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Mosquito vector survey in Guwahati city of Assam, India

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Mosquitoes of the family Culicidae are distributed worldwide and comprise about 3500 species. The diversity of the mosquito species varies among different geographical regions of the world. Assam is situated in the subtropical region with fluctuation in temperature in different seasons and heavy rainfall occurs in a particular period. So, mosquito vector surveys were conducted in different seasons to identify the distribution of different species of mosquito and to find out their seasonal patterns of abundance in the city of Guwahati situated in the south bank of the river Brahmaputra. Mosquito larvae were collected in the monsoon and the autumn season (July 2012 to October 2012) from different breeding sites including seven localities in the city using glass sucking pipette. pH and salinity of the water of the breeding sites were also measured. Altogether, seven mosquito species belonging to four genera namely *Anopheles*, *Aedes*, *Mansonia* and *Culex* were collected out of which the three genus *Anopheles*, *Culex* and *Aedes* are medically important vectors of several human diseases including, malaria, dengue, yellow fever, filariasis, Japanese encephalitis, chikungunya, etc. which are prevalent in this part of the region. The site selection for the present survey is mainly based on population density, water stagnation and unplanned drainage with poor garbage management sites of the Guwahati City of India. Most of the study sites were enriched with organic matter, sewage, green algae, short herbs, and upright vegetation. From the seven breeding sites, a total of 1557 mosquito larvae were collected. Among these, mosquito species, *Culex quinquefasciatus* was found to be most abundant species in the city comprising 29.92% (466 larvae) which was followed by *Culex tritaeniorhynchus* (26.08%, 406 larvae), *Aedes aegypti* (14.96%, 233 larvae), *Anopheles minimus* (12.01%, 187 larvae) and *Aedes albopictus* (6.29% , 98 larvae) of the total larvae collection.

Key words: Mosquito, monsoon, autumn, dengue, Japanese encephalitis, Guwahati City.

INTRODUCTION

Mosquitoes are the most important among other arthropod vectors and cause various human diseases like dengue, filaria, japanese encephalitis, chikungunia, etc.

in the tropical countries of the world. Different species of Mosquitoes generally causes discomfort, annoyance and blood loss to the host besides, they also act as prime

vector of malaria protozoan, helminth and viral agents. Mosquitoes are Dipterous flies belonging to the family Culicidae. There are about 3,500 species and sub-species, under 140 subgenera in 42 genera of mosquitoes worldwide (Walter Reed Bio-systematic Unit, 2001). Ongoing global changes attributable to human activities, for example changes in climate, healthcare, land use, pollution, population movements, and urbanization, can significantly alter the rates of transmission of mosquito-borne diseases in most parts of the world (Sutherst, 2004; Ramasamy and Surendran, 2012). Along with the most often considered climate change parameters like temperature, rainfall, and humidity, others parameters such as atmospheric particle pollution and wind can also have an impact on mosquitoes population, diversity and disease trans-mission (Sutherst, 2004; Reiter, 2001). Many mosquito transmitted diseases have been reported in the North Eastern India including Assam. In Assam, the most common vector borne diseases are malaria, dengue, filariasis, Japanese encephalitis and chikungunya. The frequency of mosquito transmitting diseases increases in the states probably due to major ecological changes in the North East India. It has been reported that deforestation, industrialization, agriculture, urban development, migration of populations, new settlements, population explosion, non planned urbanization and unplanned garbage management system in the last two decades (Malhotra and Mahanta, 1994). These major factors have influenced the ecology of the region and the breeding and species composition of mosquitoes results in the diversification of mosquito population in the region (Dev et al., 2003) and results to several public health related diseases, most of which are transmitted by several vector mosquito species.

Most of the mosquito survey studies in India (Dhanpal and Naik, 1986; Nagpal and Sharma, 1987; Khame and Khaliwal, 1988) have been carried out in relation to the geographic location. These studies provide information on the distribution of mosquito species in different regions of the states (Rajavel et al., 2001). Mosquito surveys in various states of the North Eastern region of India have been carried out during the past two decades to study the occurrence, distribution, species composition and identification of vectors (Sen et al., 1973; Rao et al., 1976; Malhotra, 1985; Malhotra et al., 1987a,b; Malhotra, 1988; Kareem et al., 1985; Das et al., 1990; Das and Baruah, 1985; Rajput and Singh, 1990; Dutta and Baruah, 1987; Dutta and Bhattacharyya, 1990; Dutta et al., 1992;

Nagpal and Sharma, 1987; Dutta et al., 2004; Dutta and Mahanta, 2006; Dutta et al., 2010a,b; Baruah and Dutta, 2012).

