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MANHOLES AS AN IMPORTANT BREEDING SITES FOR *CULEX* MOSQUITOES IN GAZIPUR CITY CORPORATION, BANGLADESH

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Abstract: A longitudinal study in under constructing Manholes (considered as mosquito breeding trap of the study area) in a newly constructing road in the ward number 35 was conducted in the post monsoon period of 2016. Four species of mosquito population were available in the stagnant water of temporary breeding sites. Among them *Cx. quinquefasciatus* was the dominant species (98.6%) followed by *Cx. tritaeniorhynchus* (0.5%), *Ar. subalbatus* (0.5%) and *Cx. fuscocephala* (0.4%). Though the breeding sites were temporary and stayed until finishing the construction, yet the results indicated the abundant population of available mosquitoes including status of key species in the urban area of the city corporation.

Key words: *Culex*, immature, under constructing manhole, mosquito breeding.

INTRODUCTION

Mosquitoes under the genus *Culex* (Diptera: Culicidae) are medically important due to their diseases causing capability and health hazards on human, domestic and wild animals. It is a notorious biting nuisance in rural, semi-urban and urban areas all over the world. Within this genus, *Cx. quinquefasciatus* is the major cosmopolitan species (Dobrotworsky 1965), which is highly anthropogenic and well known domestic mosquito (WHO 1972). Due to its cosmopolitan spreading nature and huge population burden, it has been identified as an important invasive species like *Aedes aegypti* and *Ae. albopictus* (Juliano and Lounibos 2005).

Different members of the genus *Culex* are important vectors of different diseases. Among them, *Cx. quinquefasciatus* is considered as a causing agent of different protozoan, nematodes and arboviral diseases. It is the principal and a potential vector of bancroftian filariasis and *Dirofilaria immitis*, respectively (Lai *et al.* 2000, Farid *et al.* 2001). Other *Culex* species such as *Cx. tritaeniorhynchus* and *Cx. P. pipiens* transmit arboviruses responsible for Japanese encephalitis (Van den Hurk *et al.* 2009, Turell 2012).

Commonly, *Cx. quinquefasciatus* breeds in many different water sources with high organic content, where there are no natural predators but lot of bacterial and organic food materials present that suitable to maximize its juvenile fitness,

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such breeding sites are sewage treatment ponds, drains pit latrines, etc. (Hassan *et al.* 1993, Sunahara *et al.* 1998, Dibo *et al.* 2011). These habitats are physically and chemically suitable for oviposition and immature development of the mentioned and some other species of mosquitoes (Trimble 1979). Researchers have found them to enhance the offspring survival and growth (Kiflawi *et al.* 2003). With the changing environment, this mosquito species has brought significant changes in its ovipositional behaviour. Substantial mosquito samples have been collected from container-type breeding sites, such as the artificial containers, tyres, puddles, metal and plastic containers, etc. (Juliano and Lounibos 2005), as well as from different natural containers including, leaf axils, depressions on trees, phytotelmata, etc. (Okiwelu and Noutcha 2012). This diversification of breeding nature of this mosquito species indicates its adaptive flexibility and ecological plasticity (Karlekar *et al.* 2013, Wilke *et al.* 2014). Due to the changing climate the vector breeding nature is changing, especially in temperate and subtropical climates like, Bangladesh. Hence, a good knowledge and understanding of the relevant biology and ecology of the target species is of paramount importance, which varied in different region or area of the world (Seghal and Pillai 1970, Gimnig *et al.* 2001). The latest knowledge regarding this and the environmental factors affecting mosquito abundance can help in designing optimal vector control strategies (Overgaard *et al.* 2001).

Gazipur City Corporation (GCC) is a newly formed municipality with a characteristic pattern of topography including, neighbouring forest and wetlands, situated outskirts of Dhaka city, capital of the country, Bangladesh, does not have any baseline data of *Culex* mosquito population. Therefore, a study was carried out in the under construction site, which was considered as a trap of major urban *Culex* mosquito, to know its species composition and abundance or fitness of breeding efficiency.

