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Article

Distribution and diversity of aquatic macrophytes and the assessment of physico-chemical parameters of Dakatia beel in Khulna district, Bangladesh

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Abstract: The physico-chemical characteristics of water and aquatic macrophytes from Dakatia Beel under Khulna district in Bangladesh were studied within January, 2020 to February, 2021. Twenty three species of aquatic macrophytes belonging to 15 families have been recorded. The aquatic macrophytes in Dakatia Beel collected from several sites belonging to 23 genera and 15 families (Lemnaceae, Pontederiaceae, Araceae, Convolvulaceae, Amaranthaceae, Asteraceae, Fabaceae, Polygonaceae, Ceratophyllaceae, Onagraceae, Parkeriaceae, Cyperaceae, Poaceae, Euphorbiacee, Nymphaceae). We also observed the different plant groups which comprises 6 species of floating, 10 species of emergent and only 2 species of submerged aquatic macrophytes. Dissolved oxygen ranged between 1.78 to 2.2 mg/L with a mean value 1.95 mg/L. The study area showed maximum total dissolved solid 588 ppm and the minimum in 482 ppm with a mean value of 534 ppm. Maximum value of phosphate was noted in 1029 µg/L and minimum 988 µg/L with a mean value of 1005 µg/L.

Keywords: Dakatia beel; limnology; aquatic macrophytes; physico-chemical parameters

