NBU Journal of
Plant Sciences

Vol. 8, No. 1 March 2014 p. 25-35
ISSN No 0974-6897

Plant diversity and community structure of *Hazar Takia palustrine* of central West Bengal, India

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Abstract
Hazar Takia wetland is one of the largest wetland of West Bengal with diversified floristic composition. Present study recorded 258 species of vascular plants of 59 families from this wetland. Frequency, abundant, density and species diversity has been determined through the phytosociological analysis. This wetland vegetation is now under various anthropogenic threats against its survival.

Introduction

Wetlands are the land with sufficient moisture and the hydric soil primarily supports the occurrence of wide variety of plants. The plant -water relation gradually form ideal environment for various fauna and ultimately creates a rich biodiversity zone. Flora and fauna of wetland areas select their ideal zone based on the depth of water starting from deep water submerged to emerge marshy areas. Wetlands are areas of land those are either temporarily or permanently remain water covered (Westlake & Pratt, 2006). *Hazar Takia* is an irregular shaped wetland that is situated in the Harishchandrapur-I block of Chanchal sub-division of Maldah district and is spreading over the *Pirojpur* and *Dakshin Ramnagar* Mouzas. This waterlogged *Palustrine* is composed of two lager and few smaller water-bodies. The larger two are *Hazar Takia* (19.8 ha) and *Garia* (9.66 ha) wetlands (Map 1). The total area of this complex is approximately 140 hectors and its global position is N 25°27'49.50" latitude and E 087°58'46.10" longitude. This is surrounded by several villages like Mabarakpur, Kalitola, Bidhanpur, Muragathi, Saldoi, Basatpur and Lianof. And, people of these villages are directly or indirectly depended on it. Exposed land is generally used for paddy and jute cultivation and shallow water bodies for Makhana (*Euryale ferox* Salisbury) cultivation and jute retting.

The wetland and its water get polluted due to the agricultural runoff and is gradually filling up due to erosion of upland soil and the accumulation of degraded plant parts. Maldah district has no such declared Protected Area for biodiversity conservation, so its wilderness are restricted to some reserve forest, bushy scrubs, mango orchards and, most importantly, temporary and permanent wetlands. These areas are reported to be quite rich in various floristic and faunal diversity (Prain, 1903; Acharyya, 1998; Chowdhury & Das 2010, 2011a, 2011b, 2013; Chowdhury, 2011; Chowdhry & Nandy, 2014).

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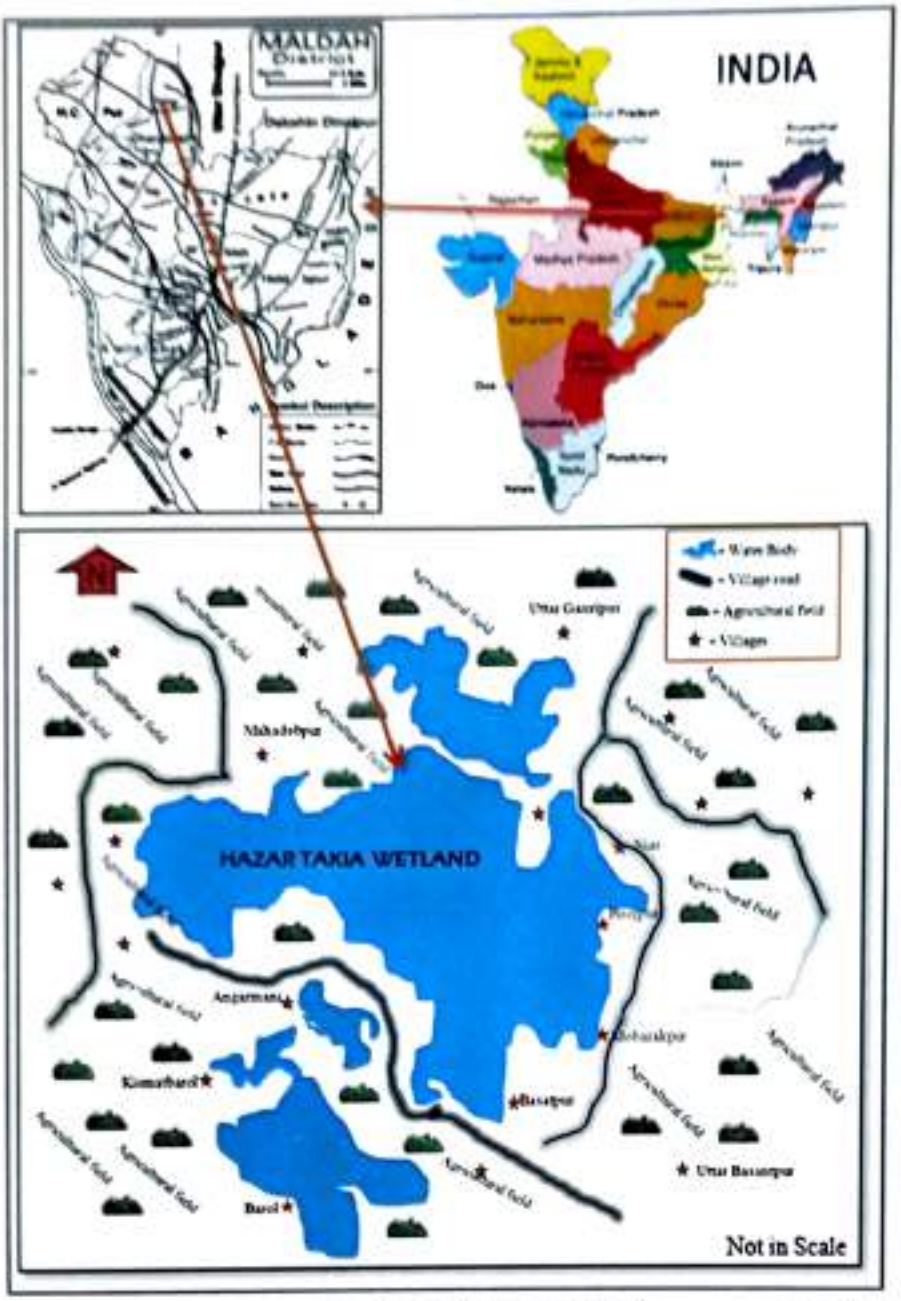
Materials and Methods

