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SUBSTRATE BASED ZOOPERIPHYTON COMMUNITIES AND SOME PHYSICOCEHMICAL FEATURES OF DHANMONDI LAKE, DHAKA, BANGLADESH

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Abstract: This study deals with the zooperiphyton communities of Dhanmondi lake, Dhaka, Bangladesh using bamboo, mehegoni and rain tree sticks as substrates along with some physicochemical features of the lake water. It was revealed that zooperiphyton communities constitute protozoa, rotifera, copepoda, cladocera, ostracoda, conchostraca, insect larvae, oligochaeta, nematoda and mollusca. Rotifera (41%), protozoa (31%) and ostracoda (14%) were the dominant groups of zooperiphyton. Among protozoans, *Epistylis* sp. (52%) and *Arcella* sp. (20%); among rotifera, *Rotaria neptunia* (32.88%), *Anuraeopsis fissa* (17%) and *Brachionus angularis* (12%); among copepoda, naupleus (52%) and *Cyclops* sp. (32%); among cladoceran, *Chydorus* sp. (28%); among ostracods, *Cypris* sp. (100%); among molluscs, *Bellamya* sp. (75%) and *Brotia* sp. (22%) were found to be the most dominant species. The average number of zooperiphyton was 43023.55 ± 5891.34 individual m^{-2} recorded from all substrates. During the study period, the physicochemical features of water of Dhanmondi lake were found to be suitable for aquatic biota. It can help in enhancing the productivity as well as sustain the aesthetic value of the lake.

Key words: Dhanmondi Lake, Physicochemical features, Zooperiphyton Communities, Substrates.

INTRODUCTION

Periphyton refers to a complex community of microbiota (algae, bacteria, fungi, animals, and inorganic and organic detritus) that is attached to substrata of inorganic or organic, living or dead objects (Wetzel 1983). They form a living mat on substrates and serve as natural food source for the culture organisms as well as improve the water quality by sequestering the excess nutrients such as dissolved reactive phosphorous, ammonia ions, nitrates in aquaculture ponds (van Dam *et al.* 2002). Periphyton communities are important components of shallow freshwater lakes as well as productivity of food web components of aquatic animal such as shell fish, prawn and fish. Dhanmondi lake, a semi artificial water body has been considered as an important part of Dhaka Metropolis for both recreational and aquaculture view point. Since its creation

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nearly half a century ago, the lake suffered tremendous threat of eutrophication until it was re-excavated a decade ago. During the pre-excavation period a number of limnological researches been carried out on the lake (Islam *et al.* 1979; Islam and Chowdhury 1979, Khondker and Rahim 1991, 1993; Khondker and Parveen 1992, Hasan *et al.* 1994). Khondker and Rahim (1993) commented on the lake water quality by using periphytic and planktonic algae. At present, part of the lake is used for sport fishing, the Department of Fisheries is operating the aquaculture in the lake. An investigation on the zooperiphytic fauna of the lake was necessary and done by using different substrates.

MATERIAL AND METHODS

The present study was conducted at Dhanmondi Lake between December 2010 and August 2011. Details of the morphometric features and geographical locations of the lake has been furnished in Islam and Chowdhury (1979). Sampling was done between 10 am and 11 am on the sampling day in an each month.

Lake water was taken by using plastic bucket from 10-20 cm below the surface. Physicochemical properties of water determined at the spot which include free CO_2, alkalinity, hardness, ammonia-nitrogen, nitrite-nitrogen (HACH water quality testing kit, model FF-2, USA); temperature, conductivity and TDS (HACH conductivity meter, model HACH *Sension* 5, USA); Dissolved Oxygen (Lutron DO meter, model DO 5509, Singapore) and pH (HANNA pH meter, model HI 8424, Italy).

