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DIVERSITY AND ABUNDANCE OF AQUATIC INSECT FAUNA IN AN URBAN FRESHWATER LAKE, HATIRJHEEL, DHAKA, BANGLADESH

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Abstract: Freshwater lakes are a crucial component of the urban ecology and offer several direct and indirect advantages to its people. Habitat degradation of native insects has happened because of development activities and unscientific natural resource management. As a consequence, many insects of freshwater lakes are now rare and endangered. A research was conducted to find out the abundance, variety and distribution of aquatic insect fauna in an urban freshwater lake, Hatirjheel, Dhaka during November 2015 to February 2016. A total of 3255 individuals of water insects comprising of 11 species and 31 genera under 20 families belonging 5 orders were recorded. The order Hemiptera contained the highest abundance (38.71%) including 7 families and 12 genera containing 5 species, while Trichoptera had the lowest (6.45%) including 2 families and 2 genera. The dominating species in the lake was *Micronecta haliploides*. The maximum 19 aquatic insect species were reported in the lake's vegetation-rich section near the Mouchak-Moghbazar flyover (Spot 1), whereas a minimum of 5 species were found near the Modhubagh bridge road (Spot 2). Species diversity index (H′ = 2.74), species richness (SR = 8.54), aquatic insect distribution evenness (J′ = 0.80), community dominance (CD = 46.94%), and Simpson's index (λ = 0.17) were analyzed in this study to determine the diversity, abundance, distribution and dominance of aquatic insect fauna in this lake.

Key words: Aquatic insects, diversity, abundance, urban freshwater lake, Dhaka city.

INTRODUCTION

The majority of animals on the planet are insects. Insects comprise over 751000 species worldwide, which are nearly three-fourths of all animal species (Borror *et al.* 1979). Aquatic insects are insects those spend a minimum part of their life cycle in the aquatic habitat. Despite the reality that most insects are terrestrial, a large portion of their variety consists of aquatic species (Westfall and Tennessen 1996). Freshwater accounts for approximately 0.01% of the world's total aquatic environment and contains approximately 100,000 species

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(8%) of the 1.3 million scientifically documented species (Dudgeon 1999). The major groups of aquatic insects make up a significant portion of the freshwater communities' biota. Aquatic insects play a vital role in the ecosystem of a body of water. They, in addition to performing ecosystem functions, are credible indicators of human impact on freshwater ecosystems. Insects are the main bio-indicators of freshwater ecosystems including lakes, ponds, wetland, streams, and rivers (Batzer and Wissinger 1996) and have shown to be useful tool for evaluating ecological theories (Foil 1998). Certain families of aquatic insects can help determine whether a water source is clean or polluted by their presence or absence (Foil 1998). A small number of studies on aquatic and semi-aquatic insects have previously been conducted in Bangladesh. Four aquatic bugs were reported from the lakes of Dhaka (Ameen and Chowdhury 1972). A survey of dragonfly nymphs was conducted by Chowdhury and Akhteruzzaman 1981. Several common damselfly larvae and their instars were reported by Ameen *et al.* 1982. Twenty-three aquatic Hemiptera species were identified from lakes of Dhaka (Ameen and Nessa 1985). Chittagong University's campus had a list of 14 aquatic and semi-aquatic Heteroptera species (Alam *et al.* 1986). Four Zygopteran larvae from the Chittagong University campus were also described by Chowdhury and Miah 1990. However, very little attention has been paid to the study of aquatic and semi-aquatic insect fauna of the urban areas of Bangladesh. The aims of this research were to explore the diversity, abundance, and distribution of aquatic insect fauna in Hatirjheel, a freshwater urban lake in Dhaka city.

MATERIAL AND METHODS

Study Area: Hatirjheel, the heart of Dhaka city, is located at 23°44′58.47″N, 90°23′48.35″E. The lake has a catchment area of over 30 square kilometers. The place is surrounded by Tejgaon, Gulshan, Badda, Banasree, Niketon, Moghbazar and some other parts. The area comprises tropical wet climate with an average rainfall of 1854 mm (73.0 in). Temperature varied from 19℃ to 24℃.

