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Seasonal Variations in Physico-Chemical Properties and Biodiversity in Betana Pond, Eastern Nepal

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Abstract

A total of 62 species of aquatic macrophytes belonging to 33 families (Alga 1, Bryophyte 1, Pteridophytes 5, Angiospermic dicots 25 and monocots 31) and 38 species of aquatic macro-fauna (Birds 17, Reptiles 3, Amphibians 3, Fishes 12, Molluscs 1 and Arthropods 2) were recorded from Betana pond, eastern Nepal. Physico-chemical parameters of the pond water displayed different characteristics with seasons. More seasonal fluctuations in turbidity (0.76-26.01 NTU), carbon dioxide (4.58-73.92 mg/l) and chloride content (2.0-7.0 mg/l) were recorded in the pond.

***Key words*:** Aquatic macrophytes, Betana pond, growth forms, macro-fauna

Introduction

Aquatic macrophytes form an important component whose abundance influence the structural and functional characteristics of aquatic ecosystems (Canfield *et al*., 1984). They affect the diversity of aquatic fauna and water quality through consequent nutrient cycling. Betana pond is important for aquatic macroflora and faunal habitats in Morang district (Jha *et al*., 2005; Subba and Thapa, 2005). Available reports on aquatic macrophytes and macro-fauna found in wetlands of eastern Nepal include Surana *et al*. (2004), Jha (2005), Chhetry (2006), Baral and Inskipp (2009). An attempt has been made to study seasonal variations in physico-chemical parameters and diversity of macro-biota in Betana pond, in this study.

Materials and methods

Betana pond, an ox-bow pond spreaded in 5.5 ha area with annual variation in water depth between 1 to 2.1 m is located at 26°39′N and 87°25′E, and altitude 115 msl; Morang district, eastern Terai region of Nepal. It is surrounded by Sal forests (Charkshe Jhaadi) in east, north and west sides, and Mahendra highway in the south. It becomes flooded during the rainy season. An intensive survey of the diversity of aquatic macro-flora and fauna found in Betana pond was undertaken in the year 2009. Identification was done by standard literature (Hooker, 1872-1897; Shrestha, 1981; Flemming *et al*., 2000; Schleich and Kastle, 2002). Growth form categories of aquatic macrophytes were adopted as per Cook (1996). Occurrences of plants were represented as ++++ (common), +++

(frequent), ++ (occasional), and + (rare). Status and occurrence of aquatic macro-fauna were recorded as: common (C), fairly common (F), local (L), migratory (M), rare (R_1), resident (R), summer (S), and winter (W). Uses of the plant species were determined by means of interview with local people and with the help of standard literature (Anonymous, 1948-1976; GON, 2007). Categories of uses were recorded as green manure/compost (GM/C), fish poison (FP), fodder (FO), food (F), handicrafts (HC), medicinal (M), thatch and cordage (TC), and religious (R), other specific uses were also noted. Physico-chemical parameters were determined by APHA (1998) (pH-pH metric, temperature-thermometric, conductivity-conductivity metric, ammonia and nitrate-photometric, phosphatic phosphorus-photometric) methods.

Results and discussion

Physico-chemical parameters of the Betana pond water displayed different characteristics with seasons (Tab. 1). pH, conductivity, turbidity, total phosphorus and total alkalinity were higher in summer whereas total dissolved solids, nitrate, total hardness- $CaCo_3$, dissolved oxygen, BOD, and chloride content were higher in winter, however, water depth, temperature, ammonia and carbon dioxide were found to be higher in rainy season. More seasonal fluctuations in turbidity (0.76-26.01 NTU), carbon dioxide (4.58-73.92 mg/l) and chloride content 2.0-7.0 mg/l) were recorded. Maximum concentration of carbon dioxide during rainy season could probably be associated with high surface area, influx of carbonic acid through rain water and active decomposition of organic matter (Mishra *et al*., 1999).