MATERIAL AND METHODS

Study area: Studies were conducted at different construction sites on roads in Ward no. 35 of GCC (Fig. 1). It is spread over 330 square kilometers and is located on the north border of the capital Dhaka of Bangladesh. The city lies within 23.88° - 24.34° and 90.15° - 90.70° latitude and longitude, respectively. The climate is sub-tropical with an annual average temperature of this area is 13 to 36°C and annual rainfall is around 2400 mm. It has a big low land, rice fields and a considerable forest area. It supports a huge population of about 2.5 million with a density of 2,505 per km^2 and an annual growth rate of 5.2% (BBS 2011). It is one of the newly formed municipalities with a vast sub-urban and rural area. The area includes two old metropolises those were established in different time since 1974 (Tongi Pourosava). The city is important due to its situational, commercial and organizational importance. It contains country's major Agricultural Research Institutes, Universities and other Organizations, and many other educational institutions including Medical Colleges, etc. This area also has experienced rapid advancement in the industrial sectors, which are contributing in high population density, accelerating urbanization with constructing new buildings, roads and drains.

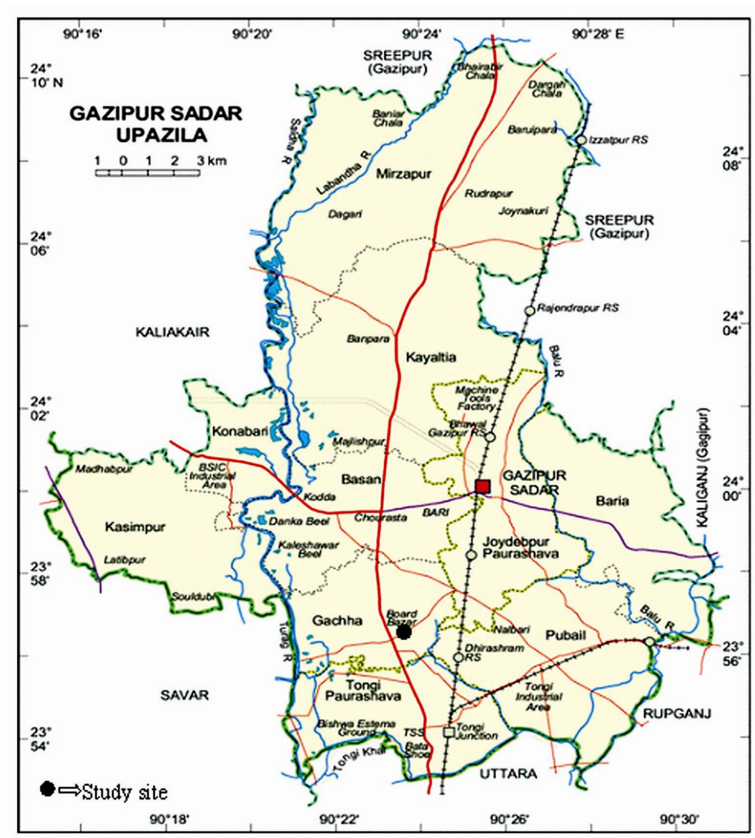

Fig. 1. Map of study site in Gazipur City Corporation.

Field sampling and larval collections: Immature stages of mosquito population were collected from the under constructing manholes during the construction of Bottola road in 2016 (Figs 2a-d). Samples were collected for a period of three months in the post monsoon period, from October to December. Twenty four manholes were randomly selected from one kilometre long under constructing road started from Boardbazar to Bottala under the ward number 35 in GCC. Immature mosquitoes were collected from the selected manholes by using standard dipping technique (Service 1993). Water samples with immature mosquito were collected by dipping a plastic dipper, 125 mm in diameter with a 900 mm wooden handle. Five dips were taken from each habitat. The collected samples (water containing immature mosquito) were transferred into labelled plastic bags with collection date, drain number, dip number, etc. and carried to the laboratory for further analysis.