Three one meter long locally available substrates such as Bamboo pole (840 cm^2), Mehogoni (910 cm^2) and Rain tree (980 cm^2) branches were installed vertically at one meter depth in replicates, separated in equal distance. The samples for zooperiphyton study, substrates were removed and scraped, braced, and washed by supply water. After washing zooperiphyton samples, water were taken into plastic buckets and then sieved through a series of standard sieves of several mesh size (2.0mm, 0.92mm and 0.2 mm) for collection of molluscan shell. And then remained sample was filtered through 55 μm meshed plankton net and finally concentrated to 25-100 ml. The filtrates were immediately preserved by 4% buffered formaldehyde solution and then labeled, transferred to laboratory for further analysis. The estimation and identification of zooperiphyton taxa were done using keys from Ward and Whipple (1959), Needham and Needham (1966), Wetzel (1983), Ali and Chakrabarti (1992), Smith (2001) and Siddiqui *et al.* (2007). Microscopic identification and enumeration were done by a compound microscope (NOVA 950 ES, China) and a Sedgewick-Rafter cell (SPS SR-Cell, UK). The abundance was expressed as the number per

meter square area. Statistical analysis was done using Microsoft Office Excel 2007 and SPSS, a computer based program for Windows (Version 11.5, 2007. Systat, Inc. USA).

RESULTS AND DISCUSSION

Physicochemical features of the lake water: Data on physicochemical quality of water have been presented in Table 1. When these (post-excavation period of the lake) are compared with those of Khondoker and Parveen (1993) i.e. pre-excavation of bottom material marked differences could be seen. Conductivity, alkalinity, free CO_2 content and nitrate dropped significantly. Water temperature fluctuated in the same manner both in the study of Khondker and Parveen (1993) and the present one. However, a slight increase in the maximum pH has been observed in the present investigation. Approximately a 2-fold drop has been observed in case of conductivity, alkalinity, free CO_2 and NO_3-N contents in the present investigation. This indicates that the excavation of bottom mud from the lake nearly 10 years ago induced a marked reduction of its eutrophication status.

Zooperiphyton Communities: The zooperiphyton communities of Dhanmondi lake were comprised of protozoa, rotifera, copepoda, cladocera, ostracoda, conchostraca, insects larvae, oligochaeta, nematoda and mollusca. Among three substrates all, the average value of zooperiphyton abundance was 43023.55 ± 5891.34 individual m^{-2}. Whereas, the mean abundance of zooperiphyton were 50889.88 ± 9938.36 individual m^{-2}, 43207.88 ± 11273.87 individual m^{-2} and 34972.88 ± 9833.13 individual m^{-2} assemblaged on Bamboo pole, Mehogoni branch and Rain tree branch substrates respectively (Table 2).

Protozoa: Periphytic protozoans was dominant group, it contribute 31% of total zooperiphyton abundance (Fig. 1) and representative by 11 taxa. Wenhui (1997) reported that protozoans were dominant group as micro-zooperiphyton with percentages of 38.10% at Dianshan Lake in China. Among protozoans, the order of dominance by percentage occurrence was as: *Epistylis* sp. (52%), *Arcella* sp. (20%), *Euglena acus* (7.13%), *Ceratium* sp. (6%) *Phacus longicaudata* (5.81%), *Volvox* sp. (4%), *Diflugia* sp. (2%), *E. oxyuris* (0.98%), *E.* sp. (0.95%), *P. pleuronecta* (0.95%) and *Phacus* sp. (0.87%). The total mean abundance of protozoans were 15964.88±3878.47 individual m^{-2} settled on Bamboo poles, 13782.11±4774.41 individual m^{-2} on Mehogoni branch and 10047.00±3311.96 individual m^{-2} on Rain tree branch substrates (Table 2). Thus substrate did have effect on the abundance of Zooperiphyton communities.

Table 1. Monthly fluctuations of different physicochemical parameters (Mean±SE) of Dhanmondi lake, Dhaka, Bangladesh

