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Md. Rezaul Karim

Department of Zoology,
University of Dhaka, Dhaka-
1000, Bangladesh

Md. Muzahidul Islam

Department of Zoology,
University of Dhaka, Dhaka-
1000, Bangladesh

Md. Sheik Farid

Department of Zoology,
University of Dhaka, Dhaka-
1000, Bangladesh

Md. Abdur Rashid

Department of Zoology,
University of Dhaka, Dhaka-
1000, Bangladesh

Tangin Akter

Department of Zoology,
University of Dhaka, Dhaka-
1000, Bangladesh

Humayun Reza Khan

Department of Zoology,
University of Dhaka, Dhaka-
1000, Bangladesh

Correspondence:

Md. Abdur Rashid

Department of Zoology,
University of Dhaka, Dhaka-
1000, Bangladesh

Email:

abdurashid71@yahoo.com

Tel: +8801911747959

Spatial Distribution and Seasonal Fluctuation of Mosquitoes in Dhaka City

Md. Rezaul Karim, Md. Muzahidul Islam, Md. Sheik Farid, Md. Abdur Rashid*, Tangin Akter, Humayun Reza Khan

ABSTRACT

In an entomological study conducted from March 2011 to February 2012, mosquito larvae and adults were collected from different breeding sites viz. drains, coconut barks, tree holes, lakes, artificial water containers and tubs in Dhaka city utilizing long aquatic nets and sweeping nets. Altogether, 3487 mosquitoes belonging to 13 species of 4 genera namely *Culex* (7), *Mansonia* (3), *Aedes* (2) and *Armigeres* (1) were sampled, all of which were under the family Culicidae. Among the collected mosquitoes *Cx. quinquefasciatus* (29%) showed the highest abundance followed by *Cx. vishnui* (23%), *Cx. tritaeniorhynchus* (14%), *Cx. gelidus* (6%), *Cx. fatigans* (5%), *Cx. fuscocephala* (5%), *Cx. hutchinsoni* (5%), *Mn. annulifera* (3%), *Mn. uniformis* (2%), *Mn. indiana* (2%), *Ae. aegypti* (2%), *Ae. albopictus* (2%) and *Ar. subalbatus* (1%). Maximum number of species were found in Osmani Uddan (12, n = 750) followed by Old Dhaka (11, n = 1648), Sohrawardi Uddan (9, n = 516) and Fullbaria Bus Station (7, n = 573). Irrespective of species specific distribution, mosquitoes were found abundantly in August when the rainy water creates numerous temporary breeding grounds. While species specific peak seasons were observed throughout the year.

Keywords: Mosquitoes, Spatial Distribution, Seasonal Fluctuation, Dhaka city

1. Introduction

Mosquitoes that are belonging to the family culicidae, are the familiar parasitic vectors of a number of transmissible and life menacing diseases such as malaria, filariasis, dengue fever, yellow fever and most of the arthropod borne viral types of encephalitis^[1, 2]. Apart from these, they cause biting annoyance and irritation through sucking blood. They are the most worrying agents in both urban and rural areas since distant past and persist till now predominantly in the developing countries and the world in general. Due to the global climate change and deforestation the faunal distribution, vectorial capacity has been changed^[3]. We have little knowledge about the biology and bionomics of the vector mosquitos⁷ viz. many mosquito species are now being resistant to insecticides^[4, 5]. Moreover, the mosquito fauna of Bangladesh is fairly rich and varied^[6]. Historically vector suppression has been viewed as a more economical and effective public health measure than medical therapy because it can be applied on an area basis without locating and treating each individual human patient^[7]. Correct identification of vector species is essential for the effective control or prevention of these diseases. In brief, Dhaka is a highly populated city with haphazard unplanned drainage system where, different types of human activities are regularly performed such as deposition of waste materials (poly bags, coconut barks, papers, house's and factory's wastages) into stagnant water that made the mosquitoes habitats for their regeneration in the year round^[5, 8, 9]. So it is very important to know the status and distribution of mosquito fauna to control mosquito and mosquito borne diseases.

Hence, an entomological surveillance was carried out in Ward no: 69 of Old Dhaka (OD), Fullbaria Bus Station (FBS), Osmani Uddan (OU) and Sohrawardi Uddan (SU) from March 2011 to February 2012 to pick out the mosquito fauna from different habitats, their present status and distribution in Dhaka city.