India has recorded over 37,000 dengue cases, including 227 dengue deaths in 2012 (<http://www.assamtribune.com/scripts/detailsnew.asp?id=dec0412/at046>). It has been reported that in the state Assam, out of total 31.53 million populations, 9.71 million populations (31%) are living in malaria high risk areas (NRHM, 2011-2012). Though there is report on decline of malaria cases in the state (26.6%) in 2010 however there was record of 40 deaths in Japanese encephalitis up to October 2010. Dengue and chikungunya was not detected until 2009 but in the year 2010, dengue emerged in the state as an epidemic form and recorded 139 cases causing one death in Assam. Dengue outbreak was reported for the first time in the state Assam in the year 2012 and the two species of *Aedes* mosquito *Aedes aegypti* and *Aedes albopictus* was reported (N.D.C.P 2011-2012). Recently more than 433 cases of dengue fever were confirmed in the Guwahati city alone and reported nine deaths in the state of Assam, India (The Assam Tribune, 2012).

The monograph on Indian Anophiline and Culicine (Christopher, 1933; and Barraud, 1934) is the only documents with coverage of the mosquitoes in some parts of Assam. Comprehensive recent information on distribution of mosquito species in North Eastern region of India is very meager. It was reported that out of the 239 described Indian culicine mosquitoes, larvae of 96 species were unknown and many additional species awaited discovery (Barraud, 1934). So, there is an urgent need for exploration and documentation of mosquito species diversity in the region for vector born disease management.

The present study aimed to identify the mosquito vectors distributed in the Guwahati city of Assam. There is no earlier mosquito survey record in the city of Guwahati except for few workers (Prakash et al, 1997a,b; Prakash et al., 1998a,b,c; Dutta et al., 1999, Dutta et al., 2010a) which studied some parts of the state and also some biosphere reserves and national parks of Assam. The biodiversity of mosquitoes is very evident, with many genera having worldwide distribution while some genera have limited or endemic distribution; so, there are scope for probability of more species that have yet to be found and described. Therefore it is imperative to explore different mosquito species of the state Assam.

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MATERIALS AND METHODS

Study area

Guwahati is the commercial capital city of the North Eastern state of Assam located (N 26° 10'45'' and E 91° 45'00'') on the south bank of the river Brahmaputra. The city of Guwahati is the most populous and rapidly growing part of the state of Assam, India, covering an area of 216.79 Km². Guwahati straddles the valley of the river Bharalu, a small tributary of the river Brahmaputra which is now regarded as one of the largest sewage canal carrying all the garbage's of the city to the river Brahmaputra. The mean annual temperature of this region records minimum 24.9 to 12.5°C in winter and 31.5 to 24.7°C in summer where June, July and August are the hottest while December and January are the coolest months with an annual rainfall of 1600 mm.

Survey of mosquito larvae

Mosquito larval collections were made from July 2012 to October 2012 including the monsoon and autumn seasons from different breeding sites including seven localities (Maligaon rail colony, Maligaon Pandughat, Bharalumukh Gate No. 8, Athgaon, Katahbari, Garchowk and Khanapara) in the city of Guwahati (Figure 1).

The breeding sites of mosquitoes are selected on the basis of population density, water stagnation and unplanned drainage with poor management of garbage (Figure 2). Sampling consisted of monthly inspections of randomly selected breeding sites of the Guwahati city. Disposable containers with water was sampling by filtering with fine mesh. Different stages of mosquito larvae were collected and transferred gently with glass sucking pipette to glass beakers separately for each spot and transported to the laboratory. After counting the total larvae of each collection sites these were killed with 70% alcohol and preserved for larval identification by following the standard keys (Das et al., 1990; Rueda et al., 1997; Rueda, 2004; Rattanarithikul et al., 2005).

The breeding sites were variable including sewage water canal, ditches, temporary water logged areas, plastic, earthen pots, discarded tire, drum and shores of the river Bharalu. Most of the study sites were enriched with rotten organic matter, sewage, green algae, short herbs, and upright vegetation.