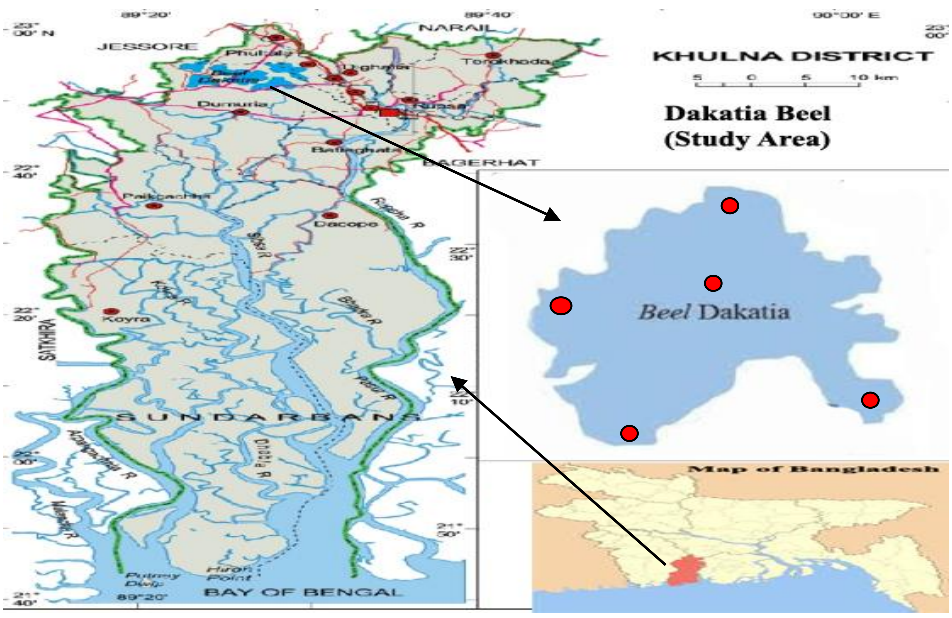
1. Introduction

Beel a large surface water body that accumulates surface runoff water through internal drainage channels; these depressions are mostly topographic lows produced by erosions and are seen all over Bangladesh (Banglapedia, 2004). Water quality observation has one amongst the best priorities in environmental protection policy. The most objective is to manage and minimize the incidence of waste destined issues, and offer to provide water of applicable quality to serve numerous functions like beverage supply, irrigation water. The standard of water is known in terms of its physical, chemical and biological parameters. Wetlands are various ecosystems that link individuals, life and atmosphere in special and mutualistic ways that through the essential equipment functions of water (Maltby and Barker, 2009). Wetlands are may be the foremost attention-grabbing landscapes within the world to possess attained world importance throughout the previous couple of decades. They're being mentioned all around the world in matters of environmental protection, pollution management, ecorestoration, diverseness conservation etc. Soil support terribly massive numbers, and a fashionable diversity, of animal and plant species (Maltby, 2009).Wetlands are necessary for the supply of environmental and ecological services (MEA, 2005) that result from functioning. Wetlands are drawing wide attention of agriculturists, natural and social scientists, urban planners, land managers, landscape designers and lots of others (Williams, 1990). Worldwide, wetlands are degraded either by their direct alteration or through the implications of changes to the supererogatory environmental and particularly hydrological inputs (Gosselink and Maltby, 1990). Macrophytes kind the majority of the soil flora. They embody floating plants similarly as those frozen with free floating leaves, the submerged, and amphibious and hygrophilous plants. Researches on soil macrophyte have started gaining importance not solely as a result of systematic stock taking of diverseness is presently given prime most priority however conjointly as a result of these plants have implications with purposeful values of wetlands. The distribution, abundance, structure and variety of macrophytes area unit full of many environmental factors and biological interactions. The relative importance of macrophytes varies in keeping with spacial and temporal scales (Lacoul and Freewoman, 2006). Some necessary environmental factors area unit related to light-weight needs of plants (Tremp, 2007), sediment characteristics (Schneider and Melzer, 2004; Paal *et al*., 2007), trophic status (Schorer e*t al*., 2000; Kocic *et al.*, 2008), and hydrology (Tremolieres *et al*., 1994; Madsen *et al*., 2001). Generally, ecological factors influencing species composition in water type a group of varied physical and chemical properties which may differ especially countries or regions (Riis *et al*., 2000; Baattrup-Pedersen *et al*., 2006). Moreover, anthropogenic influences modify several of the higher than mentioned characteristics (Pedersen *et al.*, 2006), together with macrophytes distribution patterns. Most of the studies between macrophytes and environmental factors are studied primarily in lotic ecosystems (Ferreira and Moreira 1999; Bernez *et al*., 2004; Hrivnak *et al.*, 2006; Hrivnak, 2010), however just in case of lentic ecosystems like wetlands these type of study is rare. Wetlands are extensively investigated for his or her ecology, management, conservation and restoration (Gopal *et al*., 1982; Gore, 1983; Sharitz and Gibbons, 1989; Lugo *et al*., 1990; Mitsch, 1994; McComb and Davis, 1999; Westlake *et al.*, 1999; Keddy, 2000; Mitsch and Gosselink, 2000; Fraser and Keddy 2005). In this context, the most objective of this study was to guage the physico-chemical characteristics of water, aquatic macrophytes and therefore the assessment of relationships between macrophytes assemblage and physico-chemical conditions in Dakatia Beel, Khulna District, Bangladesh.

2. Materials and Methods

2.1. Study area

Beel Dakatia (Figure 1) is located in the southwestern region of the country covering gross area 11,609 hectares (Rahman, 1995). It lies between longitudes 89°20'E and 89°35'E and latitudes 22°45'N and 23°00'N under the administrative boundaries of Dumuria, Phultala and Daulatpur upazilas of Khulna district (Banglapedia, 2004).



= Sampling Site

Figure 1. Map of the study area.

2.2. Collection of aquatic macrophytes

Sampling of the aquatic plants from Dakatia Beel was done during the January, 2020-February, 2020. Samples of aquatic plants were collected in a plastic bag and labelled, with local names, place and date of sampling. Collected samples were packed in bags neatly and brought to the laboratory for further identification. The identification of aquatic plants was done with the help of standard books, monographs and also with the help of available literatures particularly "Encyclopedia of Flora and Fauna of Bangladesh".

