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HYDROPHYTES IN THE HIGH BARIND TRACT: DIVERSITY STATUS, THREATS AND CONSERVATION

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Abstract

A survey was conducted to assess the diversity of hydrophytes in some selected locations including *Kharoil Beel* (Mohanpur), *Beel Kumari* (Tanore) and *Jobai Beel* (Sapahar) situated in High Barind Tract, Rajshahi, Bangladesh from June 2005 to May 2008. Among them *Jobai Beel* is the largest, *Beel Kumari* is medium and *Kharoil Beel* is small in size. At experimental areas a total of 151 plant species and 90 genera distributed in 44 families was identified. From the result, diversity status of the study areas, the values ranged between 0.94-0.97 in Simpson's index and 3.55-4.13 in Shannon's index. Diversity status of three study areas shows richness. Sequence of richness is as follows- *Kharoil Beel*> *Beel Kumari* > *Jobai Beel*. It is also evident that these wetlands are disturbed by anthropogenic activities. Some of the species have become threatened, some have become rare. Conservation efforts and awareness building are perquisite for the sustainability of these wetlands.

Key words: High barind tract, Hydrophytes, Diversity, Threats and conservation

Introduction

More than two thirds of Bangladesh may be classified as wetland according to the definition enunciated in the Ramasar Convention (Khan 1993). According to Ramasar Convention biologically and physically IUCN has identified a total of 39 categories of wetlands of which 30 are natural wetlands and nine man-made (Dugan 1990). Wetlands, have self sustained ecosystem which play a significant role for the formation of a wide array of biodiversity system, including diversified flora and fauna. Actually hydrophytes and wetland plants are defined in various ways. But presently broader and acceptable definition given by Cook (1996) is as- 'All pteridophytes and spermatophytes whose phtosynthetically active parts are permanently or at least for several months of each year part or whole submerged with water or which float in the surface of water' "and regarding the wetlands plants stated, wetland plants are those which grows in places where inundation must occur for at least fourteen days and saturation for at least sixty consecutive days. Prain (1903), Biswas and Caldar (1937), Cook (1996), Subramanyam (1962) etc. are the prominent workers who studied the aquatic and wetlands plants of India as a whole. The important works on hydrophytes and aquatic angiosperms in Bangladesh have been carried out by Khan and Mahbuba (1987) and Khan and Halim (1987). Khan and Halim (1987) reported 123 species most of them are well described and illustrated. Kundu (1938), Datta and Mitra (1953), Islam and Paul (1977), Islam *et al.* (1979), Zaman

(1991), Khondker *et al.* (1993), Chowdhury *et al.* (1996), Yousuf *et al.* (1997) and Irfanullah (2002) put an emphasis on the relationship between morphological, hydrological, physical and water qualities pattern of wetland system. Aquatic plant distribution has widely been investigated from different parts of country. Besides, several publications like Karim (1993), Hasan (2000) and Rashid (2006) have ventured to study the plant diversity of wetlands of some districts and regions. Islam (2004), Ali (2002), Hossain (2002) and Fatima (2005) worked on Barind tract. Ali and Ahmed (2001) and Rahman *et al.* (2010) worked on biodiversity conservation and threats on wetlands. Still there is no quantified observation (data) on the hydrophytes in respective of High Barind Tract area in the scientific process and thus their potentiality remains still underutilized. Thus present study aims to identify and assess the hydrophytes diversity in High Barind Tract, observe the scenario of threats of these wetlands which are caused by anthropogenic activities and prepare a strategy of these wetlands conservation by combining indigenous knowledge and findings of the research.

Materials and Methods

The *Kharoil Beel* is situated at Mohanpur upzilla under Rajshahi district and at the central region of the High Barind Tract. Mohanpur upzilla is bounded on the North by Manda upzilla of Naogaon zilla, on the East by Bagmara and Durgapur, upzilla on the South by Paba upzilla and on the west by Tanore upzilla. It is located between $24^0 29'$ and $24^0 38'$ north latitude and between $88^0 34'$ and $88^0 43'$ east longitude and has an area of 73.75 acres spreading over 1 mouza and the depth of water varied from 2-4 m. with a maximum reaching up to 5 m. connected the river Bornai which further connected to the river Atrai. The nature of soil in *Kharoil beel* was moderately alkaline.