Physical characters of breeding sites

Water samples from the breeding sites of the seven localities were transferred to the laboratory for measuring the physical parameters like pH and salinity.

Larval identification

The collected larvae were put into plastic vials containing clean breeding site water and transported live from the field to the laboratory. 50 percent of the collected larvae were killed with 70% alcohol and preserved in glass bottles for identification while the remaining portions were maintained separately for adult emergence for confirmation of identification. Mainly, 4th instar larvae were examined and identified according to keys as described by Das et al. (1990), Reuben et al. (1994), Rueda et al. (1997), Rueda (2004) and Rattanarithikul et al. (2005).

RESULTS AND DISCUSSION

A total of 1554 mosquito larvae were collected from the seven mosquito breeding sites of Guwahati city. Results reveal the occurrence of seven mosquito species in the study region, viz two aedine, *Aedes aegypti* (Linn.) and *Aedes albopictus* (Skuse), one anopheline, *A. minimus* (Theobald) and three culicines, *Cx. quinquefasciatus* (Say), *Cx. vishnui* (Theobald), *Cx. tritaeniorhynchus* (Giles) one mansonina, *Moansonia annulifera* (Theobald).

The total number of mosquito larvae was recorded to be highest in the month of September where the salinity and water pH was recorded as moderately low (Table 2). During the study period, the mosquito larval abundance was found to be lower in the month of October (Table 1).

Among these mosquito species, *Cx. quinquefasciatus* was found to be most abundant species in the city comprising 29.92% (466 larvae) of the total larvae collection. It was abundant in all the survey localities inhabiting mainly sewage canal, small water logged areas, etc. (Table 1); localities with temporarily high saline water (Table 2) also reported the abundance of *Cx. quinquefasciatus* in tea agro ecosystem of Assam (Mahanta et al., 2001). In the present study, it was observed that the incidence of *Cx. quinquefasciatus* larvae was higher in all the seasons indicating relative higher abundance of this mosquito in the city areas. *Cx. tritaeniorhynchus* larvae recorded 26.08% (406 larvae) of the total larvae (Table 1) and were the second most common species collected during the study period. This species of mosquito was detected in all the localities comprising small water logged areas, wells, canals, puddles, marshes, swamps, etc indicating that this species breeds in most of the sites with different range of salinity (Table 2). *Cx. tritaeniorhynchus* is regarded as the primary vector of the disease transmitting the Japanese encephalitis virus. It has been reported that *Cx. tritaeniorhynchus* has emerged as an important vector of the disease in East, South East, and South Asia (Reuben et al., 1994). The species is also reported in abundance in most part of the state of Assam causing Japanese Encephalitis including the city of Guwahati (The Assam Tribune, 2012).

In total, the highest mosquito larval population was recorded in the Maligaon rail colony area which may be due to insufficient drainage system and human population density. An expansion of habitats for mosquito larval development as a result of climate change will therefore tend to increase vector density in relation to the human population, favoring disease transmission. As the mosquito larval habitats are a complex one, it is very difficult to understand the relationship between rainfall, mosquito larval density and human population.



Figure 1. Locations of the survey area in the city of Guwahati, Assam, India.

Rainfall forms surface pools of fresh water which favored mosquito larval development habitats for the major fresh water Anopheles vectors (Ramasamy et al., 1992a,b; Surendran and Ramasamy, 2010). However, excessive rainfall can wash away these larvae and eggs resulting in reduction of the numbers of small puddles thereby temporarily lowering the rates of mosquito borne disease transmission.

Along with other mosquito species, aedes larvae are also observed in few study areas where human population is comparatively high. *Aedes aegypti* and *Aedes albopictus* represented 14.99% (233 larvae) and 6.30% (98 larvae) of the total 1554 larvae collected during the study period (Table 1). The close association of *Aedes* mosquitoes with man or anthropophilic nature has been reported earlier by different workers (Kemp and Jupp, 1991; Schultz, 1993). *A. aegypti* species was found to be highest in the month of September at Athgaon site (68, pH 7.20, Salinity-0.31%) which was followed by the