Parameters	Dec.`10	Jan.`11	Feb.`11	Mar.`11	Apr.`11	May`11	June`11	July`11	Aug.`11	Range	Mean ±SE)
Air temp. (°C)	18.00	19.00	22.00	25.00	29.00	31.00	28.00	29.00	29.00	18.00 - 31.00	25.55 ± 1.59
Water temp. (°C)	19.00	19.00	23.00	25.00	29.00	32.00	29.00	31.00	31.00	19.00 - 32.00	26.44 ± 1.70
pH	7.50	7.00	8.00	8.00	8.00	7.50	7.77	8.50	8.70	7.00 - 8.70	7.88 ± 0.17
DO (mg/l)	7.50	8.50	5.00	8.60	8.50	7.50	3.40	7.50	8.50	3.40 - 8.60	7.22 ± 0.60
Free CO_2 (mg/l)	35.00	25.60	28.50	35.60	21.50	36.40	17.00	14.20	17.00	14.20 - 36.40	25.64 ± 2.90
Alkalinity (mg/l)	72.00	102.00	112.00	99.00	80.00	110.00	115.00	78.00	80.00	72.00 - 115.00	94.22 ± 5.57
Hardness (mg/l)	80.00	96.00	99.00	101.00	99.00	103.00	84.00	87.00	96.00	80.00 - 103.00	93.88 ± 2.72
Ammonia-nitrogen (mg/l)	0.60	0.70	2.40	1.10	.80	1.20	0.60	1.20	0.90	0.60 - 2.40	1.05 ± 0.18
Nitrite-nitrogen (mg/l)	0.05	0.04	0.06	0.19	0.04	0.02	0.02	0.02	0.02	0.02 - 0.19	0.05 ± 0.01
TDS (mg/l)	202.80	201.90	198.70	220.00	220.70	198.80	185.40	198.80	187.80	185.40 -220.70	201.65 ± 4.05
Conductivity ($\mu S\ cm^{-1}$)	452.00	462.00	402.00	455.00	462.00	376.00	386.00	376.00	386.00	376.00 -462.00	417.44 ± 13.03

Table 2. Substrates and species wise abundance (Mean ±SE), grand total and percentage value of zooperiphyton (individual m²) in Dhanmondi Lake, Dhaka, Bangladesh

Group	Species	Bamboo	Mehogoni	Rain tree	G. Total	Percentage
Protozoa	*Euglena acus*	1560.78±272.71	601.33±261.74	674.3333±142.6830	2836.44	7.13%
	Eglena oxyuris	350.55±110.18	39.11±39.11	nil	389.66	0.98%
	Eglena sp.	86.00±57.10	63.55±43.45	226.66±226.66	376.21	0.95%
	Phacus longicaudata	1247.88±220.26	667.33±241.10	396.66±133.52	2311.87	5.81%
	Phacus pleuronectus	178.55±71.53	88.00±45.79	113.33±113.33	379.88	0.95%
	Phacus sp.	79.33±52.47	85.55±85.55	181.33±137.87	346.21	0.87%
	Volvox sp.	899.22±446.06	303.11±200.62	238.00±96.16	1440.33	4%
	Arcella sp.	2877.22±558.41	2980.66±1031.72	2142.00±1190.00	7999.88	20%
	Difflugia sp.	271.33±154.80	97.77±97.77	561.00±263.08	930.1	2%
	Epistylis sp.	6740.88±1859.71	8427.88±4234.94	5383.33±1944.38	20552.09	52%
	Ceratium sp.	1673.11±924.02	427.77±260.85	130.33±91.19	2231.21	6%
	Subtotal	15964.88±3878.47	13782.11±4774.41	10047.00±3311.96	39793.88	100%
Rotifera	*Rotaria neptunia*	6191.11±1053.98	5603.88±2041.45	4505.00±1574.17	16299.99	32.88%
	Filinia longiseta	568.66±332.93	183.00±183.00	nil	751.66	2%
	Anuraeopsis fissa	4344.88±1254.62	1202.66±411.97	2754.00±1351.68	8301.54	17%
	Ascomorpha sp.	847.00±447.05	232.22±160.29	68.00±68.00	1147.22	2%
	Asplanchna sp.	264.44±179.35	226.11±151.30	374.00±374.00	864.55	2%
	Keratella vulga	1964.11±496.15	694.88±308.89	963.33±245.83	3622.32	7%
	K. cochlearis	1382.00±348.16	455.33±243.85	1749.44±1307.12	3586.77	7%
	Platyias patulus	52.88±52.88	48.88±48.88	68.00±68.00	169.76	0%
	P. quadricornis	145.44±108.22	nil	nil	145.44	0%
	Brachionus plicatilis	39.66±39.66	122.00±122.00	79.33±79.33	240.99	0%
	B, angularis	2678.77±517.48	1452.33±452.30	1762.33±644.15	5893.43	12%
	B, quadridentata	224.88±119.77	140.55±70.47	221.00±125.50	586.43	1%
	B, calyciflorus	139.00±139.00	nil	90.66±90.66	229.66	0%
	B. forficula	701.00±238.47	520.44±183.02	476.00±192.33	1697.44	3%
	Lecane sp.	1157.66±272.70	2306.44±1264.58	340.00±173.36	3804.1	8%
	Monostylla sp.	529.22±129.93	224.88±157.35	90.66±90.66	844.76	2%
	Lepadella sp.	599.88±188.52	832.11±308.15	861.33±394.71	2293.32	5%
	Trichocerca cylindrica	331.11±177.34	394.11±217.09	113.33±113.33	838.55	2%
	T. longiseta	185.33±140.91	nil	nil	185.33	0%
	Subtotal	22347.11±4322.02	14639.88±3780.18	14516.44±5014.36	49576.16	100%