The *Beel Kumari* is situated at Tanore upzilla under Rajshahi district at the central region of the High Barind Tract. Tanore upzilla is bounded in the north by Niamatpur and Manda upzilla, in the south by Paba and Gaodagari, upzilla in the east by Mohanpur upzilla and in the west by Nawabgonj and Nachole upzilla. It lies between $24^0 29'$ - $24^0 43'$ north latitude and $88^0 24'$ - $88^0 38'$ east longitude area of the beel is 502.66 acre spread over Chanduria union to Chowbari union which spreading over 2 mouza. The depth of water varied from 3-5 m with a maximum reaching up to 7-10 m. connected the river river Shib which was further connected to the river Atrai. The nature of soil in *Beel Kumari* was moderately alkaline.

The *Jobai Beel* is situated on the Sapahar upzilla under Naogaon district. Sapahar upzilla is bounded in the north by West- Dinajpur of India, in the south by Porsha upzilla, in the east by Potnitola upzilla and in the west by Maldha district of India. It lies between 25^0 $01'$ - $25^0 13'$ north latitude and $88^0 26'$ - $88^0 38'$ east longitude area of 912.24 acre spreading cover 5 mouzas. The depth of the water varied from 3.5 m (app.) in dry season, maximum reaching up to 10-12 m (app.) during rainy season connected the river Dhoala and

"Purnabhaba" which further connected to the river Atrai. The nature of soil in *Jobai beel* found slightly acidic to moderately alkaline.

Climate condition of these area experiences with the longest cool winter period (79-100 days) and the highest number of days (5-10 days) with maximum atmospheric temperature above 40°C in March-May, whereas the minimum temperature started to fall below 18° ranges between November. Both in summer and winter seasons the water level of these wetlands gradually fall. Then central portion of these wetland areas proper retains water but greater portion of beels are used for cultivation of crops. June arrives with the monsoon rainfall and the water level of these wetlands begins to increase again; the process continues throughout the entire post monsoon period. During monsoon and post monsoon the three wetlands areas turn into dense aquatic vegetation.

Monthly sampling was made from a period of June 2005 to May 2008 for the collection of hydrophytes plants and to study the diversity status of three wetlands namely *Kharoil Beel*, *Beel Kumari* and *Jobai Beel*. Plant species diversity within the wetlands determined by the quadrate method was used throughout the period of investigation (Krebs 1989). In each three sites, 12 quadrates (1 × 1 acre) were randomly laid to individual number of hydrophytes belonging to each of the species met which was identified and recorded. Hydrophytes species identification was done with the help of standard literatures (Hooker 1872-1897, Roxburgh 1834, Prain 1903, Cook 1996, Kundu 1938, Khan and Halim 1987, Siddique *et al.* 2007 and Ahmed *et al.* 2008b, 2009a and 2008-2009). Simpson's diversity index Simpson (1949) and Shanon's diversity index Mac.Arthur (1963) and Peet (1974) were applied to determine species diversity and species richness.

Results and Discussion

At study areas a total of 151 species and 90 genera distributed in 44 families was identified. For each species scientific name, family and number of individuals of hydrophytes are provided (Table 1). Among the families 65.56% represented by 12 families and 34.43% represented by 32 families (Fig. 1). In wetlands plants Azollaceae, Lemnaceae, Nymphaeceae and Menyanthaceae families were found in all study area. The dominant families in order to species richness (more than 5 species) were as follows Cyperaceae with 25 species > Poaceae with 15 species > Scrophulariaceae with14 species > Polygonaceae with 7 species > Commelinaceae with 6 species > and Asteraceae with 5 species. Many of these were not found only to wetland but to nearly moist soil also. Member of Trapaceae was very rare and was found in Mohanpur only. Selaginaceae family found only in Tanore was rare. Salviniaceae family was not found in Sapahar (Table 1). The occurrence and assemblage of macrophytes were because of the affect by abiotic factor such as water quality, sediment properties, temperature and fluctuations in water level etc.