Maligaon Pandughat site (46, pH 7.04, Salinity-1.02%) and Maligaon rail colony (23, pH 7.34, Salinity-1.24%). However, *A. albopictus* species was found to be highest in the Maligaon rail colony area (36, pH 7.34, Salinity-1.24%) which was followed by Maligaon Pandughat area (32 no's- pH 7.04, Salinity-1.02%), Katahbari area (24, pH 7.32, Salinity-1.00%). The lowest population of *A. albopictus* (6, pH 7.20, Salinity-0.31%) was recorded in Athgaon area of the Guwahati City. *A. aegypti* is sensitive to changes in temperature and available moisture so the seasonal variation in population density and distribution is common. In the present survey, it was observed that in dry and cool seasons, the mosquito populations are low and they increase when temperatures increase and the wet season commences which is inconformity with the findings of other worker (Schultz, 1993).

The epidemics of dengue have been commonly associated with the rainy season (Keating, 2001). In a study conducted in Lucknow, India and Pakistan, it was

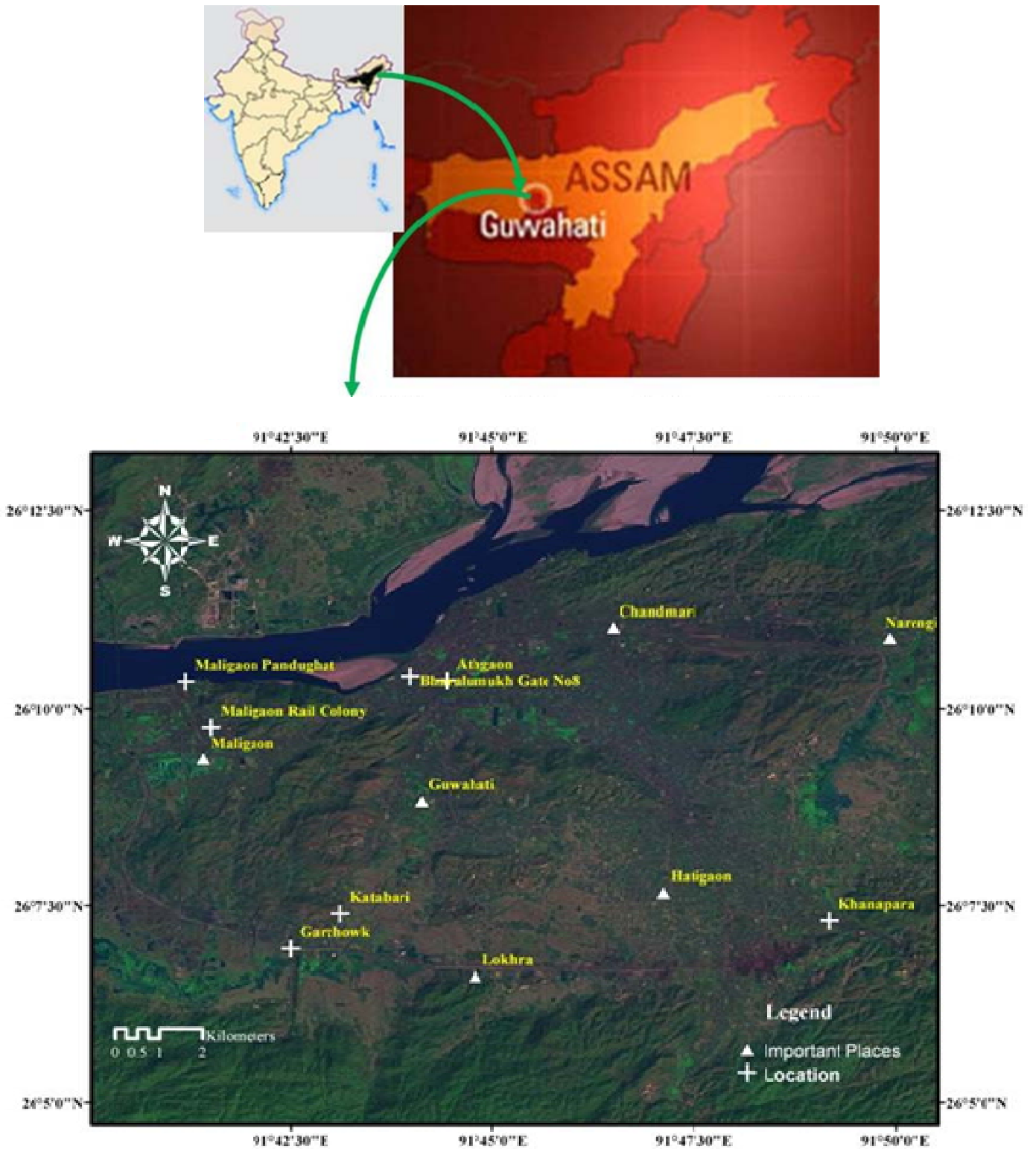


Table 1. Abundance of Mosquito species in the seven localities of the city of Guwahati.