In the laboratory, the immature mosquitoes were counted for each dip and recorded according to different instars. Ten per cent immature were killed by using 70% alcohol and preserved until laboratory identification. Others were reared and allowed to become adult. All, immature and adults were identified up to the species level according to standard taxonomic key (Harbach 1985). Collected mosquito samples were identified in the laboratory of Zoology, Bhawl Bodre Alam College, Gazipur.

Statistical analysis: The average population density of mosquito immature per dip was calculated. Means and standard deviations were calculated and compared by the one-way ANOVA. If the ANOVA shows significant inequality of the means at p = 95%, they were exposed to pair-wise comparisons based on Tukey's honestly significant difference (HSD) test. The multiple regression analysis was applied to examine the relation of the mosquito population densities. The SPSS software (Version 23 for windows, SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

Fig. 2. Under constructing manholes in study site. Arrow signs are showing the mosquito immature density in mosquito breeding sites.

RESULTS AND DISCUSSION

All under constructing manholes were good mosquito breeding place. A total of 26,742 immature mosquitoes of four species were collected from 24 under constructing manholes. There were about 74 immature per dip. Among the four species of mosquitoes, *Cx. quinquefasciatus* population shared the major followed by *Cx. tritaeniorhynchus, Ar. subalbatus* and *Cx. fuscocephala.* The population of latter three species together formed 1.4%, but not more than 0.5%, individually (Tables 1 and 2).

Table 1. Mosquito prevalence in under constructing manholes at Bottola road, Board bazaar, Gazipur

Name of species	Prevalence of mosquito immature		
	Av. No/Manhole (Range)	%	Av. immature/dip
Cx. quinquefasciatus	26358 (20-150)	98.6	73.2
Cx. tritaeniorhynchus	143 (0-7)	0.5	0.4
Cx. fuscocephala	94 (0-4)	0.4	0.3
Ar. subalbatus	147 (0-5)	0.5	0.4
Total	26742	100	74.3

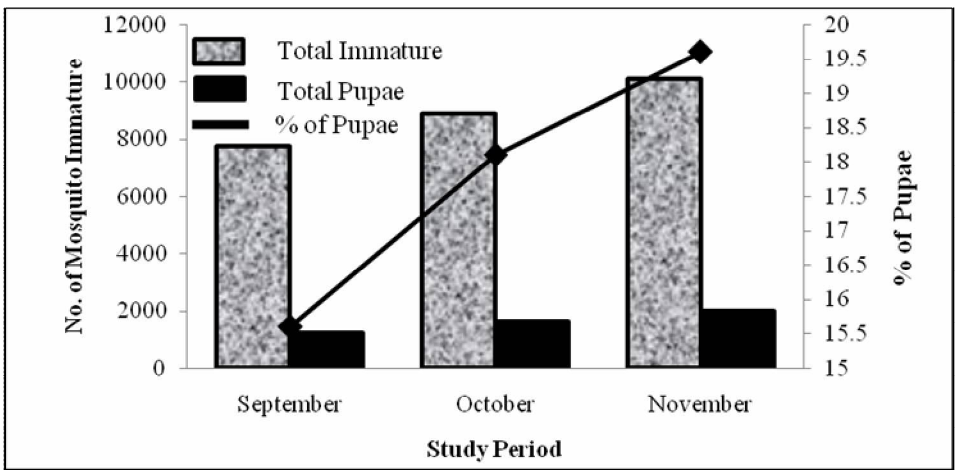

Fig. 3. Abundance of mosquito immature in under constructing manhole.

Immature mosquitoes were available in all manholes during sampling period. Total immature population gradually increased in the later months, 15 and 30% in October and November, respectively but pupal population increased in higher rate from 34 to 63% during the same period (Figs 3 and 4). Total immature increasing rate did not significantly differ from one month to another but the difference between September to November was significant ($F = 6.56$, $df = 2$, $p < 0.05$). However, the pupal increasing rate was significantly higher in the later months ($F = 27.02$, $df = 2$, $p < 0.05$).