Table 1. Name of recorded families, species and number of individuals of hydrophytes of study areas.

Family	Species Name	Locality and number of individuals		
		Kharoil Beel	*Beel Kumari*	*Jobai Beel*
Azollaceae	*Azolla pinnata*	2565	254	2819
Marsileaceae	*Marsilea minuta*	-	11	-
	Marsilea quadrifolia	2175	221	211
Adiantaceae	*Ceratopteris thalictroides*	-	224	101
Salviniaceae	*Salvinia cucullata*	1056	-	-
	Salvinia natans	1219	111	-
Acanthaceae	*Hygrophila auriculata*	211	-	217
	Hygrophila difformis	1219	1180	-
	Hygrophila polysperma	1495	1607	-
	Hygrophila quadrivalvis	17	-	-
Alismataceae	*Sagittaria guayanensis*	-	240	11
Amaranthaceae	*Alternanthera paronychioides*	272	281	222
	Alternanthera philoxeroides	481	408	403
	Alternanthera sessilis	506	439	489
Apiaceae	*Centella asiatica*	394	40	49
	Hydrocotyle sibthropioides	16	-	-
Aponogetonaceae	*Aponogeton appendiculatus*	652	236	-
	Aponogeton natans	82	-	-
	Aponogeton undulatus	662	-	-
Araceae	*Colocasia antiquorum*	560	595	536
	Lasia spinosa	16	-	-
	Pistia stratiotes	6250	6039	6898
Asteraceae	*Caesulia axillaris*	898	1264	1102
	Eclipta alba	896	748	811
	Enhydra fluctuans	1594	160	113
	Grangea maderaspatina	1031	992	734
	Spilanthes acmella	1069	1087	728
Balsaminaceae	*Hydrocera triflora*	-	-	2
Ceratophyllaceae	*Ceratophyllum demersum*	-	-	339
Commelinaceae	*Cyanotis axillaris*	-	732	72
	Commelina benghalensis	1038	942	1044
	Commelina diffusa	876	83	-
	Floscopa scandens	-	-	32
	Murdannia nudiflora	182	152	-
	Murdannia spirata	146	191	12
Convolvulaceae	*Ipomoea aquatica*	910	135	824
	Ipomoea fistulosa	509	317	490
Cyperaceae	*Carex panicea*	119	101	104
	Cyperus cephalotes	579	554	-
	Cyperus platystylis	-	530	37
	Cyperus involucratus	-	32	26

Contd.

Family	Species Name	Locality and number of individuals		
		Kharoil Beel	*Beel Kumari*	*Jobai Beel*
	Cyperus polystachyos	304	-	260
	Cyperus dives	142	29	27
	Cyperus compressus	287	292	275
	Cyperus kyllingia	278	299	255
	Cyperus exaltatus	39	547	-
	Cyperus difformis	397	378	313
	Cyperus iria	191	100	-
	Diplacrum caricinum	-	50	-
	Eleocharis actangula	83	-	-
	Elecocharis congesta	-	-	529
	Eleocharis dulcis	-	587	-
	Fimbristylis acuminata	28	273	28
	Fimbristylis aestivalis	296	-	234
	Fimbristylis dichotoma	592	-	333
	Fimbristylis miliaceae	-	395	312
	Mariscus sumatrensis	189	-	20
	Scirpus articulatus	329	400	303
	Scirpus erectus	153	-	-
	Scirpus grossus	162	398	305
	Scirpus mucronatus	73	-	-
	Scirpus lateriflorus	34	388	283
Elatinaceae	*Elatine triandra*	884	886	74
Eriocaulaceae	*Eriocaulon cinereum*	721	-	-
	Eriocaulon setaceum	303	-	172
Fabaceae	*Aeschynomene aspera*	71	7	64
	Aeschynomene indica	-	66	60
	Sesbania bispinosa	99	-	-
	Sesbania roxburghii	-	-	67
Haloragraceae	*Myriophyllum indicum*	1375	-	-
	Myriophyllum tuberculatum	1575	-	-
Hydrocharitaceae	*Blyxa aubertii*	1394	146	-
	Blyxa abubertii var. echinosperma	-	20	-
	Elodea canadensis	10	-	-
	Hydrilla verticillata	1439	144	152
	Nechamandra alternifolia	1938	-	-
	Ottelia alismoides	2624	-	268
	Vallisneria spiralis	1678	-	-
Hydrophylaceae	*Hydrolea zeylanica*	306	-	-
Lamiaceae	*Pogastemon stellatus*	310	-	-
Lemnaceae	*Lemma perpusilla*	3414	3350	3281
	Spirodela polyrhiza	2800	4170	2327
Lentibulariacae	*Utricularia aurea*	3111	-	-
	Utricularia exoleta	-	306	-
	Utricularia inflexa	-	-	32

