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DIVERSITY, ABUNDANCE, DENSITY AND HABITAT CHARACTERIZATION OF MOSQUITOES IN DHAKA, BANGLADESH

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ABSTRACT: Mosquito diversity, abundance, density, and habitats were studied at four selected breeding areas in Dhaka city from December 2015 to April 2016. A total of 3214 individuals of 10 mosquito species belonging to 3 genera namlely *Culex* (7spp.), *Aedes* (2spp.), and *Anopheles* (1sp.) were documented during the study period. The *Cx. quinquefasciatus* (37.83%) was found the highest in number followed by *Cx. vishnui* (16.74%), *Cx. tritaeniorhynchus* (16.21%), *Cx. gelidus* (9.40%), *Cx. hutchinsoni* (9.12%), *Cx. fuscocephala* (2.77%), *Cx. vagans* (2.21%), *Ae. aegypti* (3.17%), *An. annularis* (2.77%), and *Ae. albopictus* (1.15%). Maximum number of mosquitoes were found in Hazaribagh (1178 individuals), followed by Badda (1128 individuals), Demra (594 individuals), and Sutrapur (314 individuals). Mosquitoes were plentiful in March, regardless of species distribution which was influenced by rainfall and the lowest was in February. Eighteen different habitats of the mosquitoes were identified. The Simpson's Index (λ= 0.18) and Shanon's Diversity Index (H′= 1.93) indicated maximum mosquito diversity at Demra thana where species richness was 3.24. However, the Sutrapur thana (λ= 0.34, H′ =1.34) was minimum in which species richness had 2.40. The Species Evenness in the Demra thana (J′= 0.84) indicated that the species were evenly distributed whereas the Sutrapur thana (J′= 0.69) was comparatively less evenly distributed. The highest Community Dominance was 76.11% for the Sutrapur and the lowest was 49.66% for the Demra. Sorenson's Coefficient (CC) was 0.76 indicating that there was considerable overlap or similarity across the four communities.

Key words: Mosquitoes, Distribution, Species Richness, Species Evenness, Dhaka city.

INTRODUCTION

The mosquitoes are the deadliest creature on the planet and are under the class Insecta, order Diptera, family Culicidae (Chowdhury *et al.* 2000). The Culicidae mosquito family is the well-known parasitic carriers of several deadly and contagious diseases,

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including dengue fever, malaria, yellow fever, filariasis, and encephalitis (Chowdhury *et al.* 2000). Mosquito-borne diseases (MBDs) in 2018 caused about 750,000 fatalities worldwide (Mobin *et al.* 2022). The MBD occurs when mosquitoes suck their host's blood and thus transmits parasites or viruses so to the next host (Mobin *et al.* 2022). Since the distant past, they have been the biggest worrisome agents in both rural and urban areas, and they continue to exist today, mainly in developing nations and the rest of the world. Dengue fever is estimated to cost the Americas USD 2.1 billion per year, excluding the expenditure of preventive treatment (Mobin *et al.* 2022). *Aedes aegypti* is a known vector of dengue fever and dengue haemorrhagic fever (DHF). In recent time, the DHF is considered as a significant threat to many Asian nations, including Bangladesh (*Ahmed et al.* 2007).

The distribution of the fauna and the vectorial capacity have changed because of the global climate change and deforestation (Clements 1992). The biology and bionomics of mosquitoes that act as vectors are topics about which we know relatively little, and many mosquito species are now insecticide-resistant (Ameen *et al.* 1994, Ali *et al.* 1999). Among the 3000 mosquito species of the world, they are divided into 135 subgenera and 39 genera, of which 100 are known to be disease vectors for humans (Clement 1992, Reinert 2001). Only around 113 species out of over 3000 species have been identified in Bangladesh and the important genera are *Culex, Aedes Anopheles, Psorophora, Mansonia, and Haemagogus* (Alam *et al.* 2015). For any disease to be effectively controlled or prevented, accurate identification of vector species is crucial. Dhaka is a densely populated city, where human activities like the dumping of waste namely coconut barks, papers, polybags, household wastes constantly damage the drainage system. The hazard and unplanned constructions create ponderous water that serves as the habitat for mosquitoes' year-round regrowth (Ali *et al.* 1999, Ameen *et al.* 1999). Therefore, it is crucial to understand the distribution and status of the mosquito species to control mosquitoes and diseases spread by them. In this regard, a scientific study was conducted in four selected sites in Dhaka city to identify the mosquito fauna from various habitats, as well as their diversity, abundance, density, and distribution in the city of Dhaka.