Immature population density varied in different manhole. The month of September produced lowest immature in all manholes, except the manhole numbers 7 and 14. They produced the highest population than the other months. Manhole number 1, 8 and 17 produced higher population in October. And 4,9,12 and 21 number manholes produced about equal number of mosquito immature in the months of September and October. Manhole number 11, 15-16 and 18-19 produced the highest number of immature in the month of October (Fig. 5A). Almost same trend was observed in case of pupal productivity except the manhole number 20 and 22-24. Pupal production rate was the highest in October than other months (Fig. 5B).

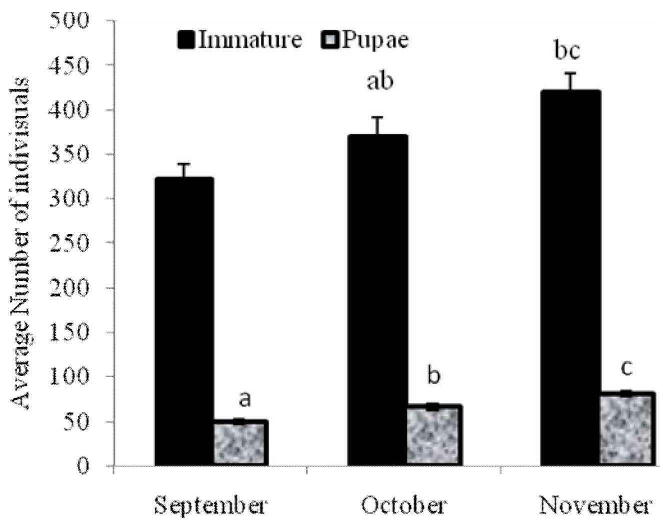

Fig. 4. The mean (±SE) numbers of mosquito immature in under constructing manhole. Bars of the same color labeled with the same letter are not significantly different ($p < 0.05$).

The manhole water (Fig. 2) produced more than 98% of *Cx. quinquefasciatus* mosquitoes that became the dominant species in the present study area. Similar findings were reported from Dhaka City Corporation, adjacent to the GCC, which comprised of 95% of its urban mosquito population from the same species earlier (Ahmed 1996). In both places, the mosquitoes were found to breed in organically rich and polluted surface water, as reported previously in different studies conducted at different corners of the world (Chatterjee *et al.* 1988, Weinstein *et al.* 1997, Opoku *et al.* 2007, Badaki 2010, Dibo *et al.* 2011, Service 2012). All manholes were not equally productive. The older manholes achieved highest densities of larvae and pupae due to its higher organic contents visually observed in its rusty water (Chaves *et al.* 2009). These rich organic matters provide an ample food for the immature (Rodcharoen *et al.* 1997). It made an unfavorable environment for the invertebrate predators of mosquito immature due to low dissolved oxygen content. Besides, increased bacterial population was there as food supplements (Nguyen *et al.* 1999). On the other hand, the newly burrowed manholes contained clearer water than the latter ones, contained the lowest densities of immature mosquitoes. Some of the earlier manholes produced higher number of pupae, might be due to the lower competition for food and space. Flooding with waste and rain water also flushed many immature mosquitoes and reduced the immature population density, but could not eliminate entirely (Dieng *et al.* 2011). So they produced continuous mosquito population until finishing the construction of manholes and running the whole drainage system. The higher population of this nuisance mosquito is increasing public sufferings day by day, by biting during day and night time. Generally, *Cx. quinquefasciatus* is a nocturnal biting mosquito (Lee *et al.* 1989), but may be getting at least necessary blood meals for a large population to produce eggs, its feeding also observed in the day time mainly in comparatively dark houses.