2.3. Collection of water sample for physico-chemical analysis

During water quality investigation, 5 sampling sites were outlined and samples were collected in the morning hours between 9 am to 11 am. For lake water sample collection, the closed bottle was dipped in the lake at the depth of 0.7 to 0.9 m, and then a bottle was opened inside and was closed again to bring it out at the surface. The samples collected from 5 different points were mixed together to prepare an integrated sample (Mishra *et*

al., 2017). Chemical parameters were determined by using standard methods immediately after taking them into laboratory (Nagamani, 2015). The collected water samples were analyzed for different physico-chemical parameters (Table 1) *viz*. pH, electric conductivity, temperature, salinity, water depth, transparency, DO and phosphate.
The water depth was measured employing a rope alongside a medium sized stone tied at one end of it and a meter tape. Water temperature was recorded with the assistance of a Centigrade thermometer. The conductivity was measured with the assistance of "Pocket Multiparameter" (HANNA Instruments, Romania; model: DiST4, HI98304) and recorded instantly. Transparency of sites was recorded with the assistance of Secchi disc. Hydrogen-ion-concentration (pH) of the water body was analyzed with the assistance of pH scale meter "Pocket Multiparameter" (HANNA Instruments, Romania; model: HI98108). Dissolved oxygen of the water body was analyzed with the assistance of portable DO30 Dissolved oxygen meter and the amount of phosphate measured by following method-

2.4. Preparation of standard

300 ppm solution was prepared by accurately weighting about 0.220 g of solid KH_2PO_4 into a 500 mL volumetric flask, and diluting it to the mark. 10 mL of the standard phosphate was transferred into 200, 250, 500 mL and a 1 L volumetric flask each, and filled it to the mark. This produced phosphate solutions of 15, 12, 6 and 3 ppm solution respectively.

2.5. Preparation of Complex

5 g of ammonium molybdate was dissolved into 100 mL of water. This Solution was transferred to a 500 mL volumetric flask. To this 160 mL of concentrated sulfuric acid was added very slowly. Once all the acid has been added, the solution was diluted to 500 mL with water.10 mL of sample was taken in a 150 mL conical flask and 20 mL of water, 2 mL of molybdate solution and a spatula of ascorbic acid crystals was added.This solution was heated slowly to boiling (a deep blue/green colour was developed) and then allowed it to cool. Repeat this for all the standards. Spectrophotometric analysis was conducted using T-60 UV/Vis spectrophotometer and here distilled water was used as a blank.

3. Results and Discussion

The physicochemical characteristics of water samples are presented in Table 1. Water temperature variation ranges from 26.9 to 27.2°C with a mean value 26.98°C. Maximum conductivity value was noted as 1.28 mS/cm and minimum as 1.03 mS/cm. Maximum pH was recorded at 8.02 and minimum at 7.43. Dissolved oxygen ranged between 1.78 to 2.2 mg/L with a mean value 1.95 mg/L. The study area showed maximum total dissolved solid at 588 ppm and the minimum at 482 ppm with a mean value of 534 ppm. Maximum value of phosphate was noted as 1029 µg/L and minimum 988 µg/L with a mean value of 1005 µg/L.
The aquatic macrophytes in dakatia beel during the present investigation are listed in Table 2. Figure 2 depicted the composition of different plant groups which comprises 6 species of floating, 10 species of emergent, 2 species of submerged, 3 species of free floating and only 2 species of floating creeper aquatic macrophytes. In all, 23 genera were identified, belonging to 15 families (Lemnaceae, Pontederiaceae, Araceae, Convolvulaceae, Amaranthaceae, Asteraceae, Fabaceae, Polygonaceae, Ceratophyllaceae, Onagraceae, Parkeriaceae, Cyperaceae, Poaceae, Euphorbiacee, Nymphaceae) (Figure 3).
Species diversity in different stations showed, (Table 3). *Wolffia arrhiza* (L.) Horkel *ex* Wimmer, *Ceratophyllum demersum* L. and *Enhydra fluctuans* Lour. Were found to be grown in all the stations. Despite the small size of the body, *Wolffia arrhiza* is one of the important ecological species in freshwater ecosystems according to quick growth, fast multiplication, high rate of absorption nutrients, and resistance to numerous toxins. It is an aquatic plant which grows in quiet water bodies such as ponds. The green part of the plant, the frond, is a sphere measuring about 1 mm wide, but with a flat top that floats at the water's surface. It has a few parallel rows of stomata. There is no root. The plant produces a minute flower fully equipped with one stamen and one pistil. It often multiplies by vegetative reproduction (Pan and Chen, 1979). *Ceratophyllum demersum* is a submerged perennial macrophyte which will normally grow with the base of its stem buried in sandy or silty substrates. It does not form roots. It is prone to dislodgement, and its buoyant stems may become free-floating. It can form a dense subsurface canopy and reach of height of 5-6m and frequently grows as a mono-specific community heights of 10m have been reported in Maraetai, New Zealand (Global Invasive Species Database, 2020). *C. demersum* can form modified leaves when it is growing near the lake bottom, which it uses to anchor to the sediment. *Ceratophyllum demersum* can be found in ponds, lakes, ditches, and quiet streams with moderate to high nutrient levels. It will grow in waters that are clear or turbid, still or flowing, and warm or ice-