Contd.

Family	Species Name	Locality and number of individuals		
		Kharoil Beel	*Beel Kumari*	*Jobai Beel*
	Utricularia stellaris	2806	299	-
Lythraceae	*Ammannia baccifera*	27	25	26
	Rotala indica	209	-	-
	Rotala rotundifolia	208	-	76
	Rotala wallichii	-	5	-
Menyanthaceae	*Nymphoides indica*	1694	166	220
	Nymphoides cristatum	144	138	-
Najadaceae	*Najas graminea*	1293	-	-
	Najas minor	827	-	-
Nymphaeceae	*Nymphaea nouchali*	2033	204	162
	Nymphaea rubra	1811	198	162
	Nymphaea stellata	-	185	162
	Euryale ferox	-	-	23
Onagraceae	*Ludwigia adscendens*	865	881	89
Poaceae	*Coix aquatica*	99	119	-
	Coix lacryma-jobi	-	-	76
	Echinochloa colona	1558	1721	1272
	Echinochloa crus-galli	1178	-	1111
	Eragrostis uniloides	-	-	75
	Hygroryza aristata	91	-	83
	Hymenachne acutigluma	108	42	80
	Leersia hexandra	144	136	146
	Leptochloa chinensis	129	109	112
	Oryza rufipogon	144	128	123
	Panicum paludosum	10	28	112
	Paspalum paspaloides	119	99	103
	Phragmites karka	-	-	121
	Saccharum spontaneum	169	138	141
	Vetiveria zizannioides	130	114	113
Polygonaceae	*Persicaria orientale*	68	382	409
	Persicaria barbatum	-	53	-
	Persicaria glabrum	-	51	-
	Persicaria hydropiper	64	-	-
	Polygonum plebejum	62	-	-
	Persicaria tomentosum	56	-	371
	Rumex martimus	40	160	-
Pontederiaceae	*Eichhornia crassipes*	1143	1152	1068
	Monochoria hastata	1479	995	80
	Monochoria vaginalis	-	-	40
Potamogetonaceae	*Potamogeton crispus*	76	-	-
	Potamogeton nodosus	-	32	-
Ranunculaceae	*Ranunculus sceleratus*	125	122	102
	Dentella repens	232	23	17
Rubiaceae	*Oldenlandia corymbosa*	226	219	-
Scrophulariaceae	*Bacopa monniera*	-	229	-
	Dopatrium junceum	222	-	187

Contd.

Family	Species Name	Locality and number of individuals		
		Kharoil Beel	*Beel Kumari*	*Jobai Beel*
	Limnophila aromatica	119	128	120
	Limnophila chinensis	62	-	-
	Limnophila cana	7	-	-
	Limnophila heterophylla	1	-	112
	Limnophila indica	1167	-	-
	Limnophila polystachya	654	-	-
	Limnophila sessiliflora	548	-	-
	Lindernia antipoda	190	212	193
	Lindernia crustacea	210	230	228
	Lindernia ciliata	-	248	-
	Lindernia rotundifolia	-	-	199
	Veronica anagallis-aquatica	-	114	12
Trapaceae	*Trapa bispinosa*	111	-	-
Verbanaceae	*Phyla nodiflora*	191	190	193
Characeae	*Chara corallina*	1013	101	706
	Nitella furcata	1125	113	674
Ricciaceae	*Riccia* sp.	148	-	-
Selaginaceae	*Selaginella* sp.	-	26	-
Boraginaceae	*Heliotropium indicum*	-	40	-
Campanulaceae	*Lobelia zeylanica*	55	-	-