Sixty two species of aquatic macrophytes (Alga 1, Bryophyte 1, Pteridophytes 5, Angiospermic dicots 25 and monocots 31) belonging to 33 families were collected from pond (Tab. 2). Six growth form categories observed in the plant species were helophytes (12), tenagophytes (19), hyperhydates (18), pleustophytes (4), vittates (6), and rosulates (3). Aquatic macrophytes were found to play substantial role in the local socio-economy; feed for livestock (14 species), edible (6 species), Medicinal (9 species), handicrafts as mats/brooms/basketry (7 species), green manure/compost (4 species), fish poison (2 species), and miscellaneous (insect repellent- *Acorus calamus*, firewood- *Ipomoea carnea*, religious- *Pandanus nepalensis* etc.)

Thirty eight species of aquatic macro fauna (Birds 17, Reptiles 3, Amphibians 3 Fishes 12, Molluscs 1 and Arthropods 2) belonging to 29 families were observed in pond (Tab. 3). Most of the aquatic birds were common and resident; *Anas crecca*, *Phalacrocorax carbo* and *Triaga ochropus* were winter migratory, however, *Egretta garzetta* was rare and resident in the Betana pond. Wild fishes were important proteinous food and income generating source for local fishermen. The pond has high potential for ecological and biological research and ecotourism.

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Table 1. Physico-chemical characteristics of water in Betana pond at different seasons.

Parameters	Seasons		
	W	S	R
Water depth (m)	1.50	1.30	2.15
pH	7.12	7.23	6.63
Temperature ˚C	17.5	29.4	30.8
Conductivity µs/cm	312	446	411
Turbidity (NTU)	0.76	26.01	1.54
TDS mg/l	234	223	201
Ammonia (NH_3) mg/l	5.60	10.20	19.92
Nitrate (NO_3) mg/l	0.24	0.03	0.03
Total phosphorus (PO_4-P) mg/l	0.08	0.93	0.15
Total hardness ($CaCO_3$) mg/l	114.20	104.94	112.32
Total alkalinity ($CaCO_3$) mg/l	110.0	115.00	109.2
Carbon dioxide mg/l	23.76	4.58	73.92
Dissolved oxygen mg/l	7.99	3.19	5.41
BOD mg/l	3.70	1.81	0.44
Chloride mg/l	7.00	6.00	2.00

W= winter, S= summer, R= rainy

Table 2. List of macrophytes occurring in Betana pond with their growth forms and uses.

Family/Macrophyte	Local Name	Occurrences	Growth form	Uses
Bryophyta				
Ricciaceae				
Riccia fluitans L.	Leu	+	Ple	-
Pteridophyta				
Azollaceae				
Azolla imbricata (Roxb.) Nakai	Pani uneu	+++	Ple	GM/C
Equisetaceae				
Equisetum debile Roxb. ex Vaucher	Kurkure	++	Hel	M
Parkeriaceae				
Ceratopteris thalictroides Brongn	Dhaniyajhaar	++	Ten	F/GM/C
Thelypteridaceae				
Meniscium proliferum (Retz.) Sw	-	++	Hel	-
Thelypteris dentata (Forsk.) St. John	-	+++	Ten	-
Angiospermae-Dicots				
Acanthaceae				
Hygrophila difformis (L. f.) Blume	Taal makhan	++	Hyp	-
H. polysperma (Roxb.) T. Anders	Taal makhan	++	Ten	-
H. quadrivalvis (Ham.) Nees	Taal makhan	++	Hyp	-
Apiaceae				
Oenanthe javanica (Blume) DC.	Bahuni saag	++	Hyp	F
Asteraceae				
Enydra fluctuans Lourerio	Sungure jhaar	+++	Vit	FO
Mikania micrantha Kunth	Banmara	++	Hel	-
Spilanthes iabadicensis A. H. Moore	Purpure jhaar	++	Ten	M
Brassicaceae				
Rorippa nasturtrium-aquaticum (L.) Hayek.	Sime saag	+++	Hyp	F
Cabombaceae				
Caboma aquatica Aublet	-	++	Vit	Aquarium plant
Callitricaceae				