2. Materials and Methods

Field collections were taken routinely at morning at least three times in every month from March 2011 to February 2012 and their averages were used for representative data. Samples were collected from twelve substations (M to X) of four stations of Dhaka city viz. Ward no 69 of old Dhaka (23°43'22''N, 90°24'19''E, elevation 49 ft), Fullbaria Bus Station (23°43'21''N, 90°24'36''E, elevation 56 ft), Osmani Uddan (23°43'34''N, 90°24'30''E, elevation 56 ft) and Sohrawardi Uddan (23°43'57''N, 90°23'54''E, elevation 54 ft) (Table 1). Mosquitoes were collected both in larvae and adult forms. Larvae were collected with the aid of plate, pipette and dropper from different spots, taken into labeled small plastic bottles following Service [10] and were brought to Entomology Laboratory, Department of Zoology, and University of Dhaka, Bangladesh with the help of insect rearing and experimental containers. Meteorological data were collected from the Meteorological Department, Shere-e-Bangla Nagar, and Dhaka. The collected larvae were kept into small plastic jars with water in the cages for adult emergence. Some of them were taken into 70% alcohol in vials for identification. The adult mosquitoes were collected from fixed catching stations, with the help of aspirator and sweeping net. The living mosquitoes were anesthetized by cotton wetted with chloroform before identification and identification was followed by Barraud [11], Reuben et al [12], Rueda [13] and

Encyclopedia of flora and fauna of Bangladesh [14] with the help of light microscope.

3. Results and Discussion

Samples were collected in twelve months (March 2011 to February 2012) of continuous process from four stations of Dhaka city (OD, FBS, OU and SU) and seasonal fluctuation was observed. Altogether, 3487 specimens belonging to the family Culicidae under four genera namely *Culex* (7), *Aedes* (2), *Mansonia* (3) and *Armigera* (1) were collected. Total 13 species of mosquitoes were identified from the sampled population (N = 3487) where, *Cx. quinquefasciatus* (29%) was found to be highest in number followed by *Cx. vishnui* (23%), *Cx. tritaeniorhynchus* (14%), *Cx. gelidus* (6%), *Cx. fatigans* (5%), *Cx. fuscocephala* (5%), *Cx. hutchinsoni* (5%), *Mn. annulifera* (3%), *Mn. uniformis* (2%), *Mn. indiana* (2%), *Ae. aegypti* (2%), *Ae. albopictus* (2%) and *Ar. subalbatus* (1%) (Figure1). Similar to current findings, *Cx. quinquefasciatus* was also found as the most predominant species throughout the year by several workers [5, 15, 16, and 17]. Although, a decreasing trend of mosquito species (27 to 5) was previously reported from 1970 to 1997 in Dhaka city [8], current study clearly illustrated the increasing trends (13 species). However, fourteen species of mosquitoes was previously reported from Ramna Lake of Dhaka city [18].

Table 1: Total collection of specimens (N=3487) from sub spots* of Ward no 69 of Old Dhaka (M, N, O, P and Q), Fullbaria Bus Station (R and S), Osmani Uddan (T, U and V) and Sohrawardi Uddan (W and X) from March 2011 to February 2012.

SN	Species	OD (11)**	FBS (7)**	OU (12)**	SU (9)**	Sub total
1	<i>Culex vishnui</i>	202	80	150	86	518
2	<i>Cx. quinquefasciatus</i>	712	252	256	206	1426
3	<i>Cx. tritaeniorhynchus</i>	162	89	72	70	393
4	<i>Cx. gelidus</i>	152	22	52	42	268
5	<i>Cx. vagans</i>	26	0	12	4	42
6	<i>Cx. hutchinsoni</i>	84	18	42	34	178
7	<i>Cx. fuscocephalus</i>	106	0	10	22	138
8	<i>Mansonia annulifera</i>	0	0	40	0	40
9	<i>Mn. uniformis</i>	2	0	46	0	48
10	<i>Mn. indiana</i>	0	0	10	0	10
11	<i>Aedes aegypti</i>	90	50	20	30	190
12	<i>Ae. albopictus</i>	54	62	40	22	178
13	<i>Armigeres subalbatus</i>	58	0	0	0	58
Sub-total		1648	573	750	516	3487
Grand total		3487				

*Pond (M), Agamasiland dustbin broken parts and Stagnant drain's water (N), Bangladesh field (O), Water containers (P), Drain of central veterinary hospital (Q), Stagnant drain (R) and Tires (S) of Fullbaria Bus Station, Stagnant drain (T), Tree holes (U) and Lake (V) of Osmani Uddan, Tree holes (W) and Stagnant water reservoir (X) of Sohrawardi Uddan.