Month of study	Locality															
	Maligaon rail colony						Maligaon Pandughat					Bharalumukh Gate No. 8				
	<i>Culex quinquefasciatus</i>	<i>Culex tritaeniorhynchus</i>	<i>Aedes aegypti</i>	<i>Aedes albopictus</i>	<i>Anopheles minimus</i>	<i>Culex vishnui</i>	<i>Culex quinquefasciatus</i>	<i>Culex tritaeniorhynchus</i>	<i>Aedes aegypti</i>	<i>Aedes albopictus</i>	<i>Anopheles minimus</i>	<i>Culex vishnui</i>	<i>Culex quinquefasciatus</i>	<i>Culex tritaeniorhynchus</i>	<i>Culex vishnui</i>	<i>Moansonia annulifera</i>
July	12	23	0	0	0	0	23	13	0	0	0	0	41	53	0	0
August	36	53	0	0	0	8	22	15	23	0	0	0	25	34	0	0
September	20	21	23	36	69	32	07	0	46	32	24	22	12	30	11	22
October	14	0	0	0	0	0	11	0	0	0	0	0	23	43	0	26

Values in each cell are the sum of larvae collected three times with the sucking pipette per locality and months.

Table 1. Continue

Month of Study	Locality																		
	Athgaon						Katahbari					Garchowk				Khanapara			
	<i>Culex quinquefasciatus</i>	<i>Culex tritaeniorhynchus</i>	<i>Aedes aegypti</i>	<i>Aedes albopictus</i>	<i>Culex vishnui</i>	<i>Moansonia annulifera</i>	<i>Culex quinquefasciatus</i>	<i>Culex tritaeniorhynchus</i>	<i>Aedes aegypti</i>	<i>Aedes albopictus</i>	<i>Culex vishnui</i>	<i>Culex quinquefasciatus</i>	<i>Culex tritaeniorhynchus</i>	<i>Anopheles minimus</i>	<i>Culex vishnui</i>	<i>Culex quinquefasciatus</i>	<i>Culex tritaeniorhynchus</i>	<i>Anopheles minimus</i>	<i>Culex vishnui</i>
July	04	0	0	0	0	0	51	02	0	0	0	11	05	0	0	09	0	0	0
August	18	11	0	0	0	0	34	01	0	0	0	14	24	0	0	20	02	0	0
September	11	20	68	6	21	0	11	10	0	24	06	09	0	28	03	28	46	66	04
October	0	0	42	0	0	09	0	0	31	0	0	0	0	0	0	0	0	0	0

Values in each cell are the sum of larvae collected three times with the sucking pipette per locality and months.

reported that dengue transmission occurred round the year with peak incidence in the post-monsoon season (Tripathi et al., 2008; Khan et al., 2010). Similarly, the present study revealed that most of the *A. aegypti* larvae were collected in four localities viz. Maligaon Pandughat (69/1554), Maligaon rail colony (23/1554), Athgaon (110/1557) and Katahbari (31/1554) region while another *Aedes* species *A. albopictus* larvae were found in Athgaon (06/1554), Maligaon Pandughat (32/1554), Katahbari (24/1554) and Maligaon rail colony (36/1554)

during post monsoon season. The main breeding sites of these two species includes discarded drums, tire, small tin container, earthen pots, small water logged areas with moderate high and low salinity of water (Table 2) indicating rapidly increasing species in the industrial city areas of Guwahati. Similarly, the two species of *Aedes* mosquitoes were also reported from different container habitats in the North-Eastern states of India (Dutta and Mahanta, 2006). It was also reported that increased industrialization and urbanization cause the breeding

Table 2. Physical characteristics of the breeding sites during the study period (July to October 2012).

