X	√	geo	Poaceae	Eco	A
181	*Sagittaria guayanensis* H.B.K.sps.	X	X	√	X	X	hydro	Alismataceae	Reh	A
182	*S. sagitifolia* L.	√	√	√	√	√	hydro	Alismataceae	Reh	A
183	*Salvinia molesta* D.S.	√	√	√	√	√	hydro	Salviniacea	Ffh	A
184	*Scirpus. articulatus* L.	√	√	√	X	√	helo	Cyperaceae	Reh	A
185	*S. debelis*	X	X	X	√	X	helo	Cyperaceae	Reh	P
186	*S. grossus* L.	X	X	X	X	√	helo	Cyperaceae	Reh	A
187	*Scoparia dulcis* L.	√	X	X	X	X	chamae	Scrophulariaceae	Eco	P
188	*Setaria glauca* (L.) Beauv.	X	X	√	X	√	geo	Poaceae	Ms	A
189	*Solanum nigrum* L.	√	√	X	X	X	chamae	Solanaceae	Eco	P
190	*S. torvum* Swartz.	√	√	√	√	√	chamae	Solanaceae	Eco	P
191	*Sphenoclea zeylanica* Gearth.	√	√	√	√	√	hydro	Campanulaceae	Ms	A
192	*Spilanthes acmella*	X	√	X	√	X	chamae	Asteraceae	Ms	P
193	*S. peniculata* Wall ex.	√	√	X	X	√	chamae	Asteraceae	Ms	P
194	*Spirodella polyrrhiza* (L.)Schl.	√	√	X	X	√	hydro	Lemnaceae	Ffh	P
195	*S. punctata*(Meyer.) Thompson.	X	X	√	√	X	hydro	Lemnaceae	Ffh	P
196	*Sporobolus diander Beauv.*	√	X	√	√	√	geo	Poaceae	Ms	P
197	*Stelleria media* (L.) Vill.	X	√	X	√	X	helo	Caryophyllaceae	Ms	P
198	*Tabernaemontana divaricata* (L.) R.Br.	X	√	X	X	X	chamae	Apocynaceae	Eco	P
199	*Tephrosia vogelii* Hook. f	X	X	X	√	X	chamae	Fabaceae	Ms	P
200	*Thysanolaena maxima* Kuntze.	X	X	X	X	√	geo	Poaceae	Ms	P
201	*Trapa bispinosa* Roxb.	X	√	X	√	√	hydro	Trapaceae	Rhfl	A
202	*T. natans* L.	√	√	√	√	√	hydro	Trapaceae	Rhfl	A
203	*Typha angustata* Bory & Chaub.	X	X	√	√	√	helo	Typhaceae	Ms	A
204	*T. elephantina* Roxb.	X	X	√	X	X	helo	Typhaceae	Ms	A
205	*Typhonium trilobatum* (L.) Schott.	√	X	X	√	X	helo	Araceae	Eco	A
206	*Urtica urens*Link.	X	√	√	X	X	chamae	Urticaceae	Eco	A
207	*Utricularia aurea* Lour.	√	√	√	√	√	hydro	Lentibulariaceae	Sfh	A
208	*U. bifide* L.	√	X	√	X	√	hydro	Lentibulariaceae	Sfh	A
209	*Vallisneria spiralis* L.	X	√	√	√	√	hydro	Hydrocharitaceae	Rsh	P
210	*Veronica capitata*	√	√	X	√	√	chamae	Urticaceae	Ms	A
211	*Wolffia arrhiza* Wimm.	X	X	√	X	√	hydro	Lemnaceae	Ffh	A
212	*Xanthium strumerium* L.	√	√	√	√	√	chamae	Asteraceae	Eco	A
213	*Xyris indica* L.	X	√	√	X	X	geo	Xyridaceae	Sfh	A

Figure- 1: Pi diagram showing the composition of life forms of aquatic macrophytes of five wetlands of Sonitpur district

