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

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ABSTRACT

Population dynamics of *Aedes aegypti* is investigated in eighteen 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, stations of Lyari, Sadar, North Nazimabad, Gulberg, Kaemari and Bin Qasim were surveyed from June 2010 through November 2010 and stations of Jamshed town, N. Karachi, Landhi, Malir and Gadap were surveyed from December 2010 through May 2011. The population varied more amongst stations than months. However, in data set of survey carried out in Dec. 2010 through May 2011, the population varied more with months (seasonality) than with the stations. The *Aedes* population generally increased in humid summer months and remained low in dry months. Liaquatabad was worst hit town with alarmingly high population throughout the observation period; varying little between the months by (Max. / Min. factor of 1.086 only). Max / Min factor was maximum in Landhi town (16.67) as the population was quite low (2.0 ± 0.45) initially in winter month of Dec. 2010 which gradually increased to 33.4 ± 0.51) in summer month of May, 2011. The dengue vector population was maximally high in Liaquatabad in February 2010 (499.6 ± 6.92 larvae per 100 mL water) followed by 482.2 ± 13.24 larvae per 100 mL water in January 2010 and reaching the lowest in April 2010 (460.0 ± 6.58). Sadar was the least – affected area on mean population basis. These results appear to agree with the data reported in available literature.

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

INTRODUCTION

The dengue infection continues to grow throughout tropical and subtropical countries affecting an estimated 50-100 million people each year (Gibbons and Vaughn, 2002). 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 in 1969 by Aslam Khan and Salman (1969) and from Balochistan and Khyber Pukhtoonkhwa by Suleman *et al.* (1993, 1995). 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 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.* (2000) 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 reported for all the eighteen towns of Karachi with corrected larval density for the station of Liaquatabad. In an earlier paper (Ahmad *et al*., 2011) population dynamics of 13 towns of Karachi was reported in which an inadvertent error crept in regarding population density of Aedes larvae in Liaquatabad town.

MATERIALS AND METHODS

To collect data on population of *Aedes aegypti* from pre-established breeding stations in 18 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 established in these localities for the sampling purpose. 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, in the towns of Kaemari, Sadar, North Nazimabad, Gulberg, Layari and Bin Qasim from June 2010 to November 2010 and stations of Jamshed town, N. Karachi, Landhi, Malir and Gadap were surveyed from December 2010 through May 2011. The data on population was expressed on 100mL water sample basis. The data was analyzed statistically.

Table 1. Eighteen towns of Karachi and their UCs selected for population dynamics of dengue vector mosquitoes.

S. NO.	TOWNS	UC VISITED FOR THE SAMPLING OF DENGUE VECTOR
01.	Baldia Town	Faqir Colony
02.	SITE Town	Pak Colony UC-1
03.	Orangi Town	Muhammed Nagar UC-4
04.	Liaquatabad Town	Dak Khana UC-4
05.	Gulshan-e-Iqbal Town	University of Karachi UC-11
06.	Korangi Town	Korangi Sector 33 UC-7
07.	Shah Faisal	Al-Falah Society (Jamia Millia Government College) UC-7
08	Keamari	Machar Colony
09.	Saddar	Garden UC-2
10.	North Nazimabad	Pahar Ganj (Block – P)
11.	Gulberg	Ayesha Manzil UC-3
12.	Lyari	Baghdadi UC-5
13.	Bin Qasim	Gulshan-e-Hadeed UC-6
14.	Jamshed	Soldier Bazar UC-12.
15.	New Karachi	Madina Colony UC-7
16.	Landhi	Dawood Chowrangi UC-3
17.	Malir	Model Colony UC-1
18.	Gadap	Zia-ul-Haq Res. Station behind Baqai Medical University

RESULTS AND DISCUSSION

Population dynamics of *Aedes aegypti* is investigated in eighteen 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. The stations of Lyari, Sadar, North Nazimabad, Gulberg, Kaemari and Bin Qasim were surveyed from June 2010 through November 2010) and stations of Jamshed town, N. Karachi, Landhi, Malir and Gadap were surveyed from December 2010 through May 2011.