Table 2 contd.

Group	Species	Bamboo	Mehogoni	Rain tree	G. Total	Percentage
	Bryocamptus sp.	nil	nil	102.00±102.00	102	1.22%
	Diaptomus sp.	978.77±325.00	117.33±117.33	158.66±106.31	1254.76	15%
Copepoda	*Cyclops* sp.	886.33±148.94	1037.66±391.13	731.00±123.76	2654.99	32%
	Naupleus	1574.11±289.79	1648.00±330.67	1127.66±297.91	4349.77	52%
	Subtotal	3439.22±668.62	2803.00±593.75	2119.33±469.12	8361.52	100%
	Alona sp.	251.33±132.28	88.00±58.66	617.66±344.27	956.99	17%
	Diaphanosoma sp.	674.33±305.97	146.66±146.66	nil	820.99	15%
	Moina sp.	nil	122.00±122.00	90.66±90.66	212.66	4%
	Alonella sp.	330.77±164.29	176.00±117.33	232.33±77.49	739.1	13%
Cladocera	*Bosmina* sp.	125.66±86.72	268.66±178.66	45.33±45.33	439.65	8%
	Pleuroxus sp.	205.00±159.63	78.22±78.22	113.33±113.33	396.55	7%
	Chydorus sp.	436.33±159.90	890.66±262.60	226.66±91.19	1553.65	28%
	Daphnia sp.	185.11±124.03	146.66±146.66	136.00±96.16	467.77	8%
	Subtotal	2208.55±528.70	1916.88±494.06	1462.00±456.47	5587.36	100%
Ostracoda	*Cypris* sp.	4928.44±1013.47	7825.11±5585.30	5751.66±1670.67	18505.21	100%
Conchostracha	*Cyzicus* sp.	429.88±188.14	183.00±183.00	260.66±188.62	873.54	100%
	Chironomus sp.	264.44±179.35	219.77±146.50	nil	484.21	34.5%
Insects/Insect larvae	*Corixa* sp.	403.55±171.24	488.00±488.00	nil	891.55	63.5%
	Ceratopogon sp.	33.11±33.11	nil	nil	33.11	2%
	Subtotal	701.11±187.91	707.77±605.59	nil	1408.87	100%
Oligochaeta	*Nais* sp.	158.66±112.19	391.11± 297.37	nil	549.77	100%
Nematoda	Unidentified Nematods	nil	341.77±251.26	124.66±86.31	466.43	100%
	Bellamya sp.	544.00±132.93	466.88±121.4036	500.00±113.50	1510.88	75%
	Brotia sp.	132.00±27.56	150.33±42.91	165.55±35.71	447.88	22%
Mollusca	*Lymnaea* sp.	6.66±3.52	nil	7.77±4.00	14.43	1%
	Indoplanorbis sp.	12.00±6.00	nil	6.66±3.72	18.66	1%
	Gyraulus sp.	17.33±5.69	nil	11.11±4.54	28.44	1%
	Subtotal	712.00±167.18	617.22±158.11	691.11±152.61	2020.29	100%
Total zooperiphyton		50889.88 ±9938.36	43207.88 ±11273.87	34972.88 ±9833.13		
Grand total zooperiphyton		43023.55 ±5891.34				
Total taxa		52				