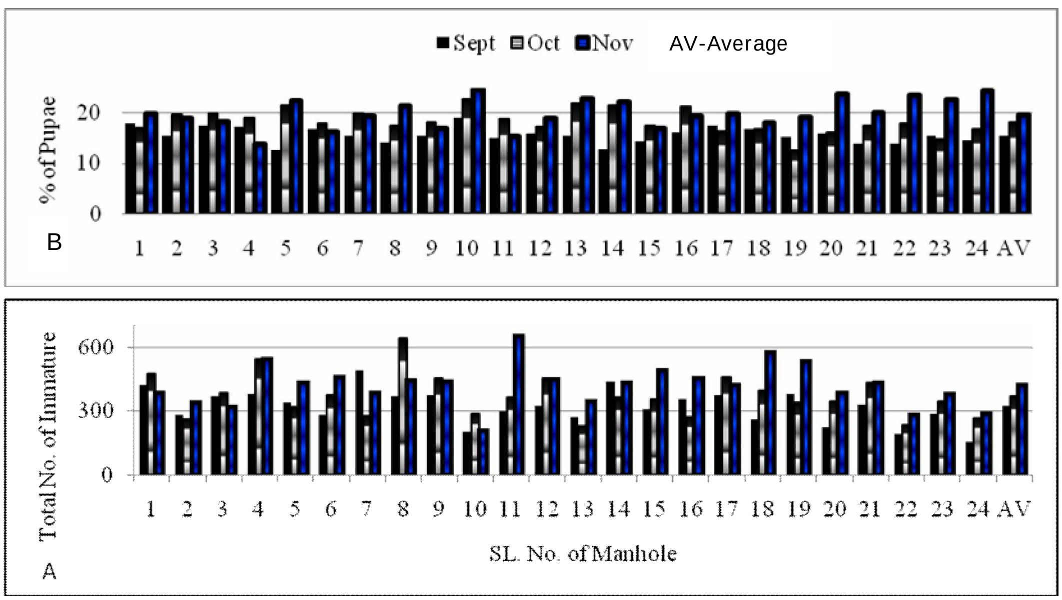

Fig. 5. Population of immature mosquitoes in different under constructing manholes: (A) Immature population and (B) Pupal population.

GCC is a newly formed municipality. Its roads, highways, drainage system, industrial infrastructure and residential areas have been started to construct systematically. Moreover, a lot of marshy lands, ponds, ditches, etc. are located within the boundary of this city corporation. Thus producing a lot of nuisance and vector mosquitoes. Public perception regarding these mosquitoes and their breeding in developmental sites are fairly developed. Therefore, implementation of effective surveillance for identification of mosquito breeding sites, their density and operating control strategies are greatly needed by close collaboration among scientists, public health sectors, other government officials and the residents. Previously, various cultural, mechanical and insecticidal control strategies were suggested and operated regarding this in the construction and other breeding sites (Gubler *et al.* 2000, Olkowski 2001, Thier 2001, Curtis *et al.* 2002). But now integrated management systems are highly pronounced. In this process, we can use modern tools like, Geographic Information Systems (GIS) to locate breeding sites. By this process the control program can conduct much more efficiently (Jacob *et al.* 2006). Satellite images and orthotopic photographs are used to characterize and identify land use patterns. GIS data file that pinpoints the location of potential mosquito breeding sites in wetlands, rural, urban and different construction sites. According to that, local government can conduct multi-way operational program to reduce costs in budget as well as achieve optimum result.

Despite of conducting the study over a short period of time and small area, the results indicated an overall population status of nuisance mosquitoes in the urban area in GCC. It also suggests that the activities of the construction sites, not only road and highways but also other construction sites, including housing and industrial projects, create new mosquito breeding sites by making changes in the ecology of the environment. These changes are suitable for supporting prolific mosquito breeding. Since the problem is created by the construction industry related to sanitation and construction; mosquito control should link with the respective authorities together with disease control and health department. Moreover, conducting integrated mosquito control with emphasizing environmental management, biological control and adequate sanitization of construction workers and owners may help reducing these nuisance mosquito population and their breeding scopes.

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