covered. *C. demersum* occupies a wide depth range, between 0.5 and 15.0 m. *Enhydra fluctuans* is a tropical herb, more sensitive to cold especially when very young. The species grows in and along ditches, water courses, margins of fish ponds and rice fields in the open, from sea-level up to 1,800 m (Gupta, 2012). It is able to reproduce by fragmentation and may be so abundant that it clogs water courses.

Table 1. Water quality parameters in different sampling sites throughout the period of study.

Parameters	**Site-1**	**Site-2**	**Site-3**	**Site-4**	**Site-5**	**Mean**	**± SD**
Temperature (°C)	27	26.9	27	27.2	26.8	26.98	0.15
Electric conductivity (mS/cm)	1.19	1.26	1.03	1.22	1.28	1.18	1.0
Total dissolved solid (ppm)	544	588	482	569	488	534.2	47.70
pH	7.43	7.48	7.53	8.02	7.76	7.644	0.25
Salinity (ppm)	730	780	630	569	620	665.8	86.48
Water depth (cm)	96.52	213.36	48.77	152.4	72.38	116.69	59.34
Transparency (cm)	22.86	27.94	16.51	30.48	19.88	23.53	5.72
Dissolved oxygen (mg/L)	2.2	1.96	1.99	1.78	1.82	1.95	0.17
Phosphate (µg/L)	1029	988	1010	1001	997	1005	15.57

Table 2. Aquatic macrophytes of the study site recorded during the study period.