Methodology for collection and identification of insects: Survey was conducted from November 2015 to February 2016. Insects were collected every 15 days between 7 a.m. to 10 a.m. They were collected from three different locations namely Mouchak-Moghbazar flyover (23°45'07.1"N 90°24'04.4"E)- Spot 1, Modhubagh bridge road (23°45'38.6"N 90°24'35.8"E)-Spot 2, and Badda hanging bridge (23°46'06.3"N 90°25'09.1"E)- Spot 3 around the lake. Insects were captured using a 20cm diameter circular net with a 0.50mm mesh size. Hard-bodied insects were kept dry, whereas soft-bodied insects were kept in 70% alcohol. A few specimens of each type of insect were transported to the

laboratory for identification, and the remainders were returned to the sampling locations. To identify insects, a simple microscope was utilized. Based on the external morphology and accessible keys, insects were identified (Rahman and Hossain 1988, Ameen and Nessa 1985, Chowdhury and Akhteruzzaman 1981, Needham and Needham 1978, Ward and Whipple 1959, Clegg 1974, Ross 1959). Photographs were also taken using a Canon Power Shot SX510 Hs.

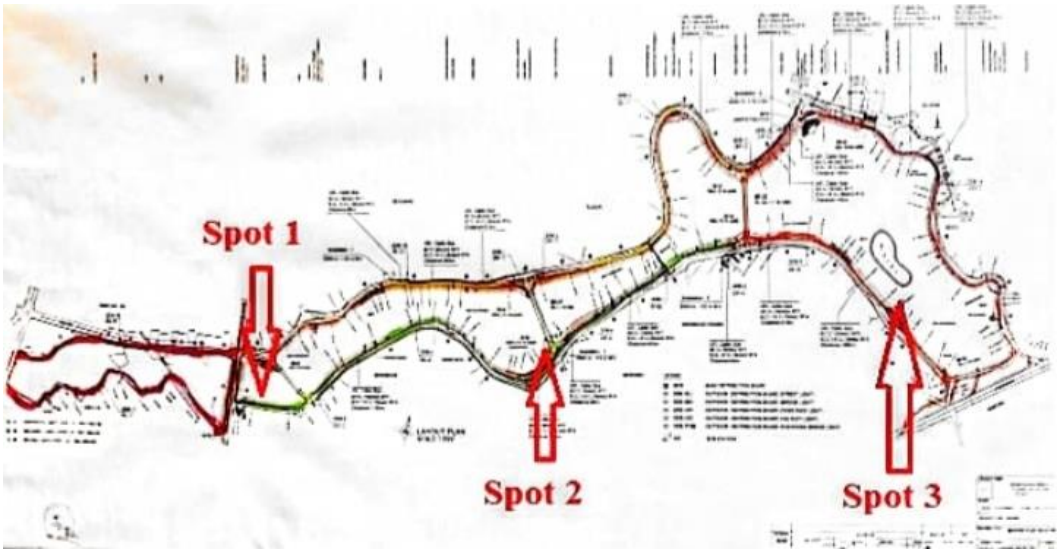

Fig.1. Map of Hatirjheel lake including Mouchak-Moghbazar flyover **(**23°45'07.1"N 90°24'04.4"E)- Spot 1, Modhubagh bridge road (23°45'38.6"N 90°24'35.8"E)- Spot 2, and Badda hanging bridge (23°46'06.3"N 90°25'09.1"E)- Spot 3.

Data analysis: An index measuring diversity and dominance was used to analyze the data. The species diversity, dominant component, and relative abundance of distinct species were all calculated by Shannon-Wiener's index, Simpson dominance index, and Pielou's evenness index respectively. On the basis of the relative abundance of the individuals, the species identified in this study were ranked.

Shannon–Wiener's Species Diversity Index (H'): Counting the number of species is the easiest way to assess species diversity. It has been derived in the present investigation using this formula: Shannon–Wiener's Species Diversity Index, H′ = $-\sum_{i=1}^{s} pi \ln pi$, Where, S = total number of genera/species in the sample, pi = $ni/_N$, ni = The number of individuals of each genera/species and N = total number of individuals of all genera/ species (Shannon and Weiner 1949).

Simpson's index: It is a diversity index that considers both the total number of species and the relative abundance of each species. Since it is universally recognized that all species at a site coexist, Simpson's diversity index (*λ*) was calculated (Ganeshaih *et al.* 1997). Simpson's Diversity Index, λ = $\frac{1}{\sum_{i=1}^{s} pi^2}$, Where, S = total number of genera/ species in the sample, pi = $^{ni}/_{N}$, ni = The number of individuals of each genera/species, *N* = Total number of individuals of all genera/ species in the sample.