Callitriche stagnalis Scopoli	-	++	Vit	
Ceratophyllaceae				-
Ceratophyllum demersum L.	-	+++	Vit	
Convolvuaceae				-
Ipomoea carnea Jacq. subsp. *fistulosa* (Mart. ex Choicy) D.F. Austin	Thetar	+++	Hyp	
Hydrophyllaceae				Fire wood
Hydrolea zeylanica (L.) Vahl	Niljal	++	Hyp	
Lythraceae				M
Rotala rotundifolia (Buch.-Ham. Roxb.) ex D. Don	-	++	Ten	
				-
Melastomaceae	Rato chulesi	+++	Hel	
Osbekia stellata Buch.-Ham. ex D. Don				F
Onagraceae	Luwange	++	Hyp	
Ludwigia octovalvis (Jacq.) Raven	Luwange	++	Ten	-
L. perennis L.				M
Polygonaceae	Pirre jhar	++	Ten	
Polygonum hydropiper L.	Pirre jhaar	++	Hyp	FP
P. lapathhifolium L.				FP
Scrophulariaceae	-	+++	Vit	
Limnophila heterophylla (Roxb.) Benth.	-	++	Hyp	M
L. indica (L.) Druce	-	++	Hel	-
Lindernia ciliata (Colsm.) Pennell	-	++	Hel	-
L. crustacea (L.) F. Muell.				-
Sphenocleaceae	Bahuni saag	++	Ten	
Sphenoclea zeylanica Gaertn.				F
Verbenaceae	-	++	Hel	
Lippia nodiflora (L.) Rich.				M
Angiospermae-Monocots				
Aponogetonaceae	-	++	Ros	
Aponogeton appendiculatus H. Bruggen				-
Araceae	Bojho	+	Ten	
Acorus calamus L.	Morange saag	+++	Ten	M/insect
Lasia spinosa (L.) Thwaites	Pani banda	+++	Pleu	repellent
Pistia stratioites L.				F
Arecaceae	Bet	+	Ten	M/GM/C
Calamus tenuis Roxb.				
Commelinaceae	Kane	+++	Ten	HC
Floscopa scandense Lour.				
Cyperaceae	Hat katuwa	+++	Hyp	FO
Carex nubigana D. Don	Mothe	++	Ten	
C. corymbosus Rottb.	Mothe	++	Ten	-
C. natans Vahl	Mothe	+++	Hyp	HC
Fimbristylis dichotoma (L.) Vahl	Mothe	+++	Hyp	FO
Mariscus compactus (Retz.) Druce	Mothe	++	Ten	FO
Pycreus flavidus (Retz.) Koyama	Gud mothe	+++	Hyp	-
Schoenoplectus mucronatus (L.) Palla				-
Eriocaulaceae	Mothe	++	Hyp	HC
Eriocaulon trilobum Ham. Kornicke				
Hydrocharitaceae	Sungure jhaar	++++	Vit	-
Blyxa japonica (Miq.) Maxim	Phulke kamal	++	Ros	
Hydrocharis morsus-ranae L.	Hile jhaar	++	Ros	FO

Ottelia alismoides (L.) Pers.				-
Juncaceae	Gund ghans	++	Hyp	M
Juncus bufonius L.				
Pandanaceae	Dandi kath	++	Hel	FO
**Pandanus nepalensis* St. John				
Poaceae	-	++	Hyp	R
Arundinella bengalensis (Sprengel) Druce	-	++	Hel	
Eragrostis unioloides (Retz.) Nees ex	-	++	Ten	FO
Steudel	-	++	Hel	FO
Isachne dispar Trin.	-	++	Hel	FO
Panicum paludosum Roxb.	Janai ghans	++	Ten	FO
Panicum psilopodium Trin.	Narkat	+++	Hel	FO
Paspalum scrobiculatum L.	Kaans	++	Ten	FO
Phragmites karka (Retz.) Trin. ex Steudel	Khas khas	++	Ten	FO/TC
Saccharum spontaneum L.				FO/TC
Vetiveria zizanioides (L.) Nash	Jal kumbhi	+++	Ple	HC
Pontederiaceae	Nil jalkumbhi	++	Hyp	
Eichhornia crassipes (Mart.) Solms.				GM/C
Monochoria hastata (L.) Solms.	Pater	++	Hyp	F
Typhaceae				
Typha angustifolia L.				HC/TC