MATERIAL AND METHODS

Hazaribagh, Demra, Badda and Sutrapur were the four areas in Dhaka city where the study was conducted (Fig 1). 16 specific locations within the four sites in Dhaka city were used for all the observations (Table 1). Adults and larvae of the mosquitoes were counted twice in a month in the morning from December 2015 to April 2016. A 10 cm diameter circular frame with such a piece of gauze fixed on it and a rod-like handle were used, based on the conventional

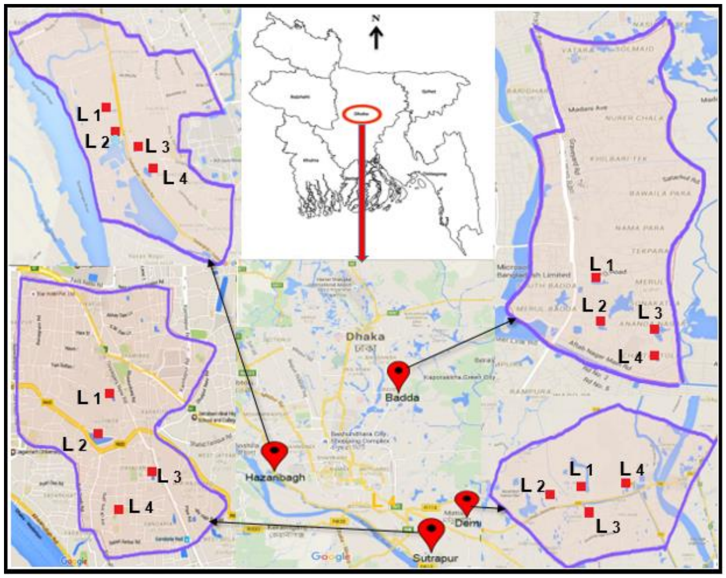

Fig. 1. Dhaka city map displaying sampling areas for various locations within the four sites.

Table 1: 16 locations within the four sites in Dhaka city

Study site	**Location**	**GPS**	**Study site**	**Location**	**GPS**
Hazaribagh	L_1	23°43'38.4" N and 90°22'05.5" E	Badda	L_1	23°46'23.0" N and 90°25'53.6" E
	L_2	23°43'36.1" N and 90°22'5.5" E		L_2	23°46'05.4"N and 90°25'38.4"E
	L_3	23°43'35.1" N and 90°22'15.1" E		L_3	23°46'04.1"N and 90°26'08.5" E
	L_4	23°43'33.4" N, and 90°22'15.1" E		L_4	23°45'48.1" N and 90°26'3.0" E
Demra	L_1	23°42'33.1" N and 90°27'08.3" E	Sutrapur	L_1	23°42'46.4"N and 90°25'17.3"E
	L_2	23°42'55.0" N and 90°27'27.4" E		L_2	23°42'36.1"N and 90°25'09.3"E
	L_3	23°43'0" N and 90°28'04.6" E		L_3	23°42'23.6"N and 90°25'31.4"E
	L_4	23°42'57.4" N and 90°27'43.0" E		L_4	23°42'46.2"N and 90°25'20.6"E

dipping method. A semi-circular disc and a dipping net were used to collect mosquito larvae from a variety of places, including drains, semi-polluted ponds, lakes, polluted ground water, tree holes, coconut shells, rainwater pools, empty paint cans, and leaf axils. The net was loaded with mud and debris after being pushed through water. After that, it was taken out of the water and put into a sizable white tray (30 x 22 x 4 cm) as described by Khan *et al.* (2014). Each mosquito larval instar was separated using a pipette. In case of emergence of adults, the larvae were gathered and put in rearing cases in the lab. For identification, many of the larvae were kept in 70% alcohol. After being killed with chloroform, the newly emerged adult mosquitoes were kept in a tiny plastic pod for identification. The adult species were collected with the aid of a sweeping net, an aspirator, and a spray sheet technique from their areas for spawning, resting, flying, and feeding. The sweeping net was swept ten times every ten minutes to collect different mosquito species.

Before identification, the live mosquitoes were put to sleep with cotton soaked in chloroform. For preservation, the collected specimens were put into distinctive plastic cases. The plastic boxes were later labelled with habitat, date, and time and brought to Jagannath University's Entomology Laboratory, Department of Zoology. Identification was then done using a light microscope followed by the procedures used by Barraud (1934) and Reuben *et al.* (1994) and Rueda (2004) and Khondker (2009). Meteorological data were collected from https://bmd.gov.bd/and
https://www.timeanddate.com/weather/bangladesh/dhaka.

