INT. J. BIOL. BIOTECH., 8 (4): 637-643, 2011.

POPULATION DYNAMICS OF DENGUE VECTOR *AEDES AEGYPTI* L. IN THIRTEEN TOWNS OF KARACHI, PAKISTAN

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ABSTRACT

Population dynamics of *Aedes aegypti* is investigated in thirteen towns of Karachi. The breeding stations were chalked and regularly visited four times (weekly) in each month. The stations of Orangi, Baldia, SITE, Liaquatabad, Gulshan-e-Iqbal, Korangi and Shah Faisal Colony were surveyed from December 2009 through May 2010 and stations of Lyari, Sadar, North Nazimabad, Gulberg, Keamari and Bin Qasim were surveyed from June 2010 through November 2010. The population varied more amongst stations than months. Liaquatabad was worst hit town with alarmingly high population throughout the observation period; varying little between the months by a factor of 1.087 only; lowest between the stations investigated. The dengue vector population in Liaquatabad was maximally high in February 2010 (2498 larvae per 100 mL water) followed by 2403 larvae per 100 mL water in January 2010and reached to the lowest in April 2010 (2299 ± 17.2). Sadar was the least –affected area. These results appear to agree with the data reported in the literature to date.

Key Words: *Aedes aegypti*, Dengue Vector, Seasonal Variation, Karachi

INTRODUCTION

The dengue infection continues to grow throughout tropical and subtropical countries world wide affecting an estimated 50-100 million people each year (Gibbons and Vaughn, 2002). Qadri *et al.* (2007) and Tariq and Qadri (2008) reported infection control strategies of dengue to create awareness in the public sector to overcome this problem. As per report by Teyssou (2009) the dengue is affecting 110 countries world over and over 3 billion people are placed at risk of infection throughout the globe, whereas 70-500 million people are infected with dengue each year including two million who develop dengue hemorrhage fever and 2000 die. WHO did not have Pakistan in the list of dengue affected countries of the world although Barraud (1928) reported not only dengue fever (DF) (vector i.e., *Aedes aegypti* L. but also this disease from Peshawar, Lahore, Dera Ghazi Khan, Khairpur and Karachi (from a report of Megaw and Gupta, 1927). Barraud (1934) also reported the distribution of *Aedes aegypti* from Peshawar to Karachi. *Ae. aegypti* and *Ae. albopictus* were reported in Punjab by Aslam Khan and Salman (1969). Naqvi (1992) reported the survey results of mosquito (including *Aedes*) from Karachi and from Balochistan and Khyber Pukhtoonkhwa by Suleman *et al.* (1993, 1996). Kammimura (1986) reported *Ae aegypti* from Karachi, Sindh. Chan *et al*. (1995) for the first time confirmed the association of dengue virus (Family Flaviviridae: Genus Flavivirus) of serotype (DEN-2) in dengue patients. Tariq and Zafar (2000) reported the reason of increase of dengue in Karachi. Tariq (2001) reported the habitats and breeding sites of *Aedes*, *Anopheles* and *Culex* in Karachi. and Jawad *et al.* (2001) from Lasbella district of Balochistan only 40 km from Karachi reported six out of seven patients with dengue virus (DEN-2) and 15 patients with this virus out of 34 dengue patients. Ministry of Health, Government of Pakistan, for the first time recorded 40 confirmed patients of dengue with 5 deaths from Karachi and in the same year WHO included Pakistan in their list of dengue-affected countries. Since then, severe epidemics of dengue is growing every year with havoc produced in Lahore last year with more than 50000 cases and nearly 500 causalities with no prescribed medicine and in the absence of any vaccine world over. The only remedy is the management of the vector population for its ultimate eradication as reported by Tariq *et al.* (2009) via biological control. Karachi division comprises eighteen towns of which all the 18 towns positively had dengue vector, *Aedes aegypti* L. (Ahmad *et al.*, 2009; Tariq *et al.* 2010). Akram *et al.* (2009) clarified the Aedes mosquitoes as daytime biting mosquitoes with seasonal distribution and species composition. In this paper, population dynamics of *Ae. aegypti* is investigated in thirteen towns of Karachi.