**OD-Old Dhaka, FBS-Fullbaria Bus Station, OU-Osmani Uddan and SU- Sohrawardi Uddan

3.1. Spatial Distribution

Maximum 12 species were found in Osmani Uddan followed by Old Dhaka (11), Sohrawardi Uddan (9) and Fullbaria Bus Station (7) (Table 1). *Ar. subalbatus* (n = 58) was found only in Old Dhaka while, *Mn. annulifera* (n = 40) and *Mn. indiana*

(n = 10) were confined to Osmani Uddan. None of the species of the genus *Mansonia* were present in Sohrawardi Uddan and Fullbaria Bus Station while all three species of the genus *Mansonia* were present in Osmani Uddan. On the other hand, only 2 individuals of *Mn. uniformis* were collected from Old

Dhaka indicating that species of this genus were concentrated mainly in Osmani Uddan. *Cx. vagans* and *Cx. fuscocephalus* were not recorded from Fullbaria Bus Station while other species of *Culex* and *Aedes* were more or less common (Table 1). Distribution pattern of mosquitoes could be explained by habitat preferences of the species. As the geographical distribution of a species in a given area without absolute barrier to dispersal, might be determined by environmental variations¹⁹ such as temperature and humidity^[20, 21]. Ameen *et al*^[4] examined 1742 breeding sites of mosquitoes from Dhaka city and concluded that lowest density of mosquitoes occurred in lakes while highest in derelict ponds. *Ae. Aegypti* was previously found in Chittagong, Chandpur, Dhaka, Goalonda and Narayanganj^[11]. Later many workers collected this

species only in Dhaka city^[22, 23, and 24]. In 1997, Knudsen^[25] first reported high density of this species in Dhaka city. Thus, the local distribution of the species was probably controlled by its reaction to environmental differences among the available range of habitats. As for example, *Aedes* species were found only in tires and tree holes during the rainy season when the reservoir were filled with rainy water for a short period of time but *Cx. quinquefasciatus* was found in all kinds of habitats and abundantly in stagnant drains suitable for its regeneration^[5]. However, breeding habitats such as drains and coconut barks were the richest habitats for the mosquitoes in the study areas while lowest mosquito diversity was recorded from Tree holes.