Diversity Analysis: As a measure of diversity, the study used Shannon's Diversity Index (H) (Shannon and Weiner 1949) and Simpson's Index (λ) (Simpson 1949). The following are the equations for the two indices:

Shannon's Diversity Index (H') = $-\sum_{i=1}^{S} pi \ln pi$, Simpson's Index (λ) = $\sum_{i=1}^{S} pi^2$

Where, p denotes the proportion (n/N) of individuals of one species discovered (n) divided by the total number of individuals discovered (N), is the natural log, is the sum of the calculations, and S denotes the number of species discovered. In most ecological research, optimal H values range between 1.5 and 3.5, with the index rarely exceeding 4. The value of the similarity index ranges from 0 to 1. (Simpson 1949).

Simpson's Diversity Index (1-λ): It functions as a diversity indicator. Two individuals chosen at random from a community are more likely to fall into different categories. The value of 1-λ ranges from 0 to 1, with high scores (close to 1) indicating high diversity and low scores (close to 0) indicating low diversity (Simpson 1949).

Simpson's Reciprocal Index: (1/λ) It can be used to assess the relative biodiversity of a community. It can be used to compare communities in order to identify intrinsic characteristics. A high index value indicates a stable site with a wide range of riches and little competition. A low index value indicates a site with a few potential niches dominated by a few species. The index value may change in response to environmental interference (MacDonald *et al.* 2017).

Species evenness *(J')*: It describes the number of species in each environment. The equation is *(J')*: =H'/ln(S). Where, J′ = Species Evenness, H= Species Diversity, and S = Number of the species (Pielou 1966). *J′* has a range of 0 to 1. When the value of *J′* approaches zero, it indicates that the species is more dominant in the community; when it approaches one, it indicates that the species is evenly distributed (Shannon and Weiner 1949).

Species Richness (SR): The following equation was used for Species Richness, SR=$\frac{S-1}{\log N}$, Where S= Total number of different species found in a sample, N= Total number of individuals of all species (Gleason 1922).

Density: It is estimated with the percentage of the specimens of the species in the total sample following by the formula (Dziêczkowski 1972). Density, D =$\frac{n}{N} \times 100$ %, where, n= numbers of specimens of each mosquito species and N = number of all specimens.

Community Dominance (CD): The simple community dominance index is the percentage of abundance contributed by the two most abundant species. The equation is as follows:

CD (%) = $\frac{y1+y2}{y} \times 100$, Where y_1= number of individuals of most dominant species or the rank-1 species, y_2 = number of individuals of the 2nd dominant species or the rank-2 species.

y = Total number of species individuals. (McNaughton 1968).

Community Similarity: Sorenson's Coefficient (CC) is used to calculate it. The equation is as follows: Coefficient of Sorensen (CC) =$\frac{4C}{S_1+S_2+S_3+S_4}$ Where, C denotes the number of species shared by the three communities, S_1 denotes the total number of species found in community 1, S_2 denotes the total number of species found in community 2, S_3 denotes the total number of species found in community 4, and S_4 denotes the total number of species found in community 4. (Sorensen 1948).

RESULTS AND DISCUSSION

A total of 3214 individuals of 10 species of mosquitoes belonging to 3 genera were recorded (Table 2). The identified genera are *Culex, Aedes,* and *Anopheles.* Among ten mosquito species, the highest in number (37.83%), was *Cx. quinquefasciatus,* whereas the lowest in number (1.15%) was *Ae. albopictus* (Fig. 2). Hossain *et al.* (2014) reported that the Dhaka Cantonment was home to three important genera, including *Anopheles*, *Culex*, and *Aedes.* Likewise, some researchers discovered that *Cx. quinquefasciatus* predominated throughout the year (Gupta 1998, Laila 2001). Although previous study from 1970 to 1997 in Dhaka city reported a tendency toward fewer mosquito species (from 27 to 5), but the current study clearly illustrated the increasing trends.

At Hazaribagh, *Cx. quinquifaciatus* had the highest prevalence among the other species (451 individuals, 38.29%), while *An. annularis* were found the lowest in number (12 individuals, 1.02%) (Table 2 and Fig 2). The month of March had the maximum population (27.93%), and the minimum (12.31%) was in February (Fig. 4). Although, 11 distinct mosquito species from the six study locations were found by Sharower *and* Latif (2017). In which *Ae. albopictus* (38.18%) and *Ar. subalbatus* (37.47%) were the two mosquito species that were most prevalent. Conversely *Cx. fuscocephala* had the lowest density (0.6%).