It was found from December 2009 to May 2010 survey that Liaquatabad was the worst hit area by *Aedes aegypti* with population of 460.0 ± 6.58 to 499.6 ± 6.92 larvae per 100 mL water procured from the water container maintained (Fig,1). 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 2). The *Aedes*

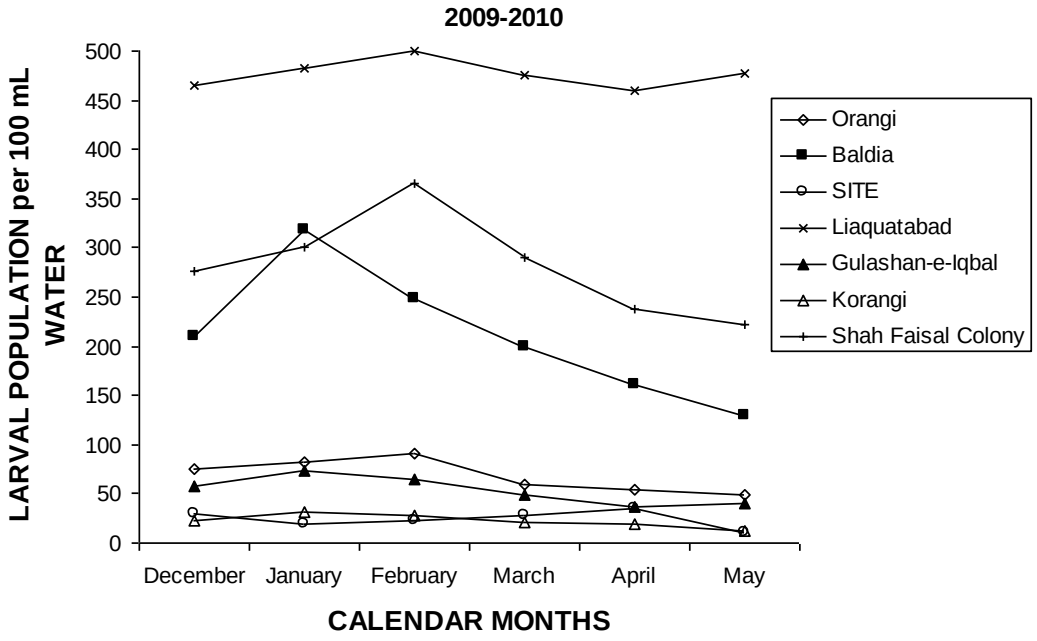

Fig. 1.Population of *Aedes aegypti* at various stations of Karachi from December, 2009 through May 2010.

Table 2. Two-way ANOVA of monthly data (Dec. 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	5239873.26	6	873312.21	2820.298	0.00001
Months	84967.395	5	16993.479	54.879	0.00001
Interactions					
Stations x Months	111545.37	30	3718.179	12.007	0.00001
Error	52021.6	168	30.652		
Total	5488407.624	209			

DMRT

Stations					Months				
Rank	Stations	Mean	N	NS-Ranges	Rank	Months	Mean	N	NS-Ranges
1	Liaquatabad	476.57	30	a	1	Feb. 10	188.514	35	a
2	Shah Faisal	282.3	30	b	2	Jan. 10	187.024	35	a
3	Baldia	211	30	c	3	Dec. 09	162.543	35	b
4	Orangi	69	30	d	4	Mar. 10	160.429	35	b
5	G. Iqbal	53.5	30	e	5	Apr. 10	143.429	35	c
6	SITE	24.2	30	f	6	May 10	134.548	35	d
7	Korangi	22.67	30	f					
$LSD_{0.05}$ = 8.969					$LSD_{0.05}$ = 8.3044				

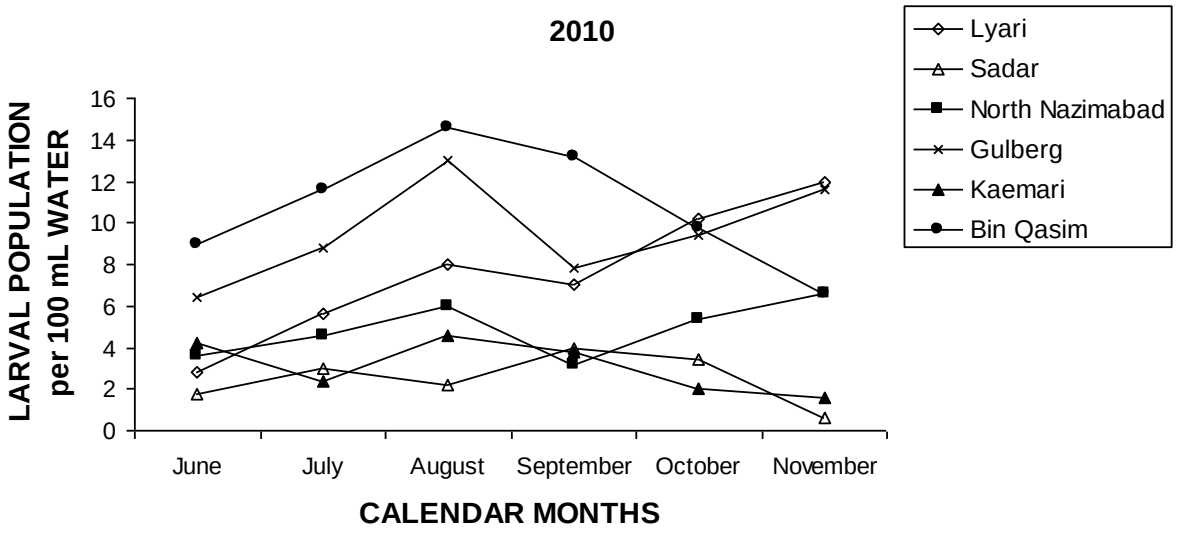

Fig. 2. Mean larval population of *A. aegypti* per 100mL water during June through November 2010 at various stations of Karachi.