Species Richness (SR): It is the most basic measure of species diversity, which was calculated using the following formula (Gleason 1922): Species Richness, SR=S-1 / logN, where, S= total number of genera/species in a sample, N= natural log of total number of individuals of all genera/species

Species Evenness (J'): The distribution of abundance among the species in a community was determined using the following (Pielou 1966): Species Evenness, *J'* = *H'*/ $\ln S$, where, H'= Shanon-Wiener's species diversity index, S = total number of the genera/species in the present study.

Community Dominance (CD): A community contains many species, one or more of which plays a dominant part in the community due to their number, size, and activities; such species were calculated by the following formula (McNaughton 1968): Community Dominance, CD (%) = $\frac{y1+y2}{y} \times 100$, Where, y_1= number of individuals of the dominant genera/species or the species with the highest rank 1, y_2 = number of members of the second dominating genera/species or the species with a rank 2, and *y* = total population of each genera /species.

RESULTS AND DISCUSSION

The aquatic insects documented from the Hatirjheel lake is shown in the Table 1. A total of 3255 individuals belonging 11 species and 31 genera under 20 families of 5 orders were recorded from this lake. The orders were Coleoptera, Diptera, Hemiptera, Odonata and Trichoptera. Among the five insect orders Hemiptera is the most abundant insect order which comprises 7 families (Belostomatidae, Naucoridae, Corixidae, Nepidae, Gerridae, Notonectidae and Pleidae) and 11 genera (*Sphaerodema, Ilyocoris, Callicorixa, Micronecta, Ranatra, Laccotrephes, Gerris, Lymngonus, Notonecta, Buenoa and Plea*). The second highest dominant order is Odonata, and it contains 4 families (Gomphidae, Libellulidae, Aeshnidae, and Coenagrionidae) and 8 genera (*Progomphus, Ictinogomphus, Libellula, Pantala, Aeshna, Coenagrion, Ceriagrion and*

Agriocnemis), whereas the order Trichoptera had a small number of representatives including 2 families and 2 genera. But according to the number of individuals 2nd dominating order is Diptera, and it contains 4 families (Culicidae, Chironomidae, Syrphidae and Psychodidae) and 6 genera (*Culex, Aedes, Anopheles, Chironomus*,*Eristalis tenax and Clogmia*). Ranking of the five-insect order based on family abundance hierarchy was Hemiptera > Odonata >diptera > Coleoptera > Trichoptera. A maximum of 19 aquatic insect genera were reported in the lake's vegetation-rich section near the Mouchak-Moghbazar flyover, while a minimum of 5 species were documented near the Modhubagh road (Fig. 1). The order Hemiptera recorded the highest species richness (12 spp.) and abundance (1789 individuals), while Trichoptera contained the lowest numbers (16 individuals). *Micronecta haliploides.* was the most dominant aquatic insect species (1181 individuals) in the lake. However, the abundance of several insect groups did not exhibit the same trend. Fig. 3 showed that members of the order Hemiptera (38.71% of the total) dominated the lake, followed by Odonata (25.81%) Diptera (19.35%), Coleoptera (9.68%), and Odonata (6.45%). *Micronecta haliploides, Culex sp., and Anopheles sp.* ranked first, second, and third in terms of relative abundance, with relative abundance of 36.28%, 10.67%, and 8.33%, respectively. The overall value of calculated diversity indices showed the diversity (H′ =2.74), and the community dominance (CD = 46.94%). Evenness of distribution of aquatic insect of the lake is 0.80. The value of Simpson's diversity index (λ =0.17), and the species richness of the lake is (SR = 8.54) (Table 1). The relative abundance of each insect family is shown in Table 2. The family Corixidae is the most abundant, with a relative abundance of 0.403. On the contrary, Brachycentridae and Leptoceridae both are the least abundant insect families, with a relative abundance of 0.002 (Table 2)**.** The findings of the existing research are in agreement with Hossain *et al.* (2015) who recorded a total of 9,891 aquatic insects of 22 families representing 6 orders from the river Buriganga and Shitalakhya in 2013. In the current investigation, the three research spots illustrate the various diversity and abundance representing 20 families, 5 aquatic insect orders including 3255 individuals. While Jana *et al.* (2009) described 10 Coleopteran, 5 Hemipteran and 3 Odonata species from Paschim Midnapore district of West Bengal at that time these were newly recorded, whereas before the current study no aquatic insects were recorded in Hatirjheel lake area.