Cx. quinquifaciatus was the dominant species at Badda (410 individuals, 36.35%). On the other hand, *Cx. fuscocephala* had the lowest prevalence (4 individuals, 0.35%) (Table 2, Fig 2). At Badda specifically, March had the highest population (30.50%), and the minimum (14.18%) was in February (Fig. 4). Bashar *et al.* (2016) observed 84 sampling sites yielded a total of 6088 mosquito larvae from 12 species and 5 genera where *Culex quinquefasciatus* was maximal (32.93%). On the contrary, *Mansonia uniformis* was the lowest (1.23%).

At Demra, *Cx. quinquifaciatus* had also the highest prevalence (197 individuals, 33.16%), and the least in number (4 individuals, 0.67%) was found in case of *An. Annularis* (Table 2, Fig 2). Clearly, March had the peak population (27.44%), and the minimum (16.33%) was in February (Fig. 4). However, Sultana *et al.* (2017) recorded a total of 3217 mosquito larvae from five species in both natural and artificial settings. The highest percentage of coexisting was occurred in tree holes (82.4%) by *Ae. albopictus*, *Ae. aegypti*, and *Ar. subalbatus*, followed by 63.2% in coconut shells (*Ae. aegypti*, *Ar. subalbatus*, and *Cx. quinquesfasciatus*), and 35.2% in water bottles (*Ae. albopictus*, *Ae. aegypti* and *Cx. quinquefasciatus*). *Ae. albopictus*, *Ar. subalbatus*, *Ae. aegypti* coexisting in numerous locations suggested by Hawley (1988) that they shared a common habitat.

At Sutrapur, *Culex quinquifaciatus* was the most prevalent species (158 individuals, 50.32%), and the least in number was found in case of both *Ae. aegypti* and *An. annularis* (4 individuals, 1.27 %). Only seven species were found in this area (Table 2, Fig 2). Particularly March had the highest population (34.71%), and the lowest (10.83%) was in February (Fig. 4). In contrast to the other three research locations, the Sutrapur area lacked three species viz., *Cx. fuscocephalus*, *Cx. vagans*, and *Ae. albopictus*. Only 4 individuals of *Cx. fuscocephalus* were identified from Badda area compared to 57 in Hazaribag and 28 in Demra. This indicated the less abundance of this species in Badda area.

Table 2: Illustration of indices change as the relative number of each mosquito species change in the study areas

Name of species	Presence in study sites	Total Abundance H	Total Abundance B	Total Abundance D	Total Abundance SP	Density H	Density B	Density D	Density SP	Various indices H	Various indices B	Various indices D	Various indices SP
Aedes aegypti (Linnaeus, 1762)	H, B, D, S	45	10	43	4	3.82	0.89	7.24	1.27	S = 10	S = 10	S = 10,	S= 7
Aedes albopictus (Skuse, 1895)	H, B, D	17	7	13	0	1.44	0.62	2.19	0	N = 1178	N = 1128	N = 594	N = 314
Anopheles annularis (Vander Wulp, 1884)	H, B, D, S	12	25	4	4	1.02	2.22	0.67	1.27	H′ =1.84	H′ =1.69	H′=1.93	H′=1.34,
Culex vishnui (Theobald, 1901)	H, B, D, S	209	150	98	81	17.74	13.30	16.50	25.80	λ=0.22	λ = 0.23	λ= 0.18	λ= 0.34,
Culex quinquifaciatus (Say, 1823)	H, B, D, S	451	410	197	158	38.29	36.35	33.16	50.39	$1-\lambda$=	$1-\lambda$ =	$1-\lambda$=	$1-\lambda$=
Culex tritaeniorhynchus (Giles, 1901)	H, B, D, S	168	260	78	15	14.26	23.05	13.13	4.78	0.78	0.77	0.82	0.66,
Culex gelidus (Theobald, 1901)	H, B, D, S	100	114	75	13	8.49	10.11	12.63	4.14	$\frac{1}{\lambda}$= 4.65	$\frac{1}{\lambda}$ = 4.38	$\frac{1}{\lambda}$ =5.43	$\frac{1}{\lambda}$= 2.95
Culex vagans (Wiedemann, 1828)	H, B, D	43	12	16	0	3.65	1.06	2.69	0	SR = 2.93	SR = 2.95	SR = 3.24	SR =
Culex hutchinsoni (Barraud,1924)	H, B, D, S	76	136	42	39	6.45	12.06	7. 07	12.42	J′ = 0.80	J′= 0.73	J′ = 0.84	2.40,
Culex fuscocephala (Theobald, 1907)	H, B, D	57	4	28	0	4.84	0.35	4.71	0	CD =	CD =	CD =	J′ =0.69
Total=10		1178	1128	594	314					56.03 %.	59.40%	49.66%	CD =
													76.11%