Table 3. Two-way ANOVA of monthly data (June, 2010 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				

population varied among months for a station but not more than by a maximum / minimum factor of 3.16. *Aedes* population in Liaquatabad was quite high throughout the observation period but varied little between the months by a Max / Min factor of 1.086 only (Table 5); lowest between the stations investigated. The population was maximally high in February 2010 (499.6 ± 6.92 larvae per 100 mL water) followed by 482.2 ± 13.24 larvae per 100 mL water in the previous month of January 2010. The population was the lowest in April 2010 (460.0 ± 6.58). *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, the population was 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.

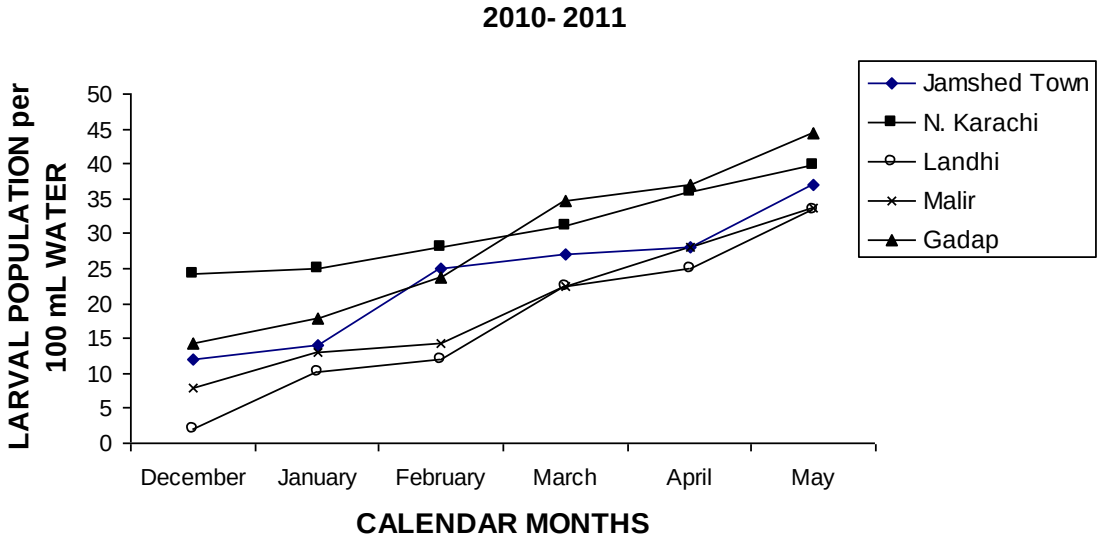

Fig. 3.Population of *Aedes aegypti* at various stations of Karachi from December, 2010 through May 2011.

Table 4. Two-way ANOVA of monthly data December, 2010 through May, 2011) of larval populations of *Aedes aegypti* in various stations of Karachi.

F RATIO					
Source	SS	df	MS	F	p
Main					
Stations	3788.07	4	947.0266	22.128	0.00001
Months	11539.28	5	2307.86	53.926	0.00001
Interactions					
Stations x Months	810.853	20	40.543	0.94733	0.5299 NS)
Error	5135.6	120	42.797		
Total	21273.84	149			

DMRT

Stations					Months				
Rank	Stations	Mean	N	NS-Ranges	Rank	Months	Mean	N	NS-Ranges
1	N. Karachi	30.7	30	a	1	MAY 11	37.64	25	a
2	Gadap	28.7	30	a	2	APR 11	30.8	25	b
3	Jamshed	23.83	30	b	3	MAR 11	27.6	25	b
4	Malir	19.86	30	c	4	FEB 11	20.6	25	c
5	Landhi	17.5	30	c	5	JAN 11	16.0	25	d
					6	DEC10	12.12	25	e
LSD $_{0.05}$ = 3.344					LSD $_{0.05}$ = 3.664				

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

Liaquatabad (476.7 ±5.78) > Shah Faisal Colony (282.3 ± 20.85) > Baldia (211..0 ± 2.7) > Orangi (69.0 ± 6.84) > Gulshan-e-Iqbal (53.5 ± 5.89) > SITE (24.16 ± 3.52) > Korangi 22.7 ± 2.74).