MATERIALS AND METHODS

To collect data on population of *Aedes aegypti* from pre-chalked breeding stations in 13 towns of Karachi (Table 1), dipping method of larvae procurement from the water containers was employed. From each breeding site five dips of 100 mL water each were taken out on weekly basis from the water containers chalked in these localities

for the sampling purpose and the average of the four weeks observation was used as mean observation for a month. The water samples were brought to the laboratory and larvae of the *Ae. aegypti* were counted. The survey was conducted in towns of Orangi, Baldia, SITE, Liaquatabad, Gulshan-e-Iqbal, Korangi and Shah Faisal Colony for six months from December 2009 to May 2010 and in the towns of Keamari, Sadar, North Nazimabad, Gulberg, Layari and Bin Qasim from June 2010 to November 2010. The data on population was expressed on 100mL water sample basis. The data was analyzed statistically.

Table 1. Eighteen (07+06+05) towns of Karachi and their UCs selected for population dynamics of dengue vector mosquitoes.

S. NO.	NAME OF TOWNS	UC, VISITED AND TO BE VISITED FOR POPULATION DYNAMICS OF DENGUE VECTOR MOSQUITOES IN EIGHTEEN (13 + 5) TOWNS OF KARACHI
Previously Reported Population Dynamics in Seven Towns of Karachi		
01.	Baldia Town	Gulshan-e-Ghazi UC-1, Islam Nagar UC-3, Saeedabad UC-5, Mujahid Colony UC-6, Faqir Colony.
02.	SITE Town	Pak Colony UC-1, near Nourus Chowrangi, Metroville UC-4, Pathan Colony UC-5.
03.	Orangi Town	Mominabad UC-1, Hanifabad UC-3, Muhammed Nagar UC-4, Ghaziabad UC-6, Gabol Colony UC-10, Data Nagar UC-11.
04.	Liaquatabad Town	Rizvia Society UC-1, Firdous Colony UC-2, Dak-Khana UC-4, Mujahid Colony UC-9, Nazimabad No.1, UC-10.
05.	Gulshan-e-Iqbal Town	Civic Centre UC-2, Gulshan-e-Iqbal UC-9, University of Karachi UC-11, Gulzar-i-Hijri UC-12, Pehlwan Goth UC-19.
06.	Korangi Town	Bilal Colony UC-1, Nasir Colony UC-2, Chakhra Goth UC-3, Mustafa Taj Colony UC-4, 100 Quarters UC-5, Gulzar Colony UC-6, Korangi Sector 33 UC-7, Zaman Town UC-8, Hasrat Mohani Colony UC-9.
07.	Shah Faisal	Natha Khan Goth UC-1, Drigh Colony UC-3, Rafah-e-Aam Society UC-6, Al-Falah Society (Jamia Millia Government College) UC-7.
Presently Reported Population Dynamics in Six Towns of Karachi		
08	Keamari	**Bhutta Village, Sultanabad UC-2, Keamari UC-3, Maripur UC-6, Machar Colony, Shershah Colony**.
09.	Saddar	Garden UC-2, Millat Nagar UC-1, Saddar UC-8, Kharadar UC-3, Clifton UC-10.
10.	North Nazimabad	Paposh Nagar UC-1, Farooq-e-Azam Bl. I, Sakhi Hasan Bl. M, Pahar Ganj Bl. P, Buffer Zone 1&2, Hydri Bl. G.
11.	Gulberg	Azizabad UC-1, Karimabad UC-2, Ayesha Manzil UC-3, Naseerabad UC-5, Yaseenabad UC-6, Shafique Mill Colony Bl. 22.
12.	Lyari	Agrataj Colony UC-1, Bihar Colony UC-7, Rangivara UC-8, Baghdadi UC-5, Khadda Memon Society UC-4, Allama Iqbal Colony UC-11, Chakiwara UC-10.
13.	Bin Qasim	Rehri Goth+Cattle Colony UC-3, Landhi UC-5, Steel Town + Gulshan-e-Hadeed UC-6.
Five Remaining Towns of Karachi to be Surveyed for Population Dynamics		
14.	Jamshed	Akhtar Colony UC-1, Mehmoodabad No. 2&5, PECHS UC-6, Quaid-e-Azam Tomb, Garden East UC-11, Soldier Bazar UC-12.
15.	New Karachi	Fatima Jinnah Colony UC-3, Madina Colony UC-7, Mustafa Colony UC-10, Khawaja Ajmer Nagri UC-11.
16.	Landhi	Muzafarabad UC-1, Muslimabad UC-2, Dawood Chowrangi UC-3, Shahrafi Goth UC-5, Bhutto Nagar UC-6, Khawaja Ajmer Colony UC-7, Landhi UC-8, Sherabad Colony UC-12.
17.	Malir	Model Colony UC-1, Kala Board UC-2, Khokrapar UC-4, Gharibabad UC-6, Ghazi Dawood Brohi UC-7.
18.	Gadap	Murad Goth Memon UC-1, Baqai Medical University Deh Tor, Deh Kathore.