Floristic exploration was done by random sampling during the years 2003 – 2008. Plants were collected throughout the year covering all the natural climatic seasons. Aquatic plants those grow in the middle of the wetland were collected using boats and fishing nets. In the laboratory, specimens were processed and mounted on herbarium sheets following Jain & Rao (1977). Identification was done using different taxonomic literature and matching with the authenticated specimens at NBU, BSHC and CAL. Voucher specimens are deposited at NBU herbarium. Phytosociological study was made using 1 m x 1 m random quadrate sapling in three different seasons. Vegetation data analyzed in computer using the methods of Mishra (1966) and Phillips (1959) to determine different parameters like frequency, density, abundance and their relativity. IVI (Important value index) was also determined for the recorded species to understand their importance in the habitat. The concentration



Map 1: Location of *Hazar Takia* wetland in Maldah District (Source: www.googleearth.org)

of dominance is calculated as $\lambda = \Sigma pi^2$, as suggested by Simpson (1963), where 'pi' is the proportional abundance of the 'i^{th}' species and pi = ni/N. The species diversity was calculated with Shannon–Weiner Index as H'= - Σ [(ni/N) suggested by Shannon – Weiner (1949). The species richness (Menhinick, 1964) was calculated as D = S/ √N 1964, where S = total number of species observed and N = total number of individuals observed. Another species richness index suggested by Margalef (1968) as (R1 = s-1/In (n) was also calculate where, s = number of species and n = number or of individuals of a species.

Result and Discussion

The present floristic surveys were conducted in *Hazar Takia* wetland of the Maldah district. Through this survey a total of 258 species of wetland vascular macrophytes (Pteridophytes and Angiosperms) representing 169 genera belonging to 59 families have been recorded. Of these 251 species of 163 genera covering 53 families are angiosperms and 7 species of 6 genera representing 6 families are pteridophytes (Fig. 1). The hydrophytes and helophytes are rapidly growing and forming a dense mat on different water bodies. The

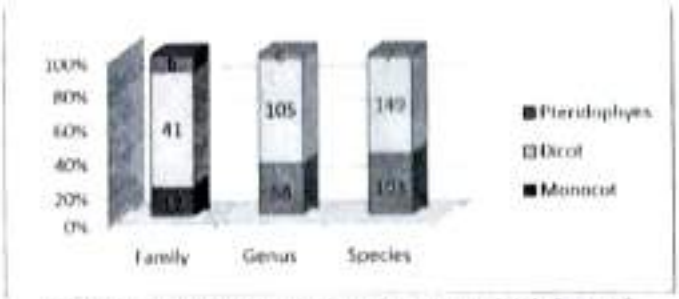


Figure 1: Graph showing the numerical data of different taxa of *Hazar Takia* wetland

middle of the water bodies are dominated by various submerged and free floating macrophytes, whereas peripheral areas are dominated by sedges, grasses and few reeds. The recorded vascular plant species along with their families and micro-habits are given in Table 1.

As the water depth of wetland is variable that leads to the growth of different species in specified micro habitat. The collected aquatic macrophytes of this wetland can be classified into different micro-habit groups following Daubenmire (1947). Among the collected plants 209 (80.69%) species belongs to wetland helophytes (WH), followed by 20 species of Emergent anchored hydrophytes (EAH), 8 species of Floating leaved anchored hydrophytes (FLAH), 08 species of Suspended hydrophytes (SH), 08 species of Floating hydrophytes (FH), 02 species of Floating shoots anchored hydrophytes (FSAH), and 02 species of Submerged anchored hydrophytes (SAH) (Fig. 2). The aquatic plants generally grow rapidly and form a very dense mat on the central parts as well as the peripheral zone of wetlands.

