Univ. j. zool. Rajshahi. Univ. Vol. 34, 2015, pp. 25-31 **ISSN 1023-6104**
http://journals.sfu.ca/bd/index.php/UJZRU

Seasonal prevalence and adult emergence of the mosquitoes in Rajshahi City Corporation (RCC), Bangladesh

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Abstract: The prevalence of *Anopheles, Culex* and *Aedes* are varying from different seasons in RCC. During the survey, total 18073 larvae were collected randomly from different habitats of four Thanas of RCC. During this experimental procedure 3485 larvae were died, and 14588 larvae survive, pupated and emerged into adult mosquitoes. The highest number of larvae collected in Shah Makhdum (4821) followed by Boalia (4471), Rajpara (4396), Motihar (4385) respectively to assay the adult emergence. The average number of adult emergence was found in Rajpara thana (79.41±8.05) followed by Shah Makhdum (76.70±10.26), Boalia (76.69±11.92) and Motihar thana (74.69±14.15) in all seasons. There were very few amount of *Aedes* (2.07%) mosquito mainly found in the rainy season. Interestingly, the highest prevalence of *Aedes* larvae was in the month of July 2013(8.00%) followed by September 2013(6.4%) and 0.5% in March (2014). On the other hand, in an average, *Anopheles* (46.30%) and *Culex* (51.00%) were found all over the survey period. The highest prevalence of *Anopheles* was found in the month of January 2014(61.30%), and *Culex* was 55.10% in October 2013. No *Aedes* larvae were found during November 2013 and February 2014. In the season 3, the number of mosquito becomes very few because of low temperature. There was a positive correlation(r) between the prevalence of mosquito larvae and meteorological parameters, where Motihar, Rajpara, Boalia and Shah Mukhdum Thanas had 0.77. 0.68, 0.74 and 0.84 coefficient of correlation values respectively. Therefore this works proved that temperature and rainfall plays an important role for the growth and development of mosquito's larvae in Rajshahi City Corporation areas.

Keywords: *Anopheles, Culex, Aedes*, prevalence, mosquito, Rajshahi City*,*

Introduction

Mosquitoes belonging to the family Culicidae, are the vectors of transmissible and life threatening diseases such as malaria, filariasis, dengue fever, yellow fever and most of the arthropod borne viral encephalitis (Huda & Banu, 1987; Chowdhury *et al*., 2000). Malaria is one of the most formidable and serious public health problems in Bangladesh (Alam *et al*., 2010). The malaria situation in Bangladesh is complex due to high species diversity and species complexes presenting different ecological behaviors (Haque *et al*., 2010; Khan & Talibi, 1972; Elias *et al*., 1982; Maheswary *et al*., 1994). Apart from these, they cause biting annoyance and irritation through sucking blood. They are the most worrying agents in both urban and rural areas, and persist predominantly in the developing countries and the globe. Due to the global climate change the faunal distribution, has been changed (Clements, 1992). We have little knowledge about the biology and bionomics of the vector mosquitoes and their resistant to insecticides **(**Ameen *et al.,* 1994). Moreover, the mosquito fauna of Bangladesh is fairly rich and varied (Ahmed, 1987). Historically vector suppression has been viewed as a more economical and effective public health concern than medical therapy, because it can be applied on an area basis without locating and treating each individual human patient (Becker *et al.,* 2010). Proper identification of vector species is essential for the effective control or prevention of these diseases. Bangladesh is a highly populated country with haphazard and unplanned drainage system where, different types of human activities are regularly performed such as deposition of waste materials such as poly bags, open and khaca drainage system, coconut barks, open pools, house's and factory's wastages into stagnant water that made the mosquitoes habitats for their regeneration round the years (Ameen *et al*., 1999; Ahmed *et al*., 2007). So it is very important to know the status and distribution of mosquito fauna as well as larvae to form adult emergence to control mosquito and mosquito borne diseases.

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Now-a-days environmental changes have a chance of breeding habitats of different mosquito species. Meteorological factors affect mosquito larvae abundance by altering the quality and quantity of breeding habitats. The relationship between climatic conditions and adult mosquito abundance or larvae can provide important information to determine parasite activity levels and disease risk (Wegbreit & Reisen, 2000, Rubio-Palis & Zimmerman, 1997, Conn *et al*., 2002, Vittor *et al*., 2006, Rosa-Freitas *et al.,* 2007). Complete information on the seasonal prevalence of mosquito fauna in a region is essential for the development of effective vector control programs (Alten *et al.,* 2000). Therefore, an entomological survey of mosquito larvae was carried out in Rajshahi City Corporation area from July 2013 to March 2014 to pick out the common mosquito fauna from different habitats, their present status and adult emergence done in the laboratory.