Month of Study	Maligaon rail colony		Maligaon Pandughat		Bharalumukh Gate No. 8		Athgaon		Katahbari		Garchowk		Khanapara	
	pH	Salinity	pH	Salinity	pH	Salinity	pH	Salinity	pH	Salinity	pH	Salinity	pH	Salinity
July	7.56	1.09	7.14	1.23	7.60	0.62	7.09	0.28	7.51	0.98	7.88	1.29	7.23	0.35
August	7.45	2.01	7.12	1.29	7.59	0.67	7.10	0.26	7.47	0.97	7.89	1.80	7.21	0.36
September	7.34	1.24	7.04	1.02	7.41	0.24	7.20	0.31	7.32	1.0	7.75	1.26	7.14	0.39
October	7.46	1.34	7.31	1.23	7.50	0.52	7.12	0.39	7.24	0.98	7.57	1.23	7.08	0.38

Data representing the averages for both pH and salinity in each locality.

grounds and their environment are more suitable for the rapid multiplication of these two species of mosquitoes (Baruah and Dutta, 2012). From the present findings, it may be assumed that being the major industrial and economic hub, the city of Guwahati has been the suitable ground for the rapid multiplication of these two dengue vector mosquito species in the region.

As the *A. aegypti* are major urban vector of dengue and can develop indoors in water containers, therefore its development is less dependent on rainfall (Barraud, 1934; World Health Organization, 2009). *Aedes* mosquitoes were found to be maximum in the month of September which was at par with the findings of other workers in north eastern climate (Baruah and Dutta, 2012) and reported the higher dengue transmission in post-monsoon season (September-December).

The alternative vector of dengue *A. albopictus*, in mainly peri-urban and rural settings, tends to undergo larval development in water collections outdoors and is therefore more dependent on rain-fed habitats (World Health Organization, 2009, Ramasamy et al., 2011). *A. albopictus* densities increase during the monsoon season in the Jaffna peninsula, a coastal zone in Sri Lanka (Surendran et al., 2007).

A. minimus (Theobald) is also moderately abundant and represents 12.03% (187/1554) larvae of the total collection (Table 1). Larvae of this species were collected from four regions of the survey area viz. Maligaon Pandughat (1.54%, 24/1554), Maligaon rail colony (4.44%, 69/1554), Garchowk (1.80%, 28/1554) and Khanapara (4.24%, 66/1554). Habitats of the larvae of this species were found in the low water flowing drains, water canals, humid swampy area, unused water tanks, etc, with comparatively low and moderate salinity (Table 2). The species has been reported as an important malaria vector in India along the foothills of the Himalayas from Uttar Pradesh (Terai region) to the North-Eastern region of the country. The presence of this mosquito species were recorded in the state of Nagaland

(Bhatnagar et al., 1982), Mizoram (Das and Baruah, 1985), Arunachal Pradesh (Dutta and Baruah, 1987) and Assam (Kareem et al., 1985; Nagpal and Sharma, 1987). Wajihullah (1992) recorded and identified *A. minimus* as a malaria vector in Sonapur PHC, district of Kamrup, Assam. Similarly, occurrence of this species was also reported in the North-Eastern states including Assam. In contrast to the present findings, there is report of sudden disappearance of the species from this region (Dev, 1996).

C. vishnui comprised 6.9% (107 larvae) out of a total of 1554 collected larvae and recorded in all localities but with different numbers (Table 1). Larvae were found in all the breeding places viz. public open canals, small water logged areas adjacent to the market places of the city of Guwahati with relatively moderate salinity (Table 2). The species was relatively more abundant in Maligaon rail colony (2.57%, 40/1554) and Athgaon area (1.35%, 21/1554) compared to the other localities. This species was also reported in various places of different districts of Assam (Khan et al., 1996). It was also regarded as one of the potential vectors of Japanese encephalitis in Assam. *Moansonia annulifera* (Theobald) represent a minimum of 3.66% (57 larvae) of the total larvae (1554) encountered (Table 1). Most of the larvae were collected in the Bharalumukh Gate No. 8 (3.08%, 48/1554) and the lowest was in the Athgaon area of the city (0.57%, 09/1554) with relatively moderate salinity of water in the habitat (Table 2). This species was also recorded earlier from Dibrugarh and reported to be prevalent in the state Assam (Chakraborty et al., 1982).

Conflict of Interests

The author(s) have not declared any conflict of interests.

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