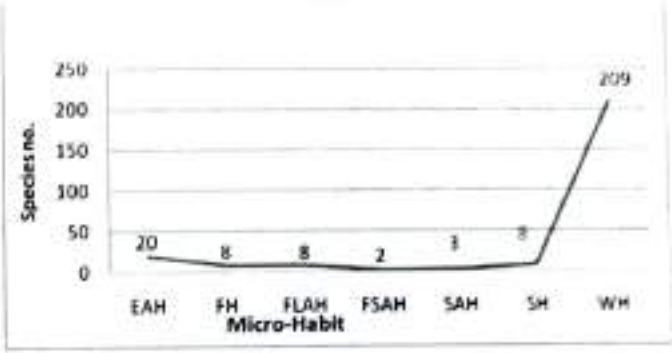


Figure 2: Number of species that shearing different micro-habit of *Hazar Takia* wetland

Table 1: Vascular plants of *Hazar Takia* wetland of Maldah district

[*Abbreviation used*: WH = Wetland helophytes, EAH = Emergent anchored hydrophytes, FLAH = Floating leaved anchored hydrophytes, SH = Suspended hydrophytes, FH = Floating hydrophytes, FSAH = Floating shoots anchored hydrophytes, SAH = Submerged anchored hydrophytes, S = Seed, Rh = Rhizome, St = Stem, Rs = Rootstalk, Of = Offset, Tu = Tuber, Ru = Runner, Sp = Spore]

Species	Family	Micro-Habit	Regena-ration
Aeschynomene aspera Linnaeus	Fabaceae	EH	S
Aeschynomene indica Linnaeus	Fabaceae	EH	S
Ageratum conyzoides Linnaeus	Asteraceae	WH	S
Alternanthera paronychioides St. Hill	Amaranthaceae	WH	S
Alternanthera philoxeroides (Martius) Grisebach	Amaranthaceae	WH	S, Ru
Alternanthera sessilis (Linnaeus) R. Brown *ex* DC.	Amaranthaceae	WH	S
Alysicarpus bupleurifolius (Linnaeus) DC.	Fabaceae	WH	S
Alysicarpus vaginalis (Linnaeus) DC.	Fabaceae	WH	S
Amaranthus lividus Linnaeus	Amaranthaceae	WH	S
Amaranthus spinosus Linnaeus	Amaranthaceae	WH	S
Amaranthus blitum spp *oleraceus* Linnaeus Costea	Amaranthaceae	WH	S
Ammannia baccifera Linnaeus	Lythraceae	WH	S
Ammannia multiflora Roxburgh	Lythraceae	WH	S
Anagallis arvensis Linnaeus	Primulaceae	WH	S
Aponogeton crispus Thunberg	Aponogetonaceae	FLAH	S, Rh