RESULTS AND DISCUSSION

Population dynamics of *Aedes aegypti* is investigated in thirteen towns of Karachi. The breeding stations were established and regularly visited each month.. The stations of Orangi, Baldia, SITE, Liaquatabad, Gulshan-e-Iqbal, Korangi and Shah Faisal Colony were surveyed from December 2009 through May 2010 (Table 2) and stations of Lyari, Sadar, North Nazimabad, Gulberg, Keamari and Bin Qasim were surveyed from June 2010 through November 2010 (Fig. 1).

Table 2. Population of *Aedes aegypti* per 100 mL water at various stations in Karachi from December, 2009 through May, 2010.

Stations	Dec. 2009	Jan. 2010	Feb. 2010	Mar. 2010	Apr. 2010	May 2010	Max/ Min Factor*
Orangi	76 ± 4.63	83 ± 4.63	91± 3.70	60 ± 4.59	55± 3.48	49 ± 3.36	1.86
Baldia	209 ± 10.03	319 ± 6.62	248 ± 7.48	199 ± 11.01	161 ± 3.99	130 ± 16.89	2.46
SITE	30 ± 7.16	19 ± 1.41	22 ± 2.74	28 ± 6.63	35 ± 7.16	11 ± 2.54	3.18
Liaquat-Abad	2328 ± 36.1	2403 ± 32.0	2498 ± 15.2	2380 ± 21.65	2299 ± 17.2	2389 ± 18.2	1.087
Gulshan – e-Iqbal	58 ± 4.59	73 ± 3.48	65± 9.82	49± 2.49	36 ± 7.16	40 ± 6.06	2.03
Korangi	23 ± 1.23	32 ± 7.16	28 ± 6.68	21 ± 1.41	19 ± 1.61	13 ± 1.14	2.46
Shah Faisal Colony	277 ± 14.30	301 ± 15.9	366 ± 13.83	290 ± 21.14	238 ± 6.10	222 ± 6.94	1.65
Max / min Factor**	101.2	126.47	111.55	113.33	121.0	17.18	-

*, Max / Min Factor - Among months but within a station.
**, Max / Min Factor – Among stations but within a month.

Table 3. Two-way ANOVA of monthly data (December 2009 through May, 2010) of larval populations of *Aedes aegypti* in various stations of Karachi.