H = Hazaribagh, B = Badda, D = Demra, SP = Sutrapur, S = Number of species, N = Total number of individual, H′ = Shannon Diversity Index, λ = Simpson's Index, $1-\lambda$ = Simpson's Index of Diversity, $\frac{1}{\lambda}$ = Simpson's Reciprocal Index, SR = Species Richness, J′ = Species Evenness, and CD = Community Dominance.

Table 3. Community Similarity among the Hazaribagh, Badda, Demra and Sutrapur thana

$$\text{Sorensen's Coefficient (CC)} = \frac{4C}{S_1+S_2+S_3+S_4} = \frac{4\times7}{10+10+10+7} = \frac{28}{37} = 0.76$$

The number of individuals of *An. annularis* was extremely poor in all the areas compared to other species. Two *Aedes* species were collected during the study period. Islam and Prithul (2021) identified only 3 species under 2 genera from nine locations at the two public universities in Dhaka City as mosquito breeding grounds. Particularly, 4415 mosquito larvae were collected, of which 1329 (30.1%) and 3086 (69.9%) were identified as *Culex* and *Aedes*, respectively. The highest percentage of *Culex* larvae (167 individuals, 10.9%), were discovered on the Jagannath University campus in the month of August, where the lowest percentage (66 individuals, 4.3%) were found in February. In contrast, the highest number of *Aedes* larvae (137 individuals, 23.8%), were discovered in the month of July, and the lowest number (9 individuals, 1.6%) were discovered in December. The maximum number of *Culex* larvae (179, 11.5%), were discovered on the campus of Dhaka University in the month of April and the lowest number (66, 4.3%) were discovered in the month of June. The current study indicated that a smaller number of mosquitoes were detected in February and more number were found in March, respectively for the Hazaribagh, Badda, Demra and Sutrapur. (Fig. 4).

In case of all study sites of the current research, the highest number of *Cx. quinquifaciatus* species was recorded in the March and this was the most prevalent of all species. From the density measurement analysis *Cx. quinquefasciatus* was found in high percentage in all the studied areas, while *An. annularis, Cx. fuscocephala, Ae albopictus, Ae. aegypti* had the lowest density in Hazaribagh, Badda, Demra and Sutrapur thana respectively. Similar study done by Bashar *et. al* (2016) where *Ae. aegypti* and *Ae albopictus* were found with high density. Previously Ameen and Moizuddin (1973) also stated that *Cx. quinquefasciatus* was the prevailing species because mosquito breeding grounds with polluted organic-rich water are comparatively more common in Dhaka city.

The present study indicated 18 different habitat environments; similarly, Bashar *et al.* (2014) discussed about 15 breeding habitats, whereas 13 habitats were common in the current investigation. Most of the species were found in semi-polluted ponds and empty containers. *Cx. vishnui, Cx. gelidus, and Cx. tritaeniorhynchus* chose to reproduce usually in drain, semi-polluted pond, freshwater lake, ground tank, empty containers, and bamboo stumps, according to the current study. *An. annularis* was also discovered in the pond, lake, and mud pool. Since *Cx. quinquefasciatus* larvae favor dirty groundwater sites such as polluted drains, so it was not discovered in the freshwater lake. They were found in drains, semi-polluted water, polluted groundwater, tree-holes, coconut shells and tyre-water. *Ae. aegypti*, *Ae. albopictus* and *Cx. fuscocephala* were also detected in coconut shells and tree holes. However, *Cx. hutchinsoni*, *Cx. vagans*, *Cx. fuscocephala* were observed in the borrow pit. In tyre warer, *Ae. aegypti*, *Ae. albopictus Cx. quinquefasciatus* were found. In drains and semi polluted ponds, *Cx. quinquefasciatus, Cx. vishnui, Cx. Tritaeniorhynchus, Cx. gelidus* were common. *Aedes* species were found in most of the habitats. Similar study done by Khan *et al.* (2014), *Aedes* species were found in containers, domestic habitats, and tree holes. Coconut shells were filled with muddy humus and water during the rainy season, making them ideal for breeding *Cx. quinquefasciatus* mosquitoes. *Ae. aegypti, Ae. Albopictus. Cx. quinquefasciatus* were discovered also in tyre water. *Cx. quinquefasciatus, Cx. vishnui, Cx. tritaeniorhynchus,* and *Cx. gelidus* were all present in semi-polluted ponds and drains. However, six breeding environments, including tree holes, leaf axils, water bottles, tires, drains, and coconut shells, were discovered by (Sultana *et al.* 2017). Ameen *et al.* (1994) looked at mosquito distribution patterns that could be accounted for by species-specific habitat preferences, the study noted that there were 1742 mosquito breeding grounds in Dhaka and found that lakes had the lowest mosquito densities and abandoned ponds had the highest. *Anopheles* and *Aedes* mosquito species prefer clear ground pools and artificial containers, but Culex species frequently procreate copiously in contaminated gutters, clogged drains, and other organically rich water retention habitats described by Ahmed *et al.* (1986). The study areas had a lot of ponds and puddles that were polluted, which made them ideal breeding grounds for *Culex* species. However, because their preferred habitat is less common, there are fewer species of *Anopheles* and *Aedes*. *Culex* species have been observed to be very prevalent in polluted waters and smelly sites by Anosike *et al.* (2007).