Argemone mexicana Linnaeus	Papaveraceae	WH	S
Axonopus compressus (Swartz) P. Beauverd	Poaceae	WH	S, Rs
Azolla pinnata R. Brown	Azollaceae	FH	Sp
Bacopa monnieri (Linnaeus) Pennell	Plantaginaceae	WH	S
Bergia ammannioides Roxburgh	Elatinaceae	WH	S
Biophytum sensitivum (Linnaeus) DC.	Oxalidaceae	WH	S
Blumea hieraciifolia (D. Don) DC.	Asteraceae	WH	S
Blumea lacera (Burman *f.*) DC.	Asteraceae	WH	S
Brachiaria distachya (Linnaeus) Stapf	Poaceae	WH	S, Rs
Brachiaria reptans (Linnaeus) Gardner & Hubbard	Poaceae	WH	S, Rs
Bulbostylis densa (Wallich) Handle-Mazzetti *ex* Karsten & Schenck	Cyperaceae	WH	S, Rs
Caesulia axillaris Roxburgh	Asteraceae	WH	S
Celosia argentea Linnaeus	Amaranthaceae	WH	S
Centella asiatica (Linnaeus) Urban	Apiaceae	WH	S, Ru
Centipeda minima (Linnaeus) A. Brown & Ascherson	Asteraceae	WH	S
Ceratopteris thalictroides (Linnaeus) Brongniart	Pteridaceae	WH	S, St
Chenopodium album Linnaeus	Amaranthaceae	WH	S
iChloris inflata Link	Poaceae	WH	S, Rs
Chrozophora rottleri (Geiseler) Jussieu *ex* Sprengel	Euphorbiaceae	WH	S
Cirsium arvense (Linnaeus) Scopoli	Asteraceae	WH	S
Cleome viscosa Linnaeus	Cleomaceae	WH	S
Clerodendrum viscosum Ventenat	Verbenaceae	WH	S
Coldenia procumbens Linnaeus	Boraginaceae	WH	S
Colocasia esculenta (Linnaeus) Schott	Araceae	WH	Rh
Colocasia nymphaefolia Kunth	Araceae	WH	Rh
Commelina benghalensis Linnaeus	Commelinaceae	WH	S
Commelina diffusa Burman *f.*	Commelinaceae	WH	S
Commelina longifolia Lamarck	Commelinaceae	WH	S
Corchorus aestuens Linnaeus	Malvaceae	WH	S
Cotula anthemoides Linnaeus	Asteraceae	WH	S
Cotula hemisphaerica (Roxburgh) Bentham & Hooker *f.*	Asteraceae	WH	S
Costus speciosus (Koenig) Smith	Costaceae	WH	Rh, S
Croton bonplandianus Baillon	Euphorbiaceae	WH	S
Crytococcum accrescens (Trinius) Stapf	Poaceae	WH	Rh
Cyanoglossum lanceolatum Forsskal	Boraginaceae	WH	S
Cynodon dectylon (Linnaeus) Persoon	Poaceae	WH	S, Rs
Cyperus compactus Retzius	Cyperaceae	WH	S, Rs
Cyperus compressus Linnaeus	Cyperaceae	WH	S, Rs
Cyperus corymbossus Rottboell	Cyperaceae	WH	S, Rs
Cyperus cyperoides (Linnaeus) Kuntze	Cyperaceae	WH	S, Rs
Cyperus difformis Linnaeus	Cyperaceae	WH	S, Rs
Cyperus digitatus Roxburgh	Cyperaceae	WH	S, Rs
Cyperus distans Linnaeus *f.*	Cyperaceae	WH	S, Rs
Cyperus flavidus Retzius	Cyperaceae	WH	S, Rs
Cyperus halpan Linnaeus	Cyperaceae	WH	S, Rs
Cyperus iria Linnaeus	Cyperaceae	WH	S, Rs

Cyperus niveus Retzius	Cyperaceae	WH	S, Rs
Cyperus pilosus Vahl	Cyperaceae	WH	S, Rs
Cyperus rotundus Linnaeus	Cyperaceae	WH	S, Rs
Dactyloctenium aegyptium (Linnaeus) Willdenow	Poaceae	WH	S, Rs
Datura stramonium Linnaeus	Solanaceae	WH	S
Dentella repens (Linnaeus) J.R. & G Forster	Rubiaceae	WH	S
Desmodium triflorum (Linnaeus) DC.	Fabaceae	WH	S
Desmostachya bipinnata (Linnaeus) Stapf	Poaceae	WH	S, Rs
Dichanthium annulatum (Forskal) Stapf	Poaceae	WH	S, Rs
Digera muricata (Linnaeus) Martius	Amaranthaceae	WH	S
Digitaria bicornis (Lamarck) Roemer & Schultes	Poaceae	WH	S, Rs
Digitaria ciliaris (Retzius) Koeler	Poaceae	WH	S, Rs
Diplazium esculentum (Retzius) Swartz	Athyriaceae	WH	Sp
Dysphania ambrosoides Linnaeus	Amaranthaceae	WH	S
Echinochloa colona (Linnaeus) Link	Poaceae	WH	S, Rs
Echinochloa crus-galli (Linnaeus) P. Beauverd	Poaceae	WH	S, Rs
Echinochloa stagnina (Retzius) P. Beauverd	Poaceae	EH	S, Rs
Eclipta alba (Linnaeus) Hasskarl	Asteraceae	WH	S
Eichhornia crassipes (Martius) Solms	Pontederiaceae	FH	Sp
Eleocharis atropurpurea (Retzius) Kunth	Cyperaceae	WH	S, Rs
Eleocharis congesta D. Don	Cyperaceae	WH	S, Rs
Eleocharis palustris R. Brown	Cyperaceae	EH	S, Rs
Eleocharis retroflexa (Poiret) Urban ssp. *chaetaria* (Roemer & Schultes) Koyama	Cyperaceae	WH	S, Rs
Elephantopus scaber Linnaeus	Asteraceae	WH	S
Eleusine indica (Linnaeus) Gaertner	Poaceae	WH	S, Rs
Emilia sonchifolia (Linnaeus) DC.	Asteraceae	WH	S
Enydra fluctuans Loureiro	Asteraceae	EH	S
Eragrostis atrovirens (Desfontaines) Trinius *ex* Steudel	Poaceae	WH	S, Rs
Eragrostis gangetica (Roxburgh) Steudel	Poaceae	WH	S, Rs
Eragrostis minor Host	Poaceae	WH	S, Rs
Eragrostis pilosa (Linnaeus) P. Beauverd	Poaceae	WH	S, Rs
Eragrostis tenella (Linnaeus) Beauverd *ex* Roemer *et* Schultes	Poaceae	WH	S, Rs
Eragrostis unioloides (Retzius) Nees *ex* Steudel	Poaceae	WH	S, Rs
Eriocaulon cinereum R. Brown	Eriocaulaceae	WH	S
Eupatorium odoratum Linnaeus	Asteraceae	WH	S
Euphorbia heyneana Sprengel	Euphorbiaceae	WH	S
Euphorbia hirta Linnaeus	Euphorbiaceae	WH	S
Euphorbia indica Lamarck	Euphorbiaceae	WH	S
Euryale ferox Salisbury	Nympaeaceae	FLAH	S
Evolvulus nummularius (Linnaeus) Linnaeus	Convolvulaceae	WH	S
Ficus heterophylla Linnaeus *f.*	Moraceae	WH	S
Fimbristylis aestivalis (Retzius) Vahl	Cyperaceae	WH	S, Rs
Fimbristylis annua (Allioni) Roemer & Schultes	Cyperaceae	WH	S, Rs
Fimbristylis dichotoma (Linnaeus) Vahl	Cyperaceae	WH	S, Rs
Fimbristylis dipsacea (Rottboell) C.B. Clarke	Cyperaceae	WH	S, Rs