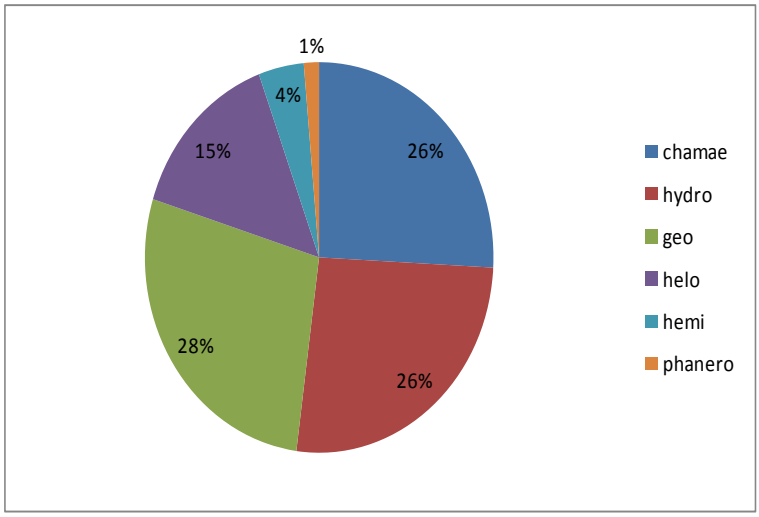
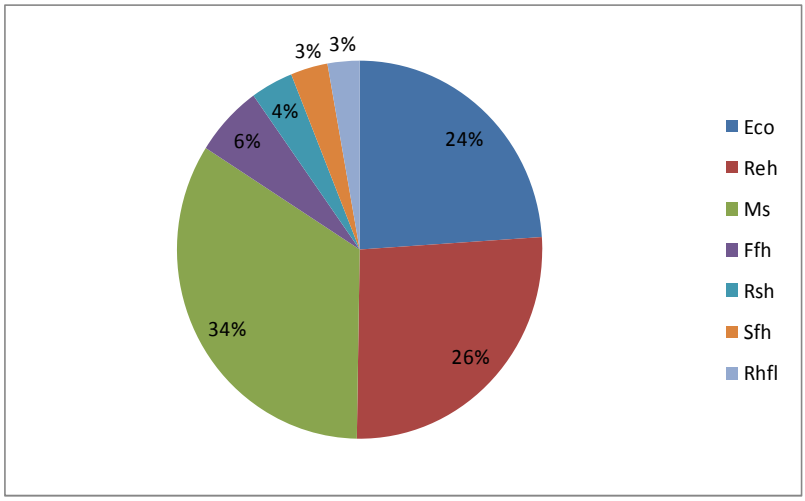


Figure- 2: Pi diagram showing the composition of habit of aquatic macrophytes of five wetlands of Sonitpur district



CONCLUSION

The study revealed that the species composition in the five wetlands of the present investigation depend on the size and structure, hydrology and extent of disturbance in the wetlands or in other words healthy existence of the wetland habitats is the prime factor for the development of important niches for the growth of different aquatic plant species in wetlands. The role of ecotone zones is also found to be significant in regulating the species compositions in the wetlands of present study. This was clearly observed in the case of Raumari and Kauribeel wetlands. These two wetlands, particularly the Raumari wetland is found to be bigger in size, better hydrological conditions and lesser amount of underlying disturbances in comparison to the other wetlands of the present study. Similar findings were also reported earlier where the water level was the main factor in controlling the species composition in the aquatic ecosystems. In such ecosystems, variations in water level may affect species composition [28]. The wetlands like Raumari and Kauribeel which have contained water for a considerable period of time of the year and possessed wider, less disturbed ecotone region, where edge effect of three environmental domains i.e. water, land and moist conditions played a significant role in better regulation of these wetland habitats. This also created environmental heterogeneity in the form of spatial variation in those wetland habitats. The heterogeneous habitats provide more niches and diverse ways of exploiting the environmental resources, and thus increase the species diversity, which is also reported earlier by workers [29, 30]. But despite of having large size and uniform periodic hydroperiod, wetlands like Sildubi and Boralimora wetlands have not been able to shown higher level species composition because of either high rate of sedimentation, and degraded ecotone regions or excessive biotic interferences in these wetlands. These wetlands were also affected by the dykes as these wetlands are bounded by dykes. These wetlands are infested by excessive growth of exotic macrophytes like *Eicchornia crassipes* and *Ipomea carnea*. When the ecosystems become more degraded the invasive species increase [31]. It is known that, especially in highly

productive ecosystems like wetlands and river systems, species diversity can be maintained only when some species are eliminated regularly [32]. Moreover, virtually there were no ecotone regions in wetlands like Sitalmari and Sildubi during the rainy season as these wetlands were bounded immediately by highlands. Excessive cultivation in the ecotone regions during the post monsoon season onwards might also be a reason for poor species compositions in these wetlands. Human activities such as agriculture or flood control lead to a decrease in wetland area or change the hydrological regime of areas. In this case dykes in the area of study have an influence on the hydroperiod and can change the distribution of wetlands.

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