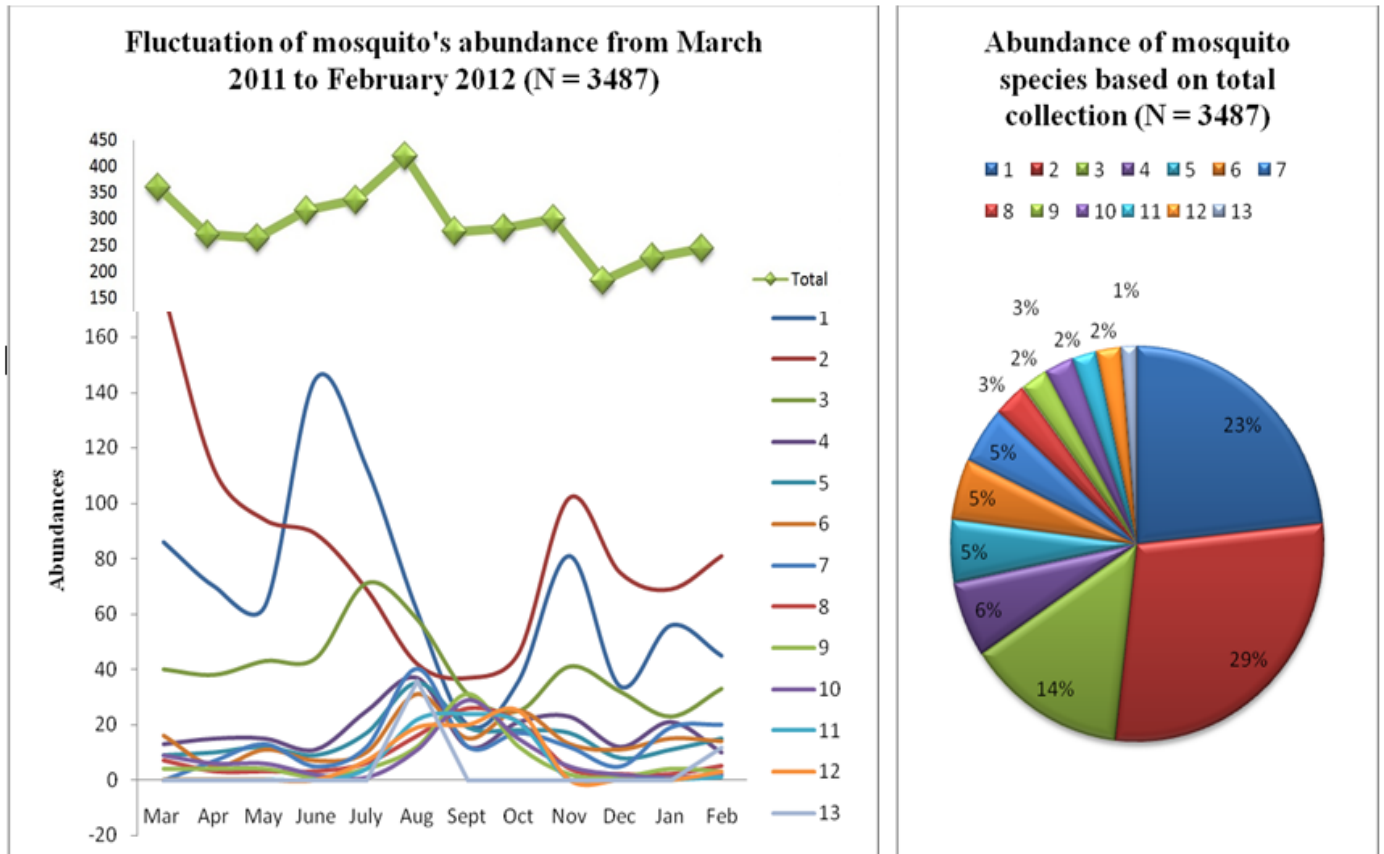


Fig 1: Abundance and fluctuation of mosquito species in the study areas based on monthly collection. Legend indicates, 1- *Culex vishnui*, 2- *Cx. quinquefasciatus*, 3- *Cx. tritaeniorhynchus*, 4- *Cx. gelidus*, 5- *Cx. fatigans*, 6- *Cx. hutchinsoni*, 7- *Cx. fuscocephalus*, 8- *Mansonia annulifera*, 9- *Mn. uniformis*, 10 *Mn. Indiana*, 11- *Aedes aegypti*, 12- *Ae. albopictus* and 13- *Armigeres subalbatus*

3.2. Seasonal Prevalence

The population trends shown by the various mosquito species during the work may provisionally be taken as a guide to their seasonal variations. It was not easy to say what factors were critical for the abundance or scarcity of a particular species in a given area, since the answer demands critical investigation of the factors affecting a population and such studies were not undertaken during the present work. As for example, *Ae. Aegypti* and *Ae. albopictus* were absent from March to June but after that both populations gradually increased up to September and again decreased up to February which indicated both species were active at wet as well as at dry weather. Similar result was also observed by Ahmed *et al*^[9] and reduction in the population was caused due to low rainfall. Besides this, the City Corporation sometime used adulticides

(permethrin 0.5% + S-Biolethrin 0.1% + Tetramethrin 0.2) and larvicides (Linden 70% & Temefos 50%) (Personal communication), which closed their regeneration from time to time and emerging chemicals of some factories also helped to becoming artificial fluctuation in full growing year round. Sometime in old Dhaka drains became totally larvae free because of highly chemical contaminated water that emerged from factories and destroyed them automatically. So their actual seasonal fluctuation became hindered. In temperate zone the atmospheric temperature was critical for the continuation of active live and development of mosquitoes while, in the tropics temperature was not a critical factor; rather, a developmental interruption in the tropics was primarily related to water fluctuations in breeding places, mainly in the dry weather^[5, 26].