Fimbristylis littoralis Gaudich	Cyperaceae	WH	S, Rs
Fimbristylis miliacea (Linnaeus) Vahl	Cyperaceae	WH	S, Rs
Fimbristylis tenera Schultes	Cyperaceae	WH	S, Rs
Fuirena ciliaris (Linnaeus) Roxburgh	Cyperaceae	WH	S, Rs
Fumaria indica (Haussknecht) Pugsley	Papaveraceae	WH	S
Glinus lotoides Linnaeus	Molluginaceae	WH	S
Glinus oppositifolius (Linnaeus) A. DC.	Molluginaceae	WH	S
Gnaphalium purpureum Linnaeus	Asteraceae	WH	S
Gnephalium polycaulon Persoon	Asteraceae	WH	S
Grangea maderaspatana (Linnaeus) Poiret	Asteraceae	WH	S
Hedyotis corymbosa (Linnaeus) Lamarck	Rubiaceae	WH	S
Heliotropium indicum Linnaeus	Boraginaceae	WH	S
Heliotropium ovalifolium Forsskal	Boraginaceae	WH	S
Hydrilla verticillata (Linnaeus *f.*) Royel	Hydrocharitaceae	SH	S, Of
Hydrolea zeylanica (Linnaeus) Vahl	Hydrophyllaceae	WH	S
Hygrophila auriculata (Schumacher) Heine	Acanthaceae	WH	S
Hygrophila difformis (Linnaeus) Sreemadhavan & Bennet	Acanthaceae	WH	S
Hygrophila polysperma (Roxburgh) T. Anderson	Acanthaceae	WH	S
Hypericum japonicum Thunberg *ex* Murray	Hypericaceae	WH	S
Imperata cylindrica (Linnaeus) Raeuschel	Poaceae	WH	S, Rs
Ipomoea aquatica Forsskal	Convolvulaceae	FSAH	S
Ipomoea carnea Jacquin	Convolvulaceae	EH	St, S
Ixeris polycephala Cassini	Asteraceae	WH	S
Jatropha gossypifolia Linnaeus	Euphorbiaceae	WH	S
Justicia diffusa Willdenow	Acanthaceae	WH	S
Justicia simplex D. Don	Acanthaceae	WH	S
Kyllinga brevifolia Rottboell	Cyperaceae	WH	S, Rs
Kyllinga nemoralis (Forster) Dandy *ex* Hutchinson	Cyperaceae	WH	S, Rs
Laphangium luteoalbum (Linnaeus) Tzvelev	Asteraceae	WH	S
Launaea aspleniifolia (Willdenow) Hooker *f.*	Asteraceae	WH	S
Leersia hexandra Swartz	Poaceae	WH	S, Rs
Lemna perpusilla Torrey	Lemnaceae	FH	S
Leptochloa panicea (Retzius) Ohwi	Poaceae	WH	S, Rs
Leucas indica (Linnaeus) R. Brown *ex* Vatke	Lamiaceae	WH	S
Limnophila heterophylla (Roxburgh) Bentham	Plantaginaceae	EH	S
Limnophila repens Bentham	Plantaginaceae	EH	S
Limnophila sessiliflora (Vahl) Blume	Plantaginaceae	EH	S
Lindernia anagallis (Burman *f.*) Pennell	Linderniaceae	WH	S
Lindernia antipoda (Linnaeus) Alston	Linderniaceae	WH	S
Lindernia cordifolia (Colsmann) Hochreutiner	Linderniaceae	WH	S
Lindernia crustacea (Linnaeus) F. Mueller	Linderniaceae	WH	S
Lindernia multiflora (Roxburgh) Mukherjee	Linderniaceae	WH	S
Lindernia oppositifolia (Retzius) Mukherjee	Linderniaceae	WH	S
Lindernia parviflora (Roxburgh) Haines	Linderniaceae	WH	S
Lindernia pyxidaria Allioni	Linderniaceae	WH	S
Lippia javanica (Burman *f.*) Sprengel	Verbenaceae	WH	S