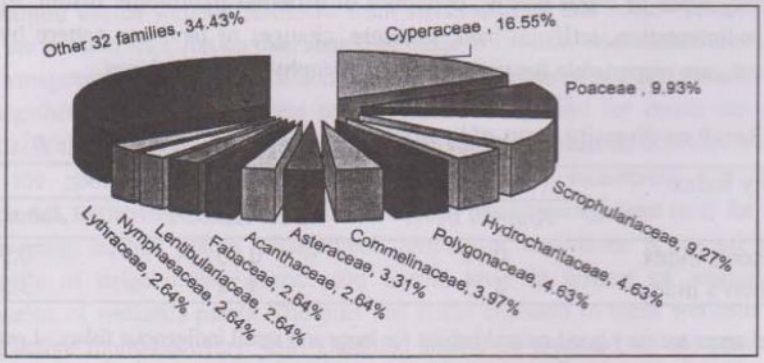

Fig.1. Distribution of species in the families.

From the Table 2 it is evedent that at *Kharoil Beel* a total of 117 species under 75 genera distributed in 38 families were present. Among these the largest number of species (19) belonging to the family Cyperaceae followed by Poaceae and Scrophulariaceae. Azollaceae, Elatinaceae, Hydrophyllaceae, Lamiaceae, Onagraceae, Verbanaceae, Ricciaceae, Rubiaceae, Campanulaceae and Trapaceae are represented by a single species. The other families had a varying number of species ranging from 2-10 (Table 1).

In *Beel Kumari*, a total of 92 species under 65 genera distributed in 34 families was identified (Table 2). Maximum number (17) of species were reported to be the member of family Cyperaceae followed by Poaceae (10). Azollaceae, Adiantaceae, Alismataceae, Boraginaceae, Selaginaceae, Verbanaceae and Rubiaceae are represented by a single species. Rest of the families had a varying number of species ranging from 2-7 (Table 1).

Table 2. Comparative analysis of species distribution of study areas.

Name of beels	Family	Genus	Species
Kharoil Beel	38	75	117
Beel Kumari	34	65	92
Jobai Beel	33	70	90

In *Jobai Beel,* a total of 90 species under 70 genera distributed in 33 families have been identified (Table 2). Maximum number of species (17) belonged to the family of Cyperaceae followed by Poaceae represented by (14) species. Azollaceae, Elatinaceae, Onagraceae, Alismataceae, Balsaminaceae, Verbanaceae, Adiantaceae, and Ceratophyllaceae are represented by a single species. The other families had a varying number of species ranging from 2-7 (Table 1).

Result suggests that hydrophytes diversity of *Kharoil Beel* was 0.97 in Simpson's index and 4.13 in Shannon's index (Table 3). In *Beel Kumari* was 0.95 in Simpson's index and 3.71 in Shannon's index (Table 3). Observation on *Jobai Beel* was 0.94 in Simpson's index and 3.55 in Shannon's index (Table 3). All of them show rich diversity. Connectivity types of water bodies, dynamics of different hydrologic matter, high flow velocity sedimentation, artificial bank structure, changes of land use pattern by human pressure etc., are responsible for variability of hydrophytes assemblages.

Table 3. Result on diversity status of hydrophytes.