F RATIO					
Source	SS	df	MS	F	p
Main					
Stations	134575164.8	6	22429194.13	32856.4	0.00001
Months	134498.21	5	26899.0642	39.41	0.00001
Interactions					
Stations x Months	175890.95	30	5863.032	8.588	0.00001
Error	114685	168	682.64		
Total	135000237.9	209			

DMRT

Stations					Months				
Rank	Stations	Mean	N	NS-Ranges	Rank	Months	Mean	N	NS-Ranges
1	Liaquatabad	2382.8	30	a	1	Feb. 10	474	30	a
2	Shah Faisal	282.3	30	b	2	Jan. 10	461.43	30	b
3	Baldia	211	30	c	3	Mar. 10	432.43	30	c
4	Orangi	69	30	d	4	Dec. 09	428.71	30	c
5	G. Iqbal	53.5	30	e	5	May 10	407.7	30	d
6	SITE	24.2	30	f	6	Apr. 10	406.1	30	d
7	Korangi	22.67	30	f					
$LSD_{0.05}$ = 13.000					$LSD_{0.05}$ = 12.330				

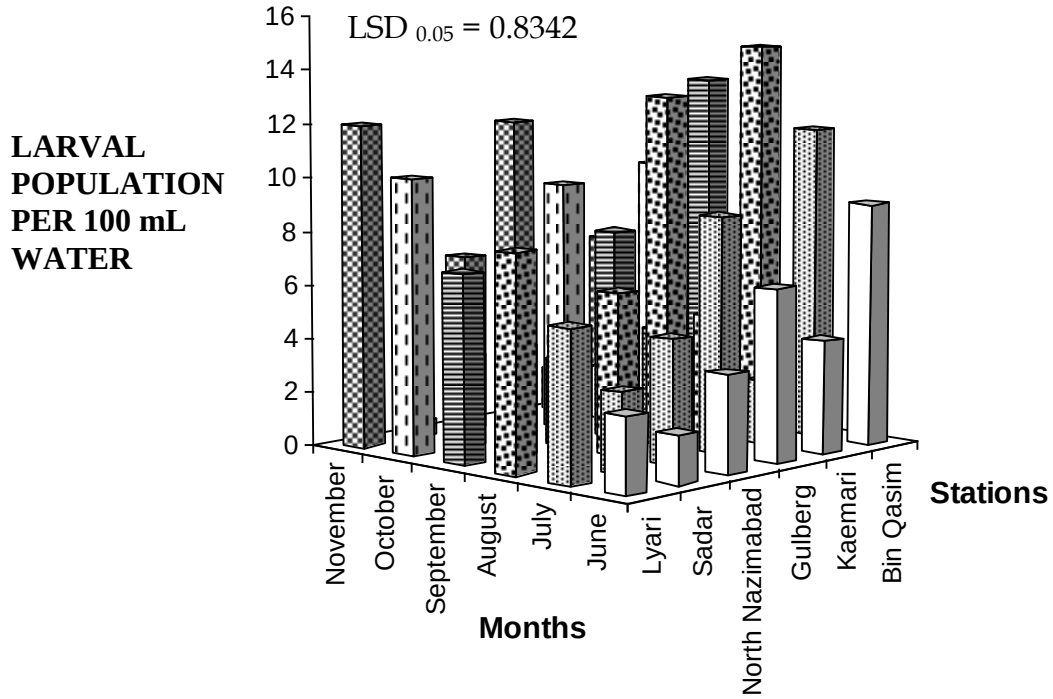

Figure 1. Mean larval population of *Ae. aegypti* per 100mL water during June 2010 through November 2010 at various stations of Karachi.

Table 4. Two-way ANOVA of monthly data (June through November, 2010) of larval populations of *Aedes aegypti* in various stations of Karachi.