Table 5. Eighteen towns of Karachi and their UCs selected for population dynamics of dengue vector mosquitoes.

S. NO.	TOWNS	MAXIMUM / MINIMUM POPULATION FACTOR (Among the months of the observation period specified)	
01.	Baldia Town	2.46	(Dec. 2009 – May, 2010)
02.	SITE Town	3.18	(Dec. 2009 – May, 2010)
03.	Orangi Town	1.86	(Dec. 2009 – May, 2010)
04.	Liaquatabad Town	1.086	(Dec. 2009 – May, 2010)
05.	Gulshan-e-Iqbal Town	2.03	(Dec. 2009 – May, 2010)
06.	Korangi Town	2.46	(Dec. 2009 – May, 2010)
07.	Shah Faisal	1.65	(Dec. 2009 – May, 2010)
08	Keamari	2.63	(June 2010 – Nov. 2010)
09.	Saddar	5.0	(June 2010 – Nov. 2010)
10.	North Nazimabad	2.07	(June 2010 – Nov. 2010)
11.	Gulberg	2.03	(June 2010 – Nov. 2010)
12.	Lyari	4.29	(June 2010 – Nov. 2010)
13.	Bin Qasim	2.21	(June 2010 – Nov. 2010)
14.	Jamshed Town	3.08	(Dec. 2010 – May, 2011)
15.	New Karachi	1.64	(Dec. 2010 – May, 2011)
16.	Landhi	16.70	(Dec. 2010 – May, 2011)
17.	Malir	4.20	(Dec. 2010 – May, 2011)
18.	Gadap	3.08	(Dec. 2010 – May, 2011)

The data on the population dynamics at stations viz. Kaemari, Sadar, N. Nazimabad, Gulberg, Lyari and Bin Qasim is presented in Fig. 2. 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 3). 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 larvae per 100 mL water).

The maximum / minimum population variation between months within a station (Table 5) 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 (larval density within parenthesis) of *A. aegypti* may be arranged as follows:

Bin Qasim (10.80 ± 1.19) > Gulberg (9.5 ± 0.99) > Lyari (6.88 ± 1.10) > N. Nazimabad (4.93 ± 0.54) > Kaemari (3.1 ± 0.51) > Sadar (2.50 ± 0.51)

The data on population dynamics of stations of Jamshed town, New Karachi, Landhi, Malir and Gadap surveyed during Dec. 2010 through May, 2011 is presented in Fig. 3). The prevalence of *Aedes* at these stations was quite low initially (2 – 25 larvae per 100 mL water) in winter month of Dec. 2010 and fluctuated differentially rising in summer substantially. Max. / Min. factor was quite high (16.7) in Landhi (Table 5). In Jamshed and Gadap towns, there was around three times increase in population in summer. In Malir town Aedes population increased four times in summer months. Two-way ANOVA (Table 4) indicated that both stations ($F = 22.128$, $p < 0.00001$) and the months of observation (seasonality; $F = 53.826$; $p < 0.00001$) influenced the population. However, there was no interaction between the two factors ($F = 0.947$; $p < 0.530$). These stations, as regards to their overall densities of the mosquito, may be arranged as given below:

New Karachi (30.7 ± 2.54) > Gadap (28.75 ± 4.83) > Jamshed (23.8 ± 3.83) > Malir (19.87 ± 5.13) > Landhi (17.5 ± 5.13)

Irrespective of the months of the population observation, the 18 towns with respect to their overall densities of *A. aegypti* larvae may be arranged as follows: Obviously, Liaquatabad town was the worst hit area and Sadar town the least affected one with *Aedes* prevalence.

Liaquatabad (476.7 ±5.78) > Shah Faisal Colony (282.3 ± 20.85) > Baldia (211..0 ± 2.7) > Orangi (69.0 ± 6.84) > Gulshan-e-Iqbal (53.5 ± 5.89) > New Karachi (30.7 ± 2.54) > Gadap (28.75 ± 4.83) > SITE (24.16 ± 3.52) > Jamshed (23.8 ± 3.83 > Korangi 22.7 ± 2.74)) > Malir (19.87 ± 5.13) > Landhi (17.5 ± 5.13) > Bin Qasim (10.80 ± 1.19) > Gulberg (9.5 ± 0.99) > Lyari (6.88 ± 1.10) > N. Nazimabad (4.93 ± 0.54) > Kaemari (3.1 ± 0.51) > Sadar (2.50 ± 0.51) >

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.

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