Rotifera: Rotifers was the major group of zooperiphyton, it comprised of 41% of total zooperiphyton (Fig. 1). It represented by 19 species in order to occurrence of percentage the following dominance were *Rotaria neptunia* (32.88%), *Anuraeopsis fissa* (17%), *Brachionus angularis* (12%), *Lecane* sp. (8%), *Keratella vulga* (7%), *Keratella cochlearis* (7%), *Lepadella* sp. (5%), *Brachionus forficula* (3%), *Filinia longiseta* (2%), *Ascomorpha* sp. (2%), *Asplanchna* sp. (2%), *Monostylla* sp. (2%), *Trichocerca cylindrical* (2%), *Brachionus quadridentata* (1%), *Platyias patulus, Platyias quadricornis* , *Brachionus plicatilis* , *Brachionus calyciflorus* and *Trichocerca longiseta.* Wenhui (1997) also reported rotifers were second dominant group as micro-zooperiphyton with percentages of 22.62% at Dianshan Lake in China. The total average abundance of rotifers 22347.11±4322.02 individual m^{-2}, 14639.88±3780.18 individual m^{-2} and 14516.44±5014.36 individual m^{-2} were recorded from Bamboo poles, Mehogoni branch and Rain tree Branch substrates (Table 2) respectively. Similar results like the periphytic differences due to substrates observed by Wahab *et al.* (1999), Rai *et al.* (2008, 2010) and Hosain *et al.* (2011).

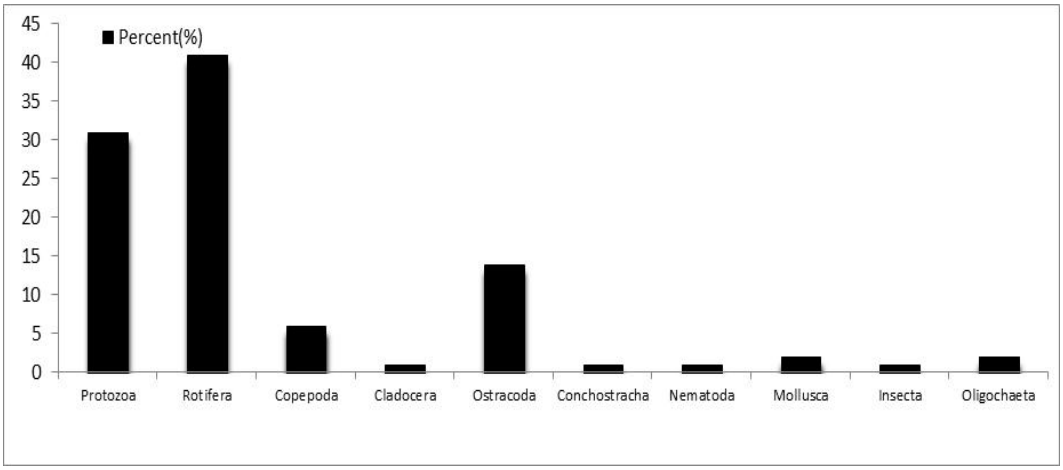

Fig. 1. Percentage composition of different zooperiphyton groups in Dhanmondi Lake, Dhaka, Bangladesh

Copepoda: Copepods constituted 6% of total zooperiphyton (Fig. 1) and represented by 3 species. Among zooperiphytic copepods the prime group was Naupleus (52%) and followed by *Cyclops* sp. (32%), *Diaptomus* sp. (15%) and *Bryocamptus* sp. (1%). The mean value of copepods were 3439.22 ± 668.62 individual m^{-2} on Bamboo pole, 2803.00 ± 593.75 individual m^{-2} on Mehogoni Branch and 2119.33 ± 469.12 individual m^{-2} inhibiting on Rain tree substrates (Table 2).

Cladocera: Periphytic cladocera constituted 1% of total zooperiphyton (Fig. 1) and representative by 8 species. Among zooperiphytic cladocera *Chydorus* sp. (28%) was the first position in order to occurrence of the dominance of percentage and followed by *Alona* sp. (17%), *Diaphanosoma* sp. (15%)., *Alonella* sp. (13%), *Bosmina* sp. (8%), *Daphnia* sp (8%) *Pleuroxus* sp. (7%) and *Moina* sp. (4%). The average value of cladocera 2208.55 ± 528.70 individual m^{-2}, 1916.88 ± 494.06 individual m^{-2} and 1462.00 ± 456.47 individual m^{-2} were recorded from Bamboo, Mehogoni and Rain tree substrates respectively (Table 2). Cladocera also reported by Azim *et al.* (2002) from Bangladesh water.