In current research, the number of species and how prevalent they were calculated by using the Shanon diversity index (H′), and similarity was identified by the Simpson diversity index (λ). Ganeshaih *et al.* (1997) mentioned that the diversity indices H′ and λ seem helpful because they take species richness into account. The highest value of H′ was 1.9 for Demra when species richness and evenness were 3.24 and 0.84, respectively that were maximum, and the lowest was 1.3 in Sutrapur when species richness and evenness were 2.40 and 0.69, respectively that were minimum, among other areas. The maximum value of λ was 0.34 in Sutrapur thana, whereas the minimum value of λ was 0.18 in Demra. Ganeshaih *et al.* (1997) stated that the Shanon diversity index (H′) increases when species evenness and richness increase. The value of λ is less that means diversity is high was described by Ludwig and Reynolds (1988). Sanjayan *et al.* (1995) demonstrated that when the value of *J′* approaches zero, it indicates that the species has become more dominant in a community. The value of *J′* in this study indicated that the species were moderately distributed but evenly distributed in Demra and less evenly distributed in Sutrapur. 1- λ is a diversity indicator. In Demra thana the value of 1- λ had 0.82 which was the highest among other three areas that indicating diversity was maximum here and Sutrapur thana had the lowest diversity owing to 1- λ was 0.66. The value of Simpson's reciprocal index (1/λ) was 5.43 for Demra, the highest among the other three areas, so this area had the most stable richness, and the lowest was 2.9, which showed low diversity. Community dominance was high (76.11%) in Sutrapur and low (49.66%) in Demra. Fig. 6 showed that Species richness in the Badda and Sutrapur areas fluctuated during the study period, whereas it was more stable in Hazaribagh and Demra Thana. Among 10 mosquito species, all were found in March at Hazaribagh, Badda, and Demra, respectively. Whereas Sutrapur had 7 species.

According to Sorensen's Coefficient, CC was 0.76 which was closer to the value of 1, so in this study, the more the communities had species in common (Table 3). The number of mosquito species decreased gradually from December to February. However, in March the number drastically increased, and in April the number again decreased significantly (Fig 3). The humidity decreased from December (70%) to March (64%), then increased in April (74%). On the other hand, temperature and rainfall increased steadily during the study period (Fig 3). Environmental variations, such as temperature and humidity, may affect a species' geographic distribution in each area where there isn't a complete barrier to its dispersal (Bates 1949, Samways 1995, Micieli and Campos 2003). In all four study areas, the mosquito population was at its lowest in December. The population then started to rise everywhere. While Demra and Sutrapur saw a steady increase, Hazaribagh and Badda saw sharp increases. The initial portion of the curves, from December to January, were concave up, indicating that the value was increasing. During February, the curves were roughly steady, and in the third place, the slop increased more in March and April (Fig 5). In this study, the average temperature ranged from 19 to 31℃ and the relative humidity level was between 64% and 74%. The highest average rainfall was measured in the month of April (156.3 mm) and the lowest was in January (7.7 mm) (Fig 3). Mosquito populations may have increased because of this. The maximum mosquito survival rate at the relevant temperatures and humidity levels had been previously reported by Murty *et al.* (2010) where numerous breeding sites being accessible, low to medium levels of humidity (55–61%), and the ideal temperature (25–30°C) may have all contributed to the high density of Cx. sp. Sharower *et al.* (2020) also stated that the temperature ranged from 22.4 to 32.2 °C, and the average humidity was 56.5%, which may had contributed to the higher mosquito abundance. Similar effects of rainfall patterns on mosquito larval habitat and population density could be observed. According to rainfall data, increased rainfall may result in the creation of new habitats that will increase mosquito populations and larval habitats. However, mosquito vectors live for a shorter period However, mosquito vectors live for a shorter period when relative humidity is lower than 60% observed by Rogers and Randolph (2006).