Diversity index	Name of the beel areas		
	Kharoil Beel	*Beel Kumari*	*Jobai Beel*
Simpson's index	0.97	0.95	0.94
Shannon's index	4.13	3.71	3.55

These beel areas are very good natural habitat for large and small indigenous fishes. Local people are engaged in catching fish for house hold consumption. In summer and winter season ,greater part of these beel are converted to agriculture. In dry season the influential persons capture the beel land illegally ,though these are government managed *jolmahal* .Besides this, a large number of economical and ecological wetland plants are used by villagers. These are *Thankuni* (*Centella Asiatic*), *Kulekhara* (*Hygrophilla* sp.), *Eclipta alba*, *Hingcha* (*Enydra Fluctuans*), *Alternanthera sessilis* (Sachishak), *Alternanthera philoxeroides* (Helencha), *Ipomoea aquatica* (Kalmi sak), *Colocosia antiquorum* (Kachu), *Centella asiatica* (Thankuni), *Enhydra fluctuans* (Helencha), *Trapa bispinosa* (Paniphal) and *Euryale ferox* (Makhna)etc.

The villagers collect them and sell them to the local market, thus supplement their household economy upturn.

The livelihoods of the people of surrounding area are mostly depended on this wetland resource (Kostori M.F.A. 2012). Consequently, the human activities in the studied area in fact mainly led to an increase in its hydrophytes diversity. During the field observation and discussion with local people it was identified that a number of threats happened due to human interventions, through conversion of wetland to agriculture land, indiscriminate use of pesticide and insecticides, pollution by domestic waste products, conversion of wetland for development work as well as land scape alteration, extensive fishing, unsustainable use of water resources, land grabbing of local people etc. led to a severe decrease in the diversity of aquatic plants of these reported areas. It was further noticed that local people tend to destroy the wetland plants as well as wetlands resources for their demands due to lack of awareness, proper intuitional coordination and management frame work and monitoring. As a result, many species of hydrophytes like *Euryale ferox, Hydrocera triflora, Oryza rufipogon* , *Trapa bispinosa* etc. and fauna are threatened. Wetland based ecosystems degenerating as well as livelihood pattern, socio -economic framework and cultural values are affected. In addition government is losing huge sum of revenues since these are *khas* land.

These wetlands aquatic system that support a wide range of aquatic plant diversity for maintaining ecological balance with their own scenic beauty, provide indispensable benefits to the human livelihood, their socio-economic system. The recommendations have been made for the sustainable conservation of hydrophytes diversity in these wetlands. Awareness, motivation and ensuring best practices among local people are necessary about wetland value and optimum use of wetland resources from environmental and socio- economic view to protect the wetland area. Action plan should be made to facilitate coordinated and cooperative based management approach. Local community and all levels of relevant personnel's should work together in the entire process of implementation phases for conservation of these wetlands. With the help of appropriate instruments, structures, realistic activities are needed to ensure the good governance in wetlands management, monitoring and community development. Initiatives should be taken for "aquatic plants management unit" for integration on concerning aquatic plants management. Sharing of experience is needed among the personnel's of neighbouring district and upzilla level in respect of management and conservation of wetlands plants. The inlet and outlet channels to these wetlands should be cleared before monsoon every year. Database should be prepared for all plant species in respective wet land areas. Conservation should be ensured and maintained by talking different activities such as plantation programme with indigenous species and maintaining close season, protecting harmful gear, such as *jal, putijal, traps* etc., demonstrating of eco friendly agriculture, utilization of hydrophytes, controlling these plants cheaply, restoring of water bodies to their intended uses and protect liberating encroached. *Jolmahal* leasing system should be phased out in favour of pro-poor community who will ensure conservation and management of these wetlands resources specially on account of aquatic plants in order to respective policy, rules and legal frame work.

Based on the field observations and present preliminary results, it may be concluded that study sites are rich in the hydrophytes diversity which however, is severely threatened because of anthropogenic pressure. Therefore, in the context of Bangladesh many hydrophytes species will be extinct before their introduction to science. In the prevailing circumstances, awareness building, motivation and best practice among local people about focusing all aspects of hydrophytes diversity of these wetlands could be acted for reaching the destination in protecting the wetland areas and strengthening their plant conservation. Finally, it appears that there is a scope for long term research on these wetlands regarding the conservation and management of their plant diversity.

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