Lobelia alsinoides Lamarck	Lobeliaceae	WH	S
Ludwigia adscendens (Linnaeus) Hara	Onagraceae	FSAH	S
Ludwigia octavalvis ssp sessiliflora (Micheli) Raven	Onagraceae	EH	S
Ludwigia perennis Linnaeus	Onagraceae	WH	S
Lygodium flexusum (Linnaeus) Swartz	Lygodiaceae	WH	Sp
Mariscus compactus (Retzius) Boldingh	Cyperaceae	EH	S, Rs
Marsilea minuta Linnaeus	Marsileaceae	FLAH	Sp
Mazus pumilus (Burman *f.*) Steenis	Phygmaceae	WH	S
Mecardonia procumbens (Miller) Small	Plantaginaceae	WH	S
Medicago lupulina Linnaeus	Fabaceae	WH	S
Melochia corchorifolia Linnaeus	Malvaceae	WH	S
Merremia hederacea (Burman *f.*) Hallier *f.*	Convolvulaceae	WH	S
Microcarpaea minima (J. Koenig *ex* Retzius) Merrill	Plantaginaceae	EH	S
Mollugo pentaphylla Linnaeus	Molluginaceae	WH	S
Monochoria hastata (Linnaeus) Solms	Pontederiaceae	EH	S
Monochoria vaginalis (Burman *f.*) K. Presl	Pontederiaceae	EH	S
Murdannia nudiflora (Linnaeus) Brenan	Commelinaceae	WH	S
Murdannia spirata (Linnaeus) Bruckner	Commelinaceae	WH	S
Myriophyllum indicum Willdenow	Haloragaceae	EH	S
Myriophyllum tuberculatum Roxburgh	Haloragaceae	EH	S
Najas graminea Delile	Hydrocharitaceae	SH	S
Najas indica (Willdenow) Chamisso	Hydrocharitaceae	SH	S
Nechamandra alternifolia (Roxburgh *ex* Wight)	Hydrocharitaceae	SH	S, Of
Nelsonia canescens (Lamarck) Sprengel	Acanthaceae	WH	S
Nesaea brevipes Koehne	Lythraceae	EH	S
Nicotiana plumbaginifolia Viviani	Solanaceae	WH	S
Nymphaea nouchali Burman *f.*	Nympaeaceae	FLAH	S, Rh
Nymphaea pubescens Willdenow	Nympaeaceae	FLAH	S, Rh
Nymphoides hydrophylla (Loureiro) Kuntze	Menyanthaceae	FLAH	S, St
Nymphoides indica (Linnaeus) Kuntze	Menyanthaceae	FLAH	S, St
Oplismenus burmannii (Retzius) P. Beauverd	Poaceae	WH	S, Rs
Oryza sativa Linnaeus	Poaceae	WH	S, Rs
Ottelia alismoides (Linnaeus) Persoon	Hydrocharitaceae	SH	S, Rs
Ottochloa nodosa (Kunth) Dandy	Poaceae	WH	S
Oxalis corniculata Linnaeus	Oxalidaceae	WH	S
Panicum repens Linnaeus	Poaceae	WH	S, Rs
Paspalidium flavidum (Retzius) A. Camus	Poaceae	WH	S, Rs
Paspalidium punctatum (Burman *f.*) A. Camus	Poaceae	WH	S, Rs
Paspalum distichum Linnaeus	Poaceae	WH	S, Rs
Paspalum scrobiculatum Linnaeus	Poaceae	WH	S, Rs
Persicaria barbata Linnaeus	Polygonaceae	WH	S
Persicaria hydropiper Linnaeus	Polygonaceae	EH	S
Persicaria lapathifolia (Linnaeus) S.F. Gray	Polygonaceae	WH	S
Persicaria orientalis (Linnaeus) Assenov	Polygonaceae	WH	S
Persicaria stagnina (Buchanon – Hamilton *ex* Meisn) Qaiser	Polygonaceae	WH	S
Phyla nudiflora (Linnaeus) Greene	Verbenaceae	WH	S