Cx. vishnui reached the peak in June and July but decreased to the lowest at September, after which fluctuation in population size was observed. The species laid eggs in rafts on the surface of water when different types of water bodies were formed. Large numbers of adults were found resting in cattle shed than human dwellings [27]. But other animals and even man were also readily attacked in the absence of the preferred host.

The population of *Cx. quinquefasciatus* showed two peaks all year round, one in March and another in December. The trends of population of this species gradually decreased from March to August and again increased up to December. Very similar to present work this species was also reported throughout the year by several researchers [15, 16, 17]. In a laboratory study in Dhaka city showed that at 27±1 °C, this species completes its life cycle less than in 10 days²⁸. The temperature and humidity of December 2011 was 25±5 °C and 66±2% respectively. Thus winter might provide them the advantages of surveillance [29, 30].

Cx. Tritaeniorhynchus reached the peak in July and then decreased gradually in the lowest in September. In Dhaka city, this species showed to be a wet weather species. It appeared during the month of May and quickly attained a peak of population in July and then decreased gradually to a minimum in October and disappeared in the last week of October [28]. Its population dynamics, based on cattle biting collections, showed a steep rise from July onwards, with the peak occurring in the last week of August, when the relative humidity was over 90% [31]. Current observation could show a little bit differences as the weathers (29±5 °C, 81% of humidity) and human activities were changed, so proper habitats might be destroyed.

Cx. gelidus, *Cx. fuscocephala*, *Cx. hutchinsoni* and *Cx. vagans* were low in number in the study areas (n = 268, 138, 178 and 42 respectively). *Cx. gelidus* appeared the highest peak in August and January while in other months, it found in reasonable number. Khan³² found its peak of population about the beginning of August and up to the middle of September in Dhaka city. *Cx. Hutchinson* laid eggs usually in rafts on water surface. Common breeding sites were different types of polluted water such as rock holes, cemented tanks, animal prints, and roadside pools etc [11]. It might be fluctuated every month by different factors such as insecticides used by Dhaka City Corporation from time to time.

Mn. indiana, *Mn. annulifera* and *Mn. uniformis* were rare in the sampled populations (n = 10, 40 and 48 respectively) and were fewer in collection than *Culex* spp. They were abundant only from August to October but in other months their population was found to be fluctuated. Horsfall³³ commented that the genus *Mansonia* was noted for prolonged aquatic interval, so the number of generations annually was reduced to one in extreme latitudes and to very few in the tropics. During the present investigations they were found throughout the work indicating the presence of several generations in a year.

Aedes and *Armigeres* species breed in tree holes and were present only in the months of rainy season viz. July to October (Fig 1). Both *A. aegypti* and *Ae. albopictus* reached the peak in September and October respectively, when the rainy water were stored in the trees holes, but in the summer when the trees holes became dried, no larvae were found. Khan [22] noted that the population of *Ae. aegypti* in Dhaka city seem to vary only slightly from season to season showing only a little increase during the rainy season, between the months of June and September. Scanlon [34] found *Ae. aegypti* to be particularly abundant in the rainy season from May to

September or October in Thailand. *Ae. albopictus* was previously reported from tree holes, bamboo stumps, coconut shell, rock holes and leaf axis³⁵ during both summer [36] and monsoon [36, 37]. In Changa Manga forest of Pakistan, the population of *Aedes* spp. began to expand in April and showed a constant level during May and early June. It again started rising slowly to a peak in the last week of August, following a steep decline until October when numbers became negligible [31].

Ar. subalbatus breeds in both natural and artificial containers, viz. tree holes, bamboo stumps and other peridomestic containers holding strongly polluted water. Larvae were found from different parts of Bangladesh in different outdoor containers, bamboo and banana stumps [24]. This species was mainly found in August and February while in other months, it was not found due to larvicide used by Dhaka City Corporation and other human activities.

4. Conclusion

The present record was a base line data about the vector mosquito species and its abundance in the study areas. It would be helpful to control mosquito and to take precautionary measures against the mosquito-borne disease in Dhaka city.

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