Materials and Methods

Study area and the survey methodology

The Rajshahi City Corporation (24°22′ N, 88°42′ E) was the main focus of the present investigation, which were consisted four Thanas and thirty administrative Wards. The survey area includes Motihar (24°21'-24°23' N, 88°32'-88°36' E), Rajpara (24°22'-24°24' N, 88°32'-88°35'E), Boalia (24°21'-24°23' N, 88°28'-88°38' E) and Shah Makhdum (24°22'-24°24' N, 88°35'-88°37' E) which was carried out from July 2013 to March 2014. Assistance from the workers of RCC was taken for searching mosquito breeding places in all accessible spots and open yards in the area. Information was also obtained on the types of larvae habitats and other relevant factors from them. Survey schedule was maintained from morning 7.00 am to 8.00 am and conducted twice a month in each Thana. The mosquito larvae habitats were classified as; (i) Both kacha and paka drains, (ii) Ponds, (iii) Open pools,(iv) Tree holes, (v) Discarded tires, (vi) Green coconut shell, (Vii) Flower vase, (viii) Poly bags and (ix) Plastic containers. During survey it was observed plants/trees were very common in all the wards under RCC.

Larval rearing technique

Mosquito's larvae were collected with the aid of plate, pipette and dropper from different spots, taken into labeled small plastic bottles following Service (1976) & WHO (1992). The larvae were brought in live to Insect Research Laboratory, Department of Zoology, University of Rajshahi, Bangladesh for further study. The mosquito's larvae which were collected from the various sources of the habitats were reared in 1000 CC beaker with tap water and were fed with glucose biscuit and yeast powder in a ratio 2:1 (Shajahan, 1996). After adult emergence, the female were provided with pigeon or hen blood meal, which was essential for the maturation of their eggs (Nessa *et. al.*, 1986). Blood meal was always supplemented by 10% glucose solution with wet 'Whatman' filter paper at the bottom was placed in the adult mosquito cage for oviposition. Occasionally a portion of the egg batches those were left on the paper strip or filter paper was set aside for storage at laboratory temperature. Larvae were allowed to develop separately according to their stage. Pupae were taken away every day from the relevant larval beaker by means of a plastic dropper. The beakers were examined daily to check the condition of the larvae, dead or moribund once was removed. The water of the beaker was changed every third day and during these process the bottom of the beaker was cleaned. Life cycles of the mosquitoes were observed these ways. 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 living mosquitoes were anesthetized by cotton wetted with chloroform and identification was under of light microscope according to Reuben *et al.* (1994) & Rueda (2004).

Statistical analysis

Statistical analyses were done on abundance data of the predominant species captured during the study to find out which environmental variables *viz.* rainfall, temperature, humidity were leading on species distributions in the study areas. Here we calculated the data with IBM-SPSS-20 and MS Excel software. Some mosquito specimens were unidentifiable due to immaturity and key body parts missing, and were not included in analysis. Mosquito prevalence was calculated as the sum of mosquitoes caught per site divided by total number of mosquitoes caught overall.

Results and Discussion

In this particular survey mainly three types of mosquitoes *Anopheles, Culex* and *Aedes* genera

were found together in four thana's of RCC habitats. During this experimental procedure 3485 larvae were died, and 14588 larvae survive, pupated and emerged into adult mosquitoes (Table 1). The highest number of larvae collected in Shah Makhdum (4821) followed by Boalia (4471), Rajpara (4396), Motihar (4385) respectively to assay the adult emergence. The habitats which were sampled in this study were formed after the onset of rains. Larvae of *Anopheles, Culex* and *Aedes* were collected from classified natural and artificial sources. Seasonal prevalence of mosquito was very high in summer (*Culex* & *Anopheles*) but *Aedes* was high in season 1. The high amount of average adult emergence of mosquito 79.41±8.05 was found in Rajpara followed by Shah Makhdum, Boalia, and Motihar were 76.70±10.26, 76.69±11.92 and 74.69± 14.15 respectively (Table 2). The highest numbers of mosquito larvae were found in Shah Makhdum, Boalia, Rajpara and Motihar thana respectively (Fig 1). During the study RCC took some steps to prevent the mosquito borne diseases, such as fumigation of the larval sources by oil smog, cleaning the dirty drain, pond, destroying mosquito's larval habitats etc.