Scientific name	**Local name**	**Family**	**Life form**	**References**
Lemna trisulca L.	Kutipana	Lemnaceae	Submerged	Siddiqui *et al.*, 2007
Eichhornia crassipes (Mart.) Solms.	Kachoripana	Pontederiaceae	Free floating	Ahmed *et al.*, 2008
Pistia stratiotes L.	Topapana	Araceae	Floating	Siddiqui *et al.*, 2007
Ipomoea aquatica Forssk.	Kalmi shak	Convolvulaceae	Floating	Ahmed *et al.*, 2008
Alternanthera philoxeroides (Mart.) Griseb.	Helencha	Amaranthaceae	Emergent	Ahmed *et al.*, 2008
Enhydra fluctuans Lour.	Helencha	Asteraceae	Emergent	Ahmed *et al.*, 2008
*Sesbania sesban (*L.) Merr.	Jyonti	Fabaceae	Emergent	Ahmed *et al.*, 2009
Persicaria hydropiper (L.) Spach	Pakurmul	Polygonaceae	Emergent	Ahmed *et al.*, 2009
Wolffia arrhiza (L.) Horkel *ex* Wimmer	Shujipana	Lemnaceae	Floating	Siddiqui *et al.*, 2007
Ceratophyllum demersum L.	Sheola	Ceratophyllaceae	Submerged	Ahmed *et al.*, 2009
Ludwigia adscendens (L.)Hara	Kesara-dum	Onagraceae	Floating	Ahmed *et al.*, 2009
Ceratopteris pteridoides (Hook.) Hiern.	Pani Dhekia	Parkeriaceae	Free floating	Siddiqui *et al.*, 2007
Actinoscirpus grossus (L.f.) Goetgh. & D.A. Simpson	Kasuru	Cyperaceae	Emergent	Siddiqui *et al.*, 2007
Hygroryza aristata (Retz.) Nees	Jangli Dhan	Poaceae	Floating creeper	Ahmed *et al.*, 2008
Phragmites karka (Retz.) Trin *ex* Steud.	Dharma	Poaceae	Emergent	Ahmed *et al.*, 2008
Ludwigia perennis L.	Not known	Onagraceae	Emergent	Ahmed *et al.*, 2009
Phyllanthus reticulatus Poir.	Chitki	Euphorbiaceae	Emergent	Ahmed *et al.*, 2008.
Eichhornia crassipes (Mart.) Solms	Kachoripana	Pontederiaceae	Free floating	Ahmed *et al.*, 2008
Colocasia esculenta (L.) Schott	Kachu	Araceae	Emergent	Siddiqui *et al.*, 2007
Ipomoea fistulosa Mart. *ex* Choisy	Dhol Kolmi	Convolvulaceae	Floating creeper	Ahmed *et al.*, 2008
Echinochola colonum (L.) Link	Shama Ghas	Poaceae	Emergent	Ahmed *et al.*, 2008
Nymphaea alba L.	Bilati Shapla	Nymphaceae	Floating	Ahmed *et al.*, 2009
Nymphaea nouchali Burm.f.	Nil-Shapla	Nymphaceae	Floating	Ahmed *et al.*, 2009

Table 3. Species diversity in Dakatia beel by different study sites.

Scientific name	Site-1	Site-2	Site-3	Site-4	Site-5
Lemna trisulca L.	-	√	-	-	√
Eichhornia crassipes (Mart.) Solms.	√	√	-	√	√
Pistia stratiotes L.	-	√	-	-	√
Ipomoea aquatica Forssk.	√	√	-	-	-
Alternanthera philoxeroides (Mart.)Griseb.	-	-	√	-	√
Enhydra fluctuans Lour.	√	√	√	√	√
Sesbania sesban (L.) Merr.	√	-	√	-	-
Persicaria hydropiper (L.) Spach	-	√	-	-	√
Wolffia arrhiza (L.) Horkel *ex* Wimmer	√	√	√	√	√
Ceratophyllum demersum L.	√	√	√	√	√
Ludwigia adscendens (L.)Hara	-	√	√	-	-
Ceratopteris pteridoides (Hook.) Hiern.	-	-	-	-	√
Actinoscirpus grossus (L.f.) Goetgh.& D.A.Simpson	√	-	-	-	-
Hygroryza aristata (Retz.) Nees	-	-	√	-	-
Phragmites karka (Retz.) Trin *ex* Steud.	-	√	√	-	-
Ludwigia perennis L.	√	-	-	-	-
Phyllanthus reticulatus Poir.	-	-	-	-	√
Eichhornia crassipes (Mart.) Solms	√	√	-	-	√
Colocasia esculenta (L.) Schott	-	√	-	√	-
Ipomoea fistulosa Mart. *ex* Choisy	√	-	-	-	√
Echinochola colonum (L.) Link	-	√	-	-	-
Nymphaea alba L.	-	-	√	-	-
Nymphaea nouchali Burm.f.	-	-	√	-	-