F RATIO					
Source	SS	df	MS	F	p
Main					
Stations	1763.117	5	352.623	131.96	0.00001
Months	184.183	5	36.836	13.790	0.00001
Interactions					
Stations x Months	567.650	25	22.706	8.497	0.00001
Error	384.8	144	2.672		
Total	2899.75	179			

DMRT

Stations					Months				
Rank	Stations	Mean	N	NS-Ranges	Rank	Months	Mean	N	NS-Ranges
1	Bin Qasim	10.8	30	a	1	AUG 10	8.06	30	a
2	Gulberg	9.53	30	b	2	OCT 10	6.73	30	b
3	Lyari	7.16	30	c	3	SEPT 10	6.5	30	b
4	N. Nazimabad	4.97	30	d	4	NOV 10	6.5	30	b
5	Kaemari	3.1	30	e	5	JULY 10	6.06	30	b
6	Saddar	2.5	30	f	6	JUNE 10	4.63	30	c
LSD $_{0.05}$ = 0.8342					LSD $_{0.05}$ = 0.8343				

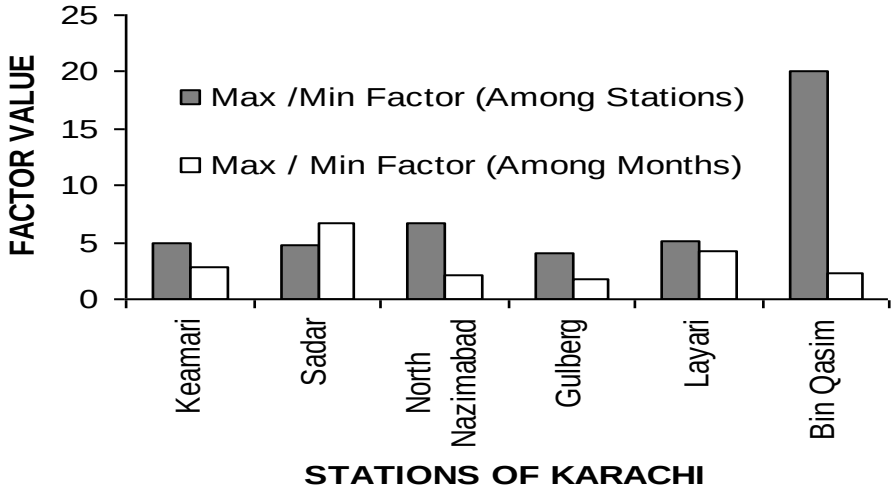

Fig. 2.Maximum / Minimum factor values for stations surveyed from June 2010 through November 2010. The analysis was made in two ways. 1) Maximum / minimum factor between stations but within a month and 2) Maximum / Minimum factor value between months within a station.

It was found from December 2009 to May 2010 survey that Liaquatabad was the worst hit area by *Aedes aegypti* with population of 2289 ± 17.2 to 2498 ± 15.2 larvae per 100 mL water procured from the water container maintained. This was followed by Baldia with *Aedes* population 130 ± 16.89 to 319 ± 6.62 larvae per 100 mL water. In other stations population build up from December 2009 to May 2010 was comparatively low. Population varied significantly among stations and months ($F = 32856.4$, $p < 0.00001$ and 39.41, $p < 0.00001$, respectively. The interaction of station x month was also significant ($F = 8.588$, $p < 0.00001$) (Table 3). Within month maximum / minimum proportion factor was high among all stations with a quantum of 101.2 – 217.18. *Aedes* population varied also among months for a station but not more than by a maximum / minimum factor of 3.16. *Aedes* population in Liaquatabad was alarmingly high throughout the observation period but varied little between the months by a factor of 1.087 only; lowest between the stations investigated. The population was maximally high in February 2010 (2498 larvae per 100 mL water) followed by 2403 larvae per 100 mL water in January 2010. The population was the lowest in April 2010 (2299 ± 17.2). *Aedes* population in stations of Orangi, Liaquatabad and Shah Faisal Colony was the highest in February 2010 and in Baldia, Gulshan-e-Iqbal and Korangi it was the highest in January 2010. In SITE, the highest larval population (35 ± 7.16 larvae per 100 mL water) was recorded in April 2010. The mosquito population of Orangi, SITE, Kaemari, and Shah Faisal Colony remained at the lowest level in May 2010. Generally speaking, the population was the highest in February and the lowest in April or May. The population variation was largely influenced by the stations and quite less influenced by the months of the observation.