Hel= helophytes, Ten= tenagophytes, Hyp= hyperhydates, Eph= epihydates, Ple= pleustophytes, Ros= rosulate, F= food, FO= fodder, FP= fish poison, GM/C= green manure/compost, HC= handicrafts, M= medicinal, R= religious, TC= thatch and cordage, * endangered wetland plant.

Table 3. List of macro-fauna and their occurrences/status in Brtana pond.

Group/Family/Macrobiota	Common/Local name	Status
Birds		
Alcedinidae		
Alcedo atthis	Small blue king fisher	R, C
Anatidae		
Nettapus coromandelianus	Cotton teal	R, C
Ardeidae		
Ardeola grayii	Pond heron	R, C
Bubulcus ibis	Cattle egret	R, C
Egretta garzetta	Little egret	R, R_1
Ciconiidae		
Anastomus oscitans	Open billied stork	R, C
Leptoptilos javanicus	Lesser adjutant stork	R, C
Dacelonidae		
Halcyon smyrnensis	White throated king fisher	R, C
Dendrrocygnidae		
Anas crecca	Common teal	W, M, C
Dendrocygna javanica	Lesser whistling teal	R, C
Jacanidae		
Metopidius indicus	Bronze winged jacana	R, C
Otididae		
Amaurornis phoenicurus	Whitebreasted water hen	R, C
Phalacrocoracidae		
Phlacrocorax carbo	Large comorant	W, M, C
P. niger	Little comorant	R, C

Podicipedidae		
Podiceps ruficollis	Little grebe	R, C
Scolopacidae		
Tringa ochropus	Green sandpiper	W, M, C
Threskiomithidae		
Pseudibis papillosa	Black ibis	R, C
Reptiles		
Colubridae		
Xenochrophis piscator	Water snake	C
Trionychidae		
Lissemys punctata	Indian flap-shelled turtle	R
Aspideretes hurum	Indian soft-shelled turtle	R
Amphibians		
Ranitidae		
Euphlyctis cyanophlyctis	Skittering frog	C
Hoplobatrachus tigerinus	Indian bull frog	C
Hoplobatrachus sp.	-	C
Fishes		
Amphinoidae		
Amphipnous cuchia	Andha bam	C
Anabantidae		
Anabus sp.	Kabai/Kotri	F
Channidae		
Chana gachuwa	Garai-hile	C
Clariidae		
Clarias batrachus	Mangur	C
Cobitidae		
Lepidocephalicthys guntea	Painya	C
Cyprinidae		
Barilius bendalensis	Guderi,fageta	C
Puntius sopher	Pothi	C
Cyprinodontae		
Aplosochilus panchax	Tietike machha	C
Gobiidae		
Glosoglobius giuris	Bulla	C
Heteropneustidae		
Heteropneustes fossilis	Singhi	C
Metacembelidae		
Mastacembelus pancalus	Kathgainchi	C
Nandidae		
Badis badis	Kalo machha	F, C
Molluscs		
Unionidae		
Lamellidens marginalis	Freshwater mussels	C
Arthropods		
Gecarcinucidae		
Paratelphusa spinigera	Mud crab	C
Palaemonidae		
Macrobrachium sp.	Prawn	C

C= common, F= fairly common, L= local, M= migratory, R1= rare, R= resident, S= summer, W= winter.

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