√ = Present, - = Absent

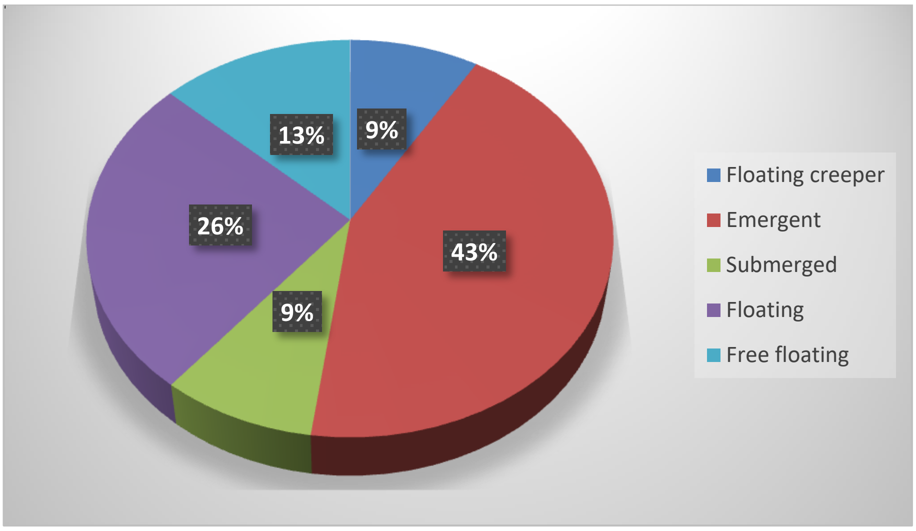


Figure 2. Life form of aquatic macrophytes.

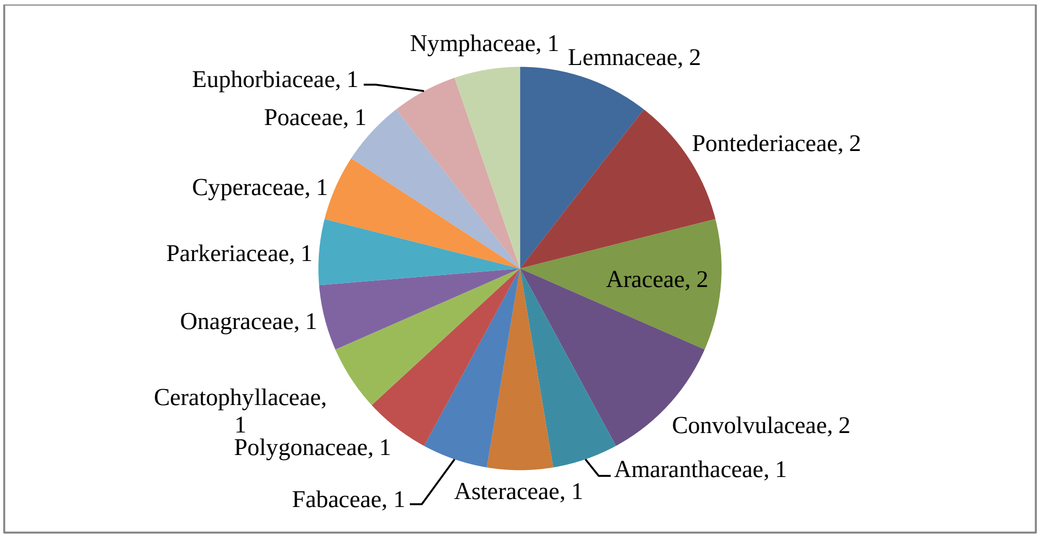


Figure 3. Composition of family in the study area.

4. Conclusions

It has been demonstrated that the physico-chemical parameters of the water quality of Dakatia beel varies significantly with a good water quality. The result showed that the beel were made in aquatic macrophytes. The surroundings of this space was terribly appropriate for the expansion of aquatic macrophytes. Submersed and floating creepers protect shorelines from erosion caused by wave action or currents. They'll conjointly facilitate to stabilize the sediment which may increase water clarity. Aquatic plants helped to make an important part of the complicated system of chemical composition for a water body. They'll conjointly influence the availability of chemical element within the water. Recently aquatic plants had received a great deal of attention for their ability to absorb pollutants from contaminated water.

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Conflict of interest

None to declare.

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