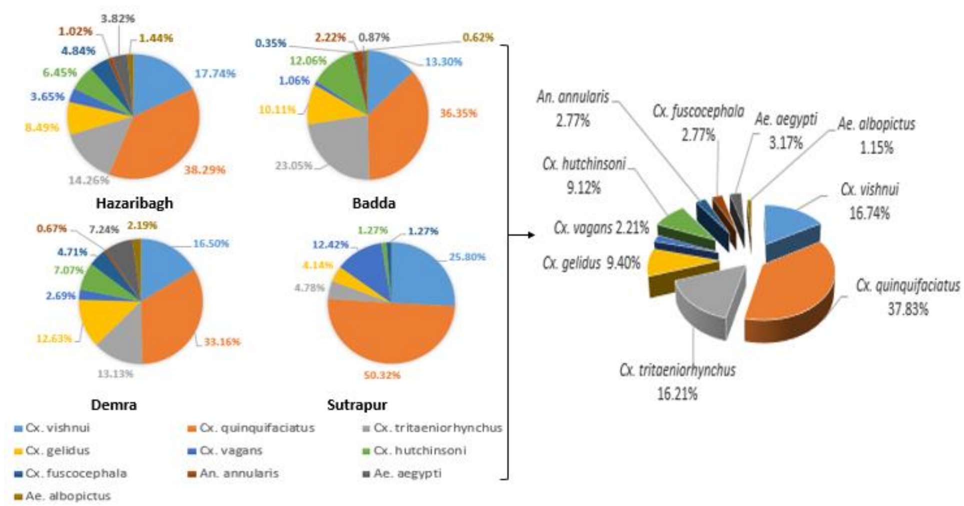

Fig. 2. Percentage of Species-wise population (%) at the four study areas

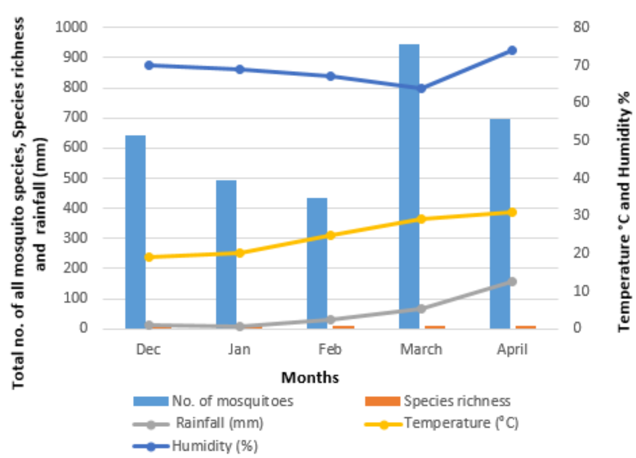

Fig. 3. Monthly species richness and populations of all mosquito species in Dhaka city, along with temperature, relative humidity and rainfall .

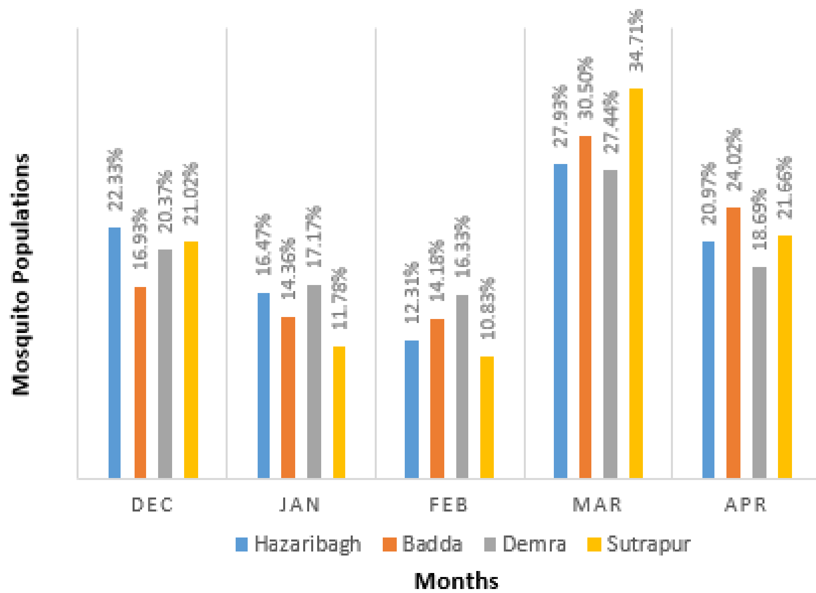

Fig. 4. Month wise mosquito populations (%) at the four thanas of Dhaka city.