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 variations (Bates, 1949) such as temperature and humidity (Samways, 1995; Micieli and Campos, 2003). Ameen *et al*. (1994) examined 1742 breeding sites of mosquitoes from Dhaka city and concluded that lowest density of mosquitoes occurred in lakes while highest in derelict ponds. *Aedes spp* was previously found in Chittagong, Chandpur, Dhaka, Goalonda and Narayangonj (Barraud, 1934) and Dhaka city **(**Ahmed *et al.,* 2007, Khan, 1984, Ahmed *et al*., 1990) but no report in Rajshahi. However this study first reports the breeding sites in tires, tree holes and flower vase found similar results to the above mentioned researcher findings. In drains highest number of mosquito breed Boalia followed by Shah Makhdum,Motihar and Rajpara respectively (Fig. 2). Thus, the local distribution of the species was probably controlled by its reaction to environmental differences among the available range of habitats. *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 *Culex and Anopheles* were found in all kinds of habitats and abundantly in stagnant drains suitable for its regeneration in all four Thanas**.** The highest numbers of mosquitoes were found in the kacha & paka drains followed ponds, ground holes, broken However, breeding habitats such as drains and ponds and ground holes were the richest habitats for the mosquitoes in the study areas while lowest mosquito diversity was recorded from tires. A similar result was found in other countries, September or October in Thailand. *Aedes albopictus* was previously reported from tree holes, bamboo stumps, coconut shell, rock holes and leaf axis (Huang,1972) during both summer (Jahan, 2003) and monsoon (Shahidulla,1982).

The density of the mosquito species fluctuated with the climatic factors such as temperature, rainfall and relative humidity was investigated many researcher (Yasuno & Tonn, 1970; Micieli & Campos, 2003). Interestingly, in this study we find the similar affect in case of rainfall and temperature effect for the prevalence of *Aedes* mosquito larvae in the four thana from the month July to October 2013 and highest was found in the Rajpara thana **(**Table 2). During the study period the pick density of the mosquitoes larvae were obtain in the rainy season. In season 1 the population become high but did not exceed the rainy season. However, in winter season 3 the density falls down. The lowest density in the present observation was found from November 2013 and February 2014 and the highest density from July 2013 and October 2013 which was much closed to other researchers (Tonn, *et al.,* 1970; Ameen *et al*., 1984; Bashar *et al.,* 2006). Natural and artificial source were the most available breeding habitat in this area that accumulated more rain water and thereby enhance the adult population density. There are several survey reports that deal with the adult or larval density found around the tropical region expressed the effect of rainy season, which were very close to the present observation and also similar works have been done by many researchers (Rao, 1967, Moore *et al.,* 1978, Khan, 1990).

The *Culex* mosquitoes breed in a wide range of habitats although they have been able to exploit same habitats as *Anopheles* mosquitoes. *Culex* is predominantly associated with urban areas but occurring also in rural. This Cosmo-tropical

mosquito *Culex* preferentially breeds in organically rich water. *Aedes* species breed in tree holes and were present only in the months of rainy season July 2013 and October 2013 (Fig. 2) was similar in Thailand (Scanlon, 1966) and India (Tandon, N. & Hati, 1987. Similarly, Khan (1980) noted that the population of *Aedes aegypti* in Dhaka city seems to vary only slightly from season to season showing only a little increase during the rainy season, between the months of June and September. Here we found the highest number of *Aedes* mosquito in season 1 followed by season 2 and season 3 as 345, 40 and 10 mosquitoes respectively in tree holes, flower vase and tires. However, the highest number of *Anopheles* was found in season 1 and lowest was in season 3 and in case of *Culex* highest was in season 1 and lowest in season 3 (Table 1). According to habitat, analysis the highest mosquitoes were found in drains followed by ponds and ground holes respectively which are natural habitats but only few mosquitoes were found in artificial or anthropogenic habitats were discarded canes, flower vases, green coconut shells and tires (Fig. 2).These larval survivality of the Anopheles mosquitoes did not differ significantly between four Thanas studied (F value 0.256). Similarly the larval survivality of *Culex* and *Aedes* mosquitoes also did not reveal significant differences between the Thanas under the study (F value 0.014, 0.491) respectively.

Table 1. Prevalence of *Anopheles, Culex,* and *Aedes* mosquitos larvae in the survey area during July 2013 to March 2014 in RCC.

Study area	Seasons									Total
	1			2			3			
	Anopheles	*Culex*	*Aedes*	*Anopheles*	*Culex*	*Aedes*	*Anopheles*	*Culex*	*Aedes*	
Motihar	789	805	52	410	602	0	440	489	0	3587
Rajpara	679	696	195	330	565	0	522	624	10	3621
Boalia	724	837	50	510	653	0	402	380	0	3556
Shah Mukdhum	889	968	48	648	507	40	402	322	0	3824
Total	3081	3306	345	1898	2327	40	1766	1815	10	GT= 14588

1= July –Sep. 2013, 2= Oct- Dec 2013, 3= Jan – March 2014, GT= Grand total

Table 2. Seasonal prevalence of mosquitoes and adult emergence from selected four Thanas of RCC during July 2013 to March 2014.