Extensive studies of aquatic insects by Nasiruddin *et al.* (2014) and Nayem *et al.* (2021) were carried out in the Chittagong University Campus and a hilly stream, Bangladesh, respectively in which order Hemiptera was dominant while the present study also recorded the highest number of Hemiptera. Four species

Table 1. Illustration of the distinctive indices alternate as the relative quantity of each aquatic insect species in the Hatirjheel Lake, Dhaka city

Order	Family	Genera/Species	Visit 1	Visit 2	Visit 3	Visit 4	Visit 5	Total (n)	Pi= n/N	Pi^2	Pi ln Pi
Coleoptera	Dytiscidae	*Dytiscus sp.* (Linnaeus, 1758)	13	12	8	2	0	35	0.010752688	0.00011562029	-0.048737628
	Gyrinidae	*Dineutus spinosus* (Fabricius, 1781)	21	18	32	9	6	86	0.026420891	0.000698063	-0.096002956
	Hydrophilidae	*Hydrophilus cashmirensis* (Redtenbacher, 1844)	15	11	21	12	1	60	0.01843318	0.000339782	-0.073614803
Diptera	Culicidae	*Culex sp.* (larvae) (Linnaeus, 1758)	105	128	57	38	19	347	0.106605223	0.011364674	-0.23864888
		Aedes sp. (larvae) (Meign, 1818)	27	36	42	57	21	183	0.056221198	0.003160823	-0.161830549
		Anopheles sp. (larvae) (Meign, 1818)	21	36	98	103	13	271	0.083256528	0.00693165	-0.206961471
	Chironomidae	*Chironomus sp.* (larvae) (Meign, 1803)	18	23	13	7	3	64	0.019662058	0.000386597	-0.077253494
	Syrphidae	*Eristalis tenax* (Linnaeus, 1758)	23	15	17	0	0	55	0.413533835	0.171010233	-0.365156969
	Psychodidae	*Clogmia sp.* (larvae) (Williton, 1893)	48	57	31	30	36	202	0.062058372	0.003851242	-0.172502406
	Belostomatidae	*Sphaerodema annulatum* (Fabricius,1803)	13	18	30	21	12	94	0.028878648	0.000833976	-0.10236478
Hemiptera	Naucoridae	*Ilyocoris sp.* (Stal, 1861)	12	7	3	5	15	42	0.012903226	0.000166493	-0.056132619
	Corixidae	*Callicorixa sp.* (White, 1873)	24	32	38	25	14	133	0.040860215	0.001669557	-0.130654559
		Micronecta haliploides. (Kirkadly,1897)	213	301	231	172	264	1181	0.362826421	0.131643012	-0.367844578
	Nepidae	*Ranatra longipes* (Stal,1861)	6	2	3	0	0	11	0.003379416	1.14205E-05	-0.019229054
		Laccotrephes ruber. (Linnaeus, 1764)	0	0	2	0	0	2	0.000614439	3.77536E-07	-0.004543654
	Gerridae	*Gerris sp.*(Fabricius,1794)	2	3	1	1	0	7	0.002150538	4.62481E-06	-0.013208684
		Lymnogonus sp.(Mayr,1865)	13	12	20	10	11	66	0.020276498	0.000411136	-0.079043726
	Notonectidae	*Notonecta maculata.* (Linnaeus, 1758)	31	37	27	39	31	165	0.050691244	0.002569602	-0.151161395
		Buenoa sp.(Kirkadly,1904)	2	4	15	11	13	45	0.013824885	0.000191127	-0.059188273
		Anisops sp. (Kirkadly,1904)	0	0	1	0	1	2	0.000614439	3.77536E-07	-0.004543654
	Pleidae	*Plea sp.*(Fieber, 1817)	2	13	18	1	7	41	0.012596006	0.000158659	-0.05509966
Odonata	Gomphidae	*Progomphus sp.* (Selys,1854)	0	0	0	2	12	14	0.004301075	1.84992E-05	-0.023436086
		Ictinogomphus sp. (Cowley, 1934)	0	0	5	6	2	13	0.003993856	1.59509E-05	-0.022058059
	Libellulidae	*Libellula depressa.* (Linnaeus, 1758)	0	0	0	7	8	15	0.004608295	2.12364E-05	-0.024792154
		Pantala flavescens (Fabricius, 1798)	0	0	0	2	1	3	0.000921659	8.49455E-07	-0.006441784
	Aeshnidae	*Aeshna sp.* (Fabricius,1775)	0	0	0	10	14	24	0.007373272	5.43651E-05	-0.036201982
	Coenagrionidae	*Coenagrion sp.* (Kirby, 1890)	0	0	0	7	11	18	0.005529954	3.05804E-05	-0.028742355
		Ceriagrion sp. (Selys 1876)	4	5	13	12	15	49	0.015053763	0.000226616	-0.063167506
		Agriocnemis pygmaea (Rambur,1842)	3	4	0	1	3	11	0.003379416	1.14205E-05	-0.019229054
Trichoptera	Brachycentridae	*Brachycentrus sp.* (Curtis, 1834)	1	2	4	1	0	8	0.002457757	6.04056E-06	-0.014767448
	Leptoceridae	*Triaenodes sp.*(Mclachlan, 1865)	5	0	1	2	0	8	0.002457757	6.04056E-06	-0.014767448
Total		31	622	776	731	593	533	N=3255	1	0.165070304	-2.737327668