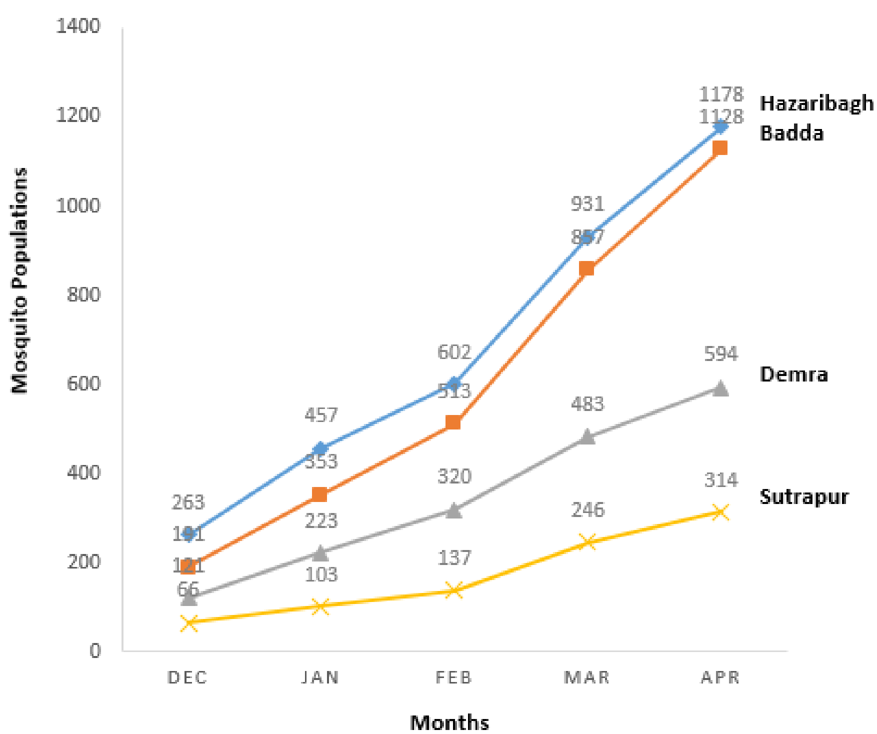

Fig. 5. Monthly cumulative population curve of different mosquito species at the study areas .

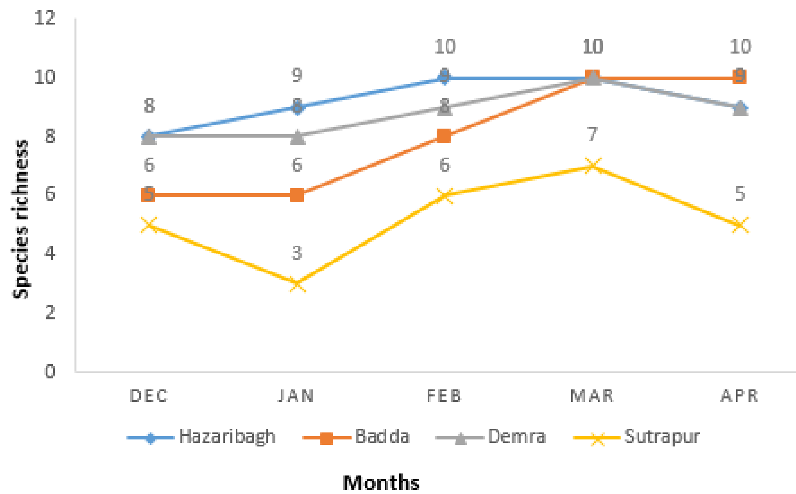

Fig. 6. Species richness curves of mosquitoes for pooled data at the study areas.

CONCLUSION

This research demonstrates the diversity, abundance, density and habitats of 10 mosquito species with statistical analysis of several indicators, and many environmental factors such as temperature, humidity, rainfall. Temperature and rainfall have a strong influence on the variety and number of mosquito species. Additional research is needed for proper management of mosquito species in the study areas.

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