Phyllanthus amarus Schumacher & Thonning	Euphorbiaceae	WH	S
Phyllanthus urinaria Linnaeus	Euphorbiaceae	WH	S
Phyllanthus virgatus Froster	Euphorbiaceae	WH	S
Physalis minima Linnaeus	Solanaceae	WH	S
Pistia stratiotes Linnaeus	Araceae	FH	Of, S
Pogostemon stellatus (Loureiro) Kuntze	Lamiaceae	WH	S
Polycarpon prostratum (Forsskal) Ascherson & Schweinfurth	Caryophyllaceae	WH	S
Polygonum plebeium R. Brown	Polygonaceae	WH	S
Portulaca oleracea Linnaeus	Portulacaceae	WH	S
Potamogeton crispus Linnaeus	Potamogetonaceae	SH	S
Potamogeton nodosus Poiret	Potamogetonaceae	SH	S
Pouzolzia hirta (Blume) Hasskarl	Urticaceae	WH	S
Pouzolzia zeylanica (Linnaeus) Bennett	Urticaceae	WH	S
Pseudognaphalium affine (D. Don) Anderberg	Asteraceae	WH	S
Ranunculus sceleratus Linnaeus	Ranunculaceae	WH	S
Rorippa benghalensis (DC.) Hara	Brassicaceae	WH	S
Rotala densiflora (Roth) Koehne	Lythraceae	WH	S
Rotala indica (Willdenow) Koehne	Lythraceae	WH	S
Rotala rotundifolia (Buchanan-Hamilton) Koehne	Lythraceae	WH	S
Rottboellia cochinchinensis (Loureiro) W.D. Clayton	Poaceae	WH	S, Rs
Rumex dentatus Linnaeus	Polygonaceae	WH	S
Rumex maritimus Linnaeus	Polygonaceae	WH	S
Rungia pectinata (Linnaeus) Nees	Acanthaceae	WH	S
Saccharum arundinaceum Retzius	Poaceae	WH	S, Rs
Saccharum spontaneum Linnaeus	Poaceae	WH	S, Rs
Sacciolepis indica (Linnaeus) Chase	Poaceae	WH	S, Rs
Sacciolepis interrupta (Willdenow) Stapf	Poaceae	WH	S, Rs
Sagittaria guayanensis Humbolt, Bonpland & Kunth	Alismataceae	WH	S
Sagittaria sagittifolia Linnaeus	Alismataceae	FLAH	S
Salvinia cucullata Roxburgh *ex* Bory	Salviniaceae	FH	Sp
Salvinia natans (Linnaeus) Allioni	Salviniaceae	FH	Sp
Sataria glauca (*Linnaeus*) P. Beauverd	Poaceae	WH	S, Rs
Schoenoplectus articulatus (Linnaeus) Palla	Cyperaceae	EH	S, Tu
Schoenoplectus juncoides (Roxburgh) Palla	Cyperaceae	WH	S, Tu
Schoenoplectus lateriflorus (Gemlin) Lye	Cyperaceae	EH	S, Tu
Schoenoplectus supinus (Linnaeus) Palla	Cyperaceae	WH	S, Tu
Scirpus michelianum Linnaeus	Cyperaceae	WH	S, Tu
Scoparia dulsis Linnaeus	Plantaginaceae	WH	S
Senna tora (Linnaeus) Roxburgh	Fabaceae	WH	S
Seseli diffusum (Roxburgh *ex* Smith) Santapau & Wagh	Apiaceae	WH	S
Sida acuta Burman *f.*	Malvaceae	WH	S
Solanum nigrum Linnaeus	Solanaceae	WH	S
Solanum torvum Swartz	Solanaceae	WH	S
Sonchus asper (Linnaeus) Hill	Asteraceae	WH	S
Sphaeranthus indicus Linnaeus	Asteraceae	WH	S
Sphenoclea zeylanica Gaertner	Sphenocleaceae	WH	S

Spilanthes calva DC.	Asteraceae	WH	S
Spirodela polyrrhiza (Linnaeus) Schleiden	Lemnaceae	FH	S
Sporobolus diander (Retzius) P. Beauverd	Poaceae	WH	S, Rs
Stellaria wallichiana Bentham *ex* Haines	Caryophyllaceae	WH	S
Tonningia axillaris (Linnaeus) Kuntze	Commelinaceae	WH	S
Utricularia aurea Loureiro	Lentibulariaceae	SAH	S, St
Utricularia gibba Linnaeus	Lentibulariaceae	SAH	S, St
Utricularia inflexa Forsskal	Lentibulariaceae	SAH	S, St
Vallisneria spiralis Linnaeus	Hydrocharitaceae	SH	S, Ru
Vernonia cinerea (Linnaeus) Lessing	Asteraceae	WH	S
Veronica anagallis-aquatica Linnaeus	Plantaginaceae	WH	S
Vetiveria zizanioides (Linnaeus) Nash *in* Small	Poaceae	WH	S
Wolffia arrhiza (Linnaeus) Horkel *ex* Wimmer	Lemnaceae	FH	S
Xanthium indicum Koenig *ex* Roxburgh	Asteraceae	WH	S