Number of genera /species (S) = 31, Total number of individual (N) = 3255, Shannon Diversity Index (H) = 2.7373277, Simpson's Index (λ) = 0.1650703, Simpson's Index of Diversity ($1-\lambda$) = 0.8349297, Simpson's Reciprocal Index ($\frac{1}{\lambda}$) = 6.05802497, Species Richness = 8.54, Species Evenness (J') = 0.80 , and Community Dominance (CD) = 46.94%.

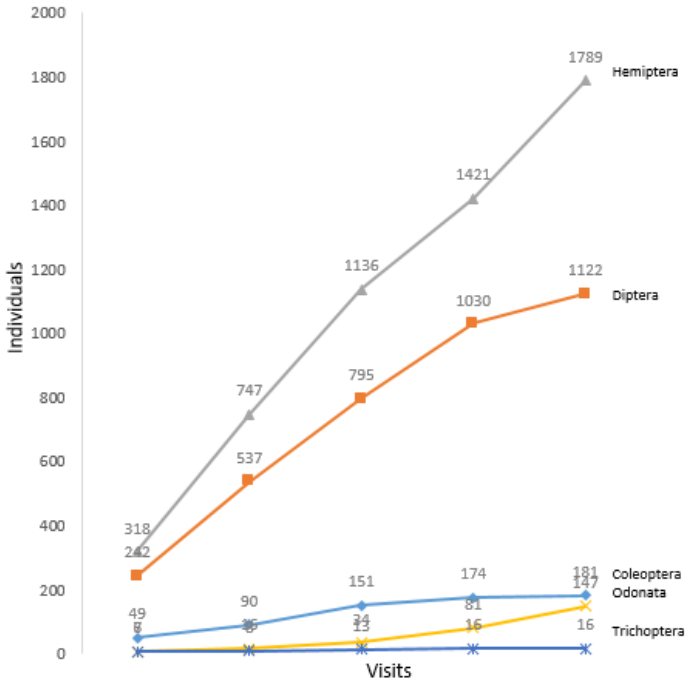

Fig. 2. Cumulative frequency of individuals of five orders for pooled data.

Table 2. Relative abundance of different families of collected aquatic insects from the Hatirjheel Lake, Dhaka city

Order	Family	Genera/Species	Individuals	Relative Abundance
Coleoptera	Dytiscidae	1	35	0.01075268817
	Gyrinidae	1	86	0.02642089093
	Hydrophilidae	1	60	0.01843317972
Diptera	Culicidae	3	801	0.2460829493
	Chironomidae	1	64	0.01966205837
	Syrphidae	1	55	0.01689708141
	Psychodidae	1	202	0.06205837173
Hemiptera	Belostomatidae	1	94	0.02887864823
	Naucoridae	1	42	0.0129032258
	Corixidae	2	1314	0.40368663594
	Gerridae	2	73	0.02242703533
	Nepidae	2	13	0.0039938556
	Notonectidae	3	212	0.06513056835
	Pleidae	1	41	0.01259600614
Odonata	Gomphidae	2	27	0.00829493087
	Libellulidae	2	18	0.00552995391
	Aeshnidae	1	24	0.00737327188
	Coenagrionidae	3	78	0.02396313364
Trichoptera	Brachycentridae	1	8	0.00245775729
	Leptoceridae	1	8	0.00245775729