Ostracoda: Ostracods constituted of 14% of total zooperiphyton (Fig. 1) and it was represented by only *Cypris* sp. (Table 2). The total average abundance of *Cypris* sp. were 4928.44 ± 1013.47 individual m^{-2} attached on Bamboo pole, 7825.11 ± 5585.30 individual m^{-2} on Mehogoni branch and 5751.66 ± 1670.67 individual m^{-2} on Rain tree branch substrates. Zooperiphytic ostracods also reporte by Semoneva and Sharapova (2012) from the natural and artificial substrates such as stones, sunken wood, macrophytes, silts, peaty sits, clays, plastic surfaces glass plates of waterbodies and watercourses of Thymen Oblast (Western Siberia).

Conchostraca: Conchostraca was non dominant group and formed 1% of total zooperiphyton abundance (Fig. 1) as well as represented by *Cyzicus* sp. (Table 2). The average abundance of zooperiphytic *Cyzicus* sp. were 429.88 ± 188.14 individual m^{-2}, 183.00±183.00 individual m^{-2} and 260.66 ±188.62 individual m^{-2} residing on Bamboo, Mehogoni and Rain tree substrates respectively. Conchostraca observed by Sharapova (2010).

Nematoda: Unindentified nematodes were non dominant of zooperiphyton (Fig. 1) and the total mean value were 341.77 ± 251.26 individual m^{-2} and 124.66 ± 86.31individual m^{-2} recorded from Mehogoni and Rain tree substrates respectively as well as totally absent from Bamboo poles. Nematodes also reported by Hosain *et al.* (2011) from Curzon hall pond.

Mollusca: Periphytic grazer Molluscan fauna constituted of 2% of total zooperiphyton abundance (Fig. 1) and representative by 5 species. Among zooperiphytic mollusca *Bellamya* sp. (75%) was most abundant and followed by *Brotia* sp. (22%), *Lymnaea* sp. (1%), *Indoplanorbis* sp. (1%) *and Gyraulus* sp (1%) the order of occurrence of percentage abundance. Wenhui (1997) reported the periphytic gastropoda was dominated community with 96.4% of the total biomass. The total average abundance of periphyton grazer macrozooperiphytic molluscan fauna were 712.00 ± 167.18 individual m^{-2} grazed on Bamboo pole, 617.22 ± 158.11 individual m^{-2} on Mehogoni branch and 691.11 ± 152.61 individual m^{-2} on Rain tree branch substrates (Table 2). Macrozooperophytic

molluscan fauna also reported by Skalskaya *et al.* (2008) from a small river; Sharapova (2010a, 2010b) from a cooling water pool and a small of West Siberia.

Insecta: Periphytic insecta was one of the least dominant group of zooperiphyton and represented by 3 species. Among insects population *Corixa* sp. (63.5%) was most dominant and followed by *Chironomus* larva (34.5%) and *Ceratopogon* sp. (1%) of occupied of percentage value of total insects abundance (Table 2).The total average abundance of periphytic insects were 701.11 ± 187.91 individual m^{-2} assembleged on Bamboo pole, 707.77 ± 605.59 individual m^{-2} on Mehogoni branch and totally absent on Rain tree branch substrates (Table 2). Sharapova (2010a,b) observed that chironomid larva settled on immersed willow and stones from the UK River.

Oligochaeta: Zooperiphytic oligochaets was also non dominant group (Fig.1) and represented by *Nais* sp. The mean value of *Nais* sp. were 158.66 ± 112.19 individual m^{-2} settled on Bamboo substrates, 391.11 ± 297.37 individual m^{-2} on Megogoni substrates and totally absent from Rain tree substrates (Table 2). Sharapova (2010a,b) reported pollution signal producing periphytic oligocheats on rubble bedding at the base bridge and concrete pieces at Obrochnoye oxbow lake of the Tura River in Russia.

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