Season	Study area							
	Motihar		Rajpara		Boalia		Shah Makhdum	
	Total larvae survived	Percentage (%) of adult emerge	Total larvae survived	Percentage (%) of adult emerge	Total larvae survived	Percentage (%) of adult emerge	Total larvae survived	Percentage (%) of adult emerge
1	662	84.17	444	86.21	460	95.63	644	85.19
	463	86.38	512	85.33	634	78.47	477	72.82
	521	83.36	614	77.72	517	77.98	784	80.16
2	590	82.52	422	83.07	504	82.22	660	85.71
	340	84.58	368	77.8	530	79.58	450	80.79
	82	52.23	105	62.5	129	54.89	85	53.13
3	102	63.75	165	73.33	80	61.54	124	78.48
	277	53.15	264	79.52	292	77.87	290	83.57
	550	82.09	727	89.17	410	82	310	70.45
Mean±SD		74.69±14.15		79.41±8.05		76.69±11.92		76.70±10.26

1= July –Sep. 2013, 2= Oct- Dec 2013, 3= Jan – March 2014,

Table 3. Coefficient of correlation values for the larvae survival and environmental factors on the four Thanas of RCC.

Study area	Rainfall	Temperature	Humidity	r^2	Regression values
Motihar	0.595*	0.841***	0.541^{ns}	o.77	Y= -3.80.059+31.573X
Rajpara	0.512^{ns}	0.674*	0.316^{ns}	0.68	Y= -186.229+23.744X
Boalia	0.697*	0.807**	0.589*	0.74	Y= -277.220+27536X
Shah Mukhdum	0.768**	0.893***	0.694*	0.84	Y=-530.092+38.724X

ns=Non significant, *= p<0.05, **=<0.01, ***=p<0.001

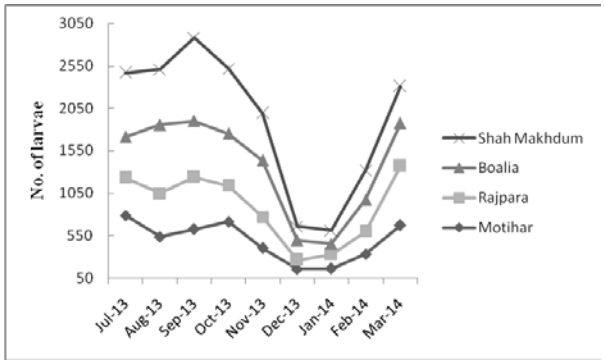

Fig. 1. Seasonal prevalence of mosquito larvae in four Thanas of RCC during July 2013 and March 2014.

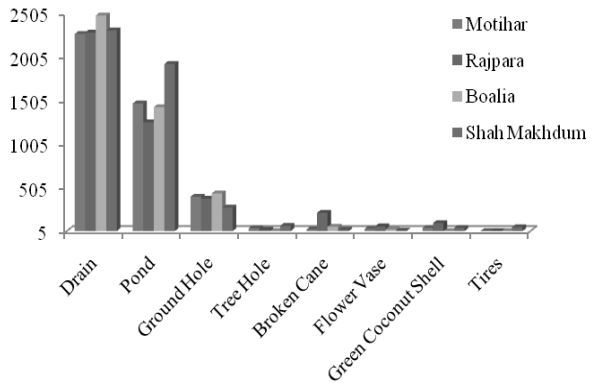

Fig. 2. Prevalence of mosquito larvae in natural and artificial habitats during July 2013 to March 2014 in four Thanas under RCC.

In this research it was observed that comparatively worm and hot temperature was more suitable for mosquito larval growth and development. During the study the average rainfall, temperature, and humidity was 24.1±26.84, 29.95±4.32 and 98.92±0.83 (data now shown here) showed a significant relation with temperature in Shah Makhdum ($p<0.001$), Boalia <0.01), Motihar ($p<0.01$) and Rajpara ($p<0.05$) respectively (Table 3).Similarly with rainfall showed significant relation with larval suvivality only in Shah Makhdum ($p<0.01$), Boalia ($p<0.05$) and Motihar ($p<0.05$) respectively. Interestingly there are no significant relationship with humidity except in Shah Makhdum ($p<0.05$) and Boalia ($p<0.05$). Similar works have been carried out in some other countries on the climatic conditions and adult mosquito abundance or larvae can provide important information to determine parasite activity levels and disease risk (Conn *et al*., 2002, Vittor *et al*., 2006, Rosa-Freitas *et al.,* 2007, Ameen *et al.,* 1984).

In our country December and January are the main winter season. So in this time the abundance of mosquito greatly reduced. Therefore this works proved that temperature and rainfall plays an important role for the growth and development of mosquito's larvae in RCC areas. However, there is need for further entomological studies to describe the adult mosquito populations including their feeding, resting behaviors and role in disease transmission especially malaria and other mosquito-borne diseases. This is the first entomological study in this area which sought to understand the habitats of mosquito larvae and their species composition in this area.

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Manuscript accepted on 09.06.2015