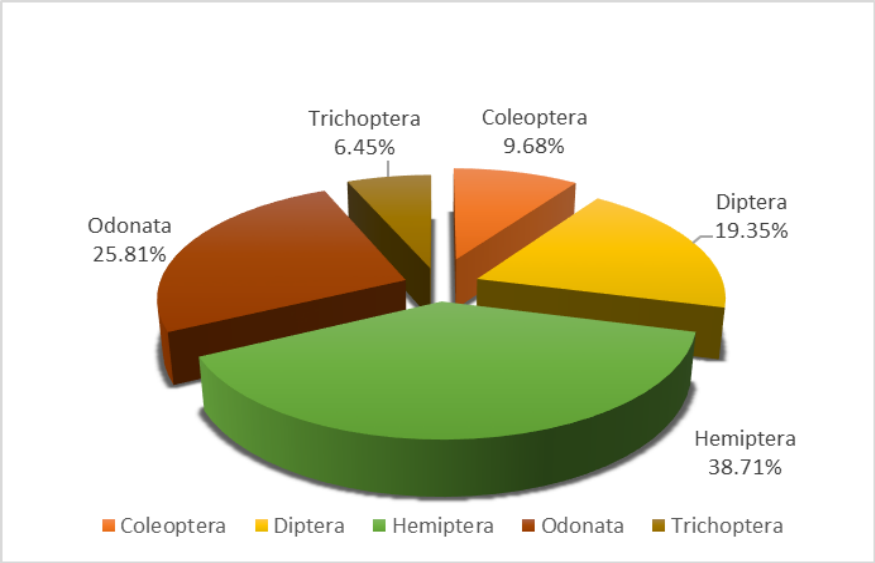

Fig. 3. Abundance of aquatic insects (%) under the 5 order recorded in the Hatirjheel lake, Dhaka city.

of damselfly larvae were identified by Ameen *et al.* (1982) from Dhaka, while four zygopteran larvae were described by Chowdhury and Miah (1990) from the campus of Chittagong University. *Coenagrion sp.*, a species of zygopteran nymph, was among those recorded by Ameen *et al.* (1982) and Chowdhury and Miah (1990). *Ictinogompus sp., Aeshna sp., Libellula sp.* and *Pantala sp.* were also described by Nasiruddin *et al.* (2014) whereas present study is considered with *Coenagrion sp, Ictinogompus sp., Aeshna sp., Libellula sp.* and *Pantala sp.* The present study reveals two genera of the order Trichoptera including *Triaenodes sp. and Brachycentrus sp.,* while Hossain (2008) also noted *Triaenodes sp.*

The results of different species diversity indices at Hatirjheel are reported in Tables 1. Shanon's diversity index (2.74) appears to have a low value and the value of Simpson's index also represented 0.17, showing a low diversity of aquatic insects in the present study. The evenness index (0.08) sheds light on the species' relative abundance in the community. Comparatively in the lake of Chittagong the value of species richness (3.81) and species evenness (0.93) were high described by Nasiruddin *et al.* (2014) that indicates high diversity and population of different insect species are distributed uniformly (Pielou 1966). According to Ganeshaih *et al.* (1997), the diversity indices H′ is useful because they take species richness into account. According to Ludwing and Reynolds

(1988), the value of λ decreases as diversity rises. The current study site exhibits low aquatic insect diversity as measured by the Simpson's index of diversity (0.83) and the Simson's reciprocal index (6.06). Maximum 19 species of aquatic insects can be found in Spot 1 (Mouchak-Moghbazar flyover). The location's aquatic habitat and water quality may be the primary causes of this abundance Nasiruddin *et al*. (2014).

CONCLUSION

Numerous urban, man-made, and natural freshwater lakes benefit humans and aquatic life in both direct and indirect ways. During the present investigation, a total of 11 species under 31 genera were recorded in the lake at different spots. The number of aquatic insects varied among the spots. In the month of December 2015, the highest insect abundance was recorded. Hemipteran and Dipteran insects dominance suggested that Dhaka's urban freshwater lakes are moderately polluted. Review of the related literature suggests that only a limited number of reports are available in Bangladesh. Therefore, adequate emphasis should be given to study the insect diversity of the fresh water lakes of Bangladesh.

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