Phytosociological analysis of vegetation is quite important as it gives clear idea about the importance of existing species in the habitat and their composition. To understand the community structure, 70, 72 and 65 quadrate samplings were executed at random, respectively, in pre-monsoon, monsoon and post-monsoon seasons. Aggregating all the pre-monsoon, monsoon and post-monsoon quadrate data in a single head and further computation shows the overall annual phytosociological vegetation structure of this wetland. The recorded data also include the presence of a total of 7707 individuals of 126 species, those are found within 209 quadrates in the sampling area. The analyzed data shows that *Eichhornia crassipes* [F = 38.76 & RF = 6.28], represents the highest Frequency (F) and Relative Frequency (RF), followed *Nymphoides hydrophylla* [F = 26.32 & RF = 4.26], *Enydra fluctuans* [F = 25.36 & RF = 4.11] and *Alternanthera sessilis* [F = 23.92 & RF = 3.88].

Azolla pinnata [D = 5.72 & RD = 15.50] shows maximum Density (D) and Relative Density (RD), followed by *Lemna perpusilla* [D = 4.62 & RD = 12.52] and *Eichhornia crassipes* [D = 2.25 & RD = 12.52]. *Lemna perpusilla* [A = 87.73 & RA = 12.87] shows maximum Abundance (A) and Relative Abundance (RA), followed by *Spirodela polyrrhiza* [A = 63.83 & RA = 9.36], *Azolla pinnata* [A = 45.96 & RA = 6.74] and *Kyllinga nemoralis* [A = 14.67 & RA = 2.15]. Maximum IVI value scored by *Lemna perpusilla* [IVI = 26.24] following *Azolla pinnata* [IVI = 24.26], *Spirodela polyrrhiza* [IVI = 14.80] and *Eichhornia crassipes* [IVI = 13.23]. On the other hand, *Cotula hemisphaerica* and *Croton bonplandianus* showed the minimum value [IVI = 0.24].

Analysis of quadrate data of three different seasons exposed the clear picture of Species Diversity and Species Richness of this wetland complex (Fig. 3). For the annual picture, Shannon-Weiner Index for Species Diversity was calculated to be 1.61 and the highest value exhibits 1.57 during post-monsoon, when pre-monsoon shows 1.39 and monsoon shows 1.17. The Simpson Index for Concentration of Dominance was observed at 0.05. The value is much higher (0.14) during monsoon and is followed by monsoon and post-monsoon at 0.08 and 0.04 respectively. The Species Richness value was calculated using Menhinick (1964) and Margalef (1968) Indices. Menhinick Index for Species Richness shows 1.42 for yearly picture. Post-monsoon shows higher value with 1.46 followed by pre-monsoon (1.45) and monsoon (0.99). Margalef Index shows yearly value of 0.76. Pre-monsoon shows highest value with 0.93, followed by post-monsoon (0.83) and monsoon (0.80).

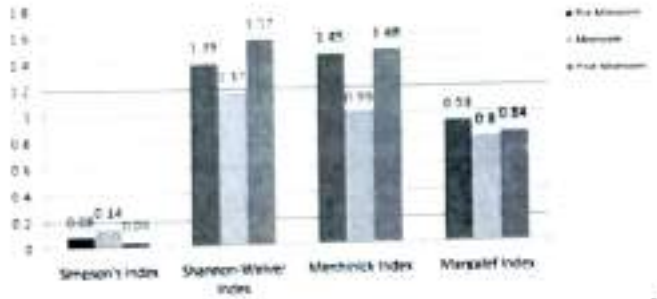


Figure 3: Graph showing overall yearly picture of species diversity and richness in *Hazar Takia* wetland

The Species Diversity and Species Richness of this wetland are moderate with low Concentration of Dominance for the vegetation. The wetland is quite diverse during pre-monsoon season. The Species Richness and Concentration of Dominance are quite high during monsoon. The result of the analysis showed that the vegetation of this wetland is quite disturbed and dispersed.

Conclusion

The vegetation of *Hazar Takia* wetland is very interesting and also attracts different migratory avifauna therefore maintaining a stable aquatic ecosystem. But, the extremely high degree of anthropogenic interferences is steadily degrading the habitat and the vegetation is quickly losing its elements. Wide use of wetland water for irrigation, rapid conversion into agricultural land for rice and Makhana cultivation (*Euryale ferox*) affecting its vegetation badly. In addition, this wetland suffers much due to insufficient rain because of global climate change and is drying up very fast. Though it is a one of the 23 largest wetlands of West Bengal, but,no any conservation policy was adopted for this. Unless proper conservation measures are taken immediately the excellent wetland vegetation will loose its rich biological diversity very soon.

Acknowledgments

The first author is thankful to CSIR, New Delhi for financial support to conduct this work. Thanks are also due to the director of Botanical Survey of India for his permission to work in CAL and BSHC herbaria and libraries.

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