In brief the stations under survey may be arranged in following order as regard to the *Aedes* population during the survey period.

Liaquatabad >>> Shah Faisal Colony > Baldia > Orangi > Gulshan-e-Iqbal > SITE > Korangi

The data on the population dynamics at stations viz. Keamari, Sadar, N. Nazimabad, Gulberg, Lyari and Bin Qasim is presented in Fig. 1. These stations were comparatively much less affected with *Aedes* population which couldn't exceed 15 larvae per 100 mL water at any station. Two-way ANOVA of the data indicated that both stations ($F = 131.96$, $p < 0.00001$) and months of observation ($F = 13.79$, $p < 0.00001$) influenced the mosquito population significantly. Of course, population varied more due to stations than the months of observation (Table 4). The interaction of these two factors was also significant ($F = 8.49$, $p < 0.00001$). Bin Qasim exhibited the highest population and Sadar the least. The maximum population was recorded to 14.6 larvae per 100 mL water at Bin Qasim in August 2010. The ever lowest population recorded was in Sadar (0.6 larva per 100 mL water).

As indicated by the maximum / minimum proportion factor (Fig. 2) there was the largest variation between stations for the month of November 2010 (Factor = 20). For other months such a variation factor was not more than 6.63. The maximum / minimum population variation between months within a station was found to range from 1.81 to 6.67 (mean = 3.32 ± 0.76). Such a factor was the lowest for Gulberg and the largest for the Sadar. It may, however, be mentioned that the absolute population at Sadar remained substantially low as compared to the other stations. The stations surveyed during June 2010 to November 2010 as regards to the prevalence of *A. aegypti* may be arranged as follows:

Bin Qasim > Gulberg > Lyari > N. Nazimabad > Keamari > Sadar

This paper is a baseline research and would provide comparison on scientific lines. Tariq *et al.* (2011) showed that from January to June the increase in percentage of positive containers out of the household containers observed in different towns of Karachi increased in respect of larvae and pupae appeared positively correlated with the increase in temperature. Bonnewepster and Brug (1932) has also shown that the female *Ae. aegypti* bites more readily between 26 and 35 ^{o}C; between 19 and 25 ^{o}C it is slow in sucking blood and below 15 – 19 ^{o}C it doesn't do it all. Its spreading is limited by climate. They have also shown that the larvae of this species develop well at 38 to 40 ^{o}C and at 44 ^{o}C the mortality is very high and at 48 ^{o}C all of them died. Pupae behaved similarly. Viosca (1925) reported that *Ae. aegypti* is relatively abundant during the dry season of summer and early fall (in Horstall, 1955). These studies appear to agree with the results of the present studies that there appears to be some correlation between the population and the months of collection. The temperature in any area of Karachi hardly goes much below the tolerance limit of these larvae especially in view of the fact that *Ae. aegypti* breeds exclusively in the household artificial containers. In various towns of Karachi, therefore, the larvae are found round the year and also there appears to be much more correlation between higher population with the exclusive station i.e. Liaquatabad town and Bin Qasim town. Either these areas for their dense human population harbour a much higher population of *Ae. aegypti* or to which such living conditions favour.

ACKNOWLEDGMENTS

The authors are thankful to Pakistan Academy of Sciences for providing funds for this project entitled- The Survey, Distribution, Population Dynamics and Biological Control of Mosquitoes Causing Dengue Fever in Karachi (Ref No. 5-9/PAS/3392 dated 13-5-2009) to control the dengue vector mosquitoes in Karachi.

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(*Accepted for publication October 2011*)