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Seasonal Prevalence of *Aedes aegypti* Larvae in Agra

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Abstract Mosquitogenic sites were surveyed from various water collections of Agra City for two years (2009 and 2010). *Aedes aegypti* population density in Agra City is considerably more in the collected mosquito larval samples. *Aedes aegypti* larval density was estimated for various months of an year. From April, the larval index starts increasing. The larval density is high from May to July. The maximum *Aedes aegypti* larval density was noticed during July to October during rainy season. In August, a decline in larval index is noticed. Again larval density increased considerably. Maximum larval density prevailed in the months of September (30.5) and October (24.5) in 2009 and in July (20.7), September (19.9) and October (20.0) in 2010. Prevalence of the maximum larval density of *Aedes aegypti* in Agra city had a direct impact over the incidence of Dengue cases. In the months of October in 2009 and November in 2010 the larval density again decreased. From December to February, the larval index was considerably low. Avoiding small water collections by careful water management, usage of larvivorous predators and organizing literacy campaigns can be a remedy for vector *Aedes aegypti* breeding.

Keywords *Aedes Aegypti*, Larval Density, Dengue, Agra

1. Introduction

Dengue is a silent viral disease spread by the vector mosquito *Aedes aegypti* which belong to the family Culicidae and order Diptera. *Aedes aegypti* preferably breed in artificial collections of water. Agra, the city of Taj Mahal is close to Delhi, the capital of India and is situated on the banks of river Yamuna. Incidence of dengue occur in the recent past years in this region. In Southeast Asia, a strong association between dengue vectors and rainfall has been well established[1, 2]. Breeding places in the city arise from the neglected features of the construction sites, stagnant drain water collections, tanks, coolers and receptacles of rain water collections. The population of *Aedes aegypti* fluctuates with temperature, rainfall and humidity. Dengue infections were generally encountered during or after rain, as an outcome of rise in vector population[3].

The optimal temperature for *Aedes aegypti* larva is 28°C. Above this the rate of development is high and below 18°C the growth gets prolonged[4]. Above 36°C larval development is not complete[5]. Extreme hot and dry weather may kill most of the eggs[6] and render adult vectors inactive[7] . *Aedes aegypti* population is high in rainy season and low in extreme hot weather. During rainy season the risk of virus transmission by the vector is greater.

Control measures of *Aedes aegypti* larva is necessary as Dengue fever (DF) and Dengue haemorrhagic fever (DHF) cases increase proportionally with the larval density[8]. The dengue control programmes are organised to reduce the breeding sites and to control the immature and adult *Aedes aegypti*[9]. Larvivorous fish are used to control the mosquito vectors. The fish *Poecilia reticulate* has been used to control *Culex* sp. and *Anopheles gambiae* in rivers and lakes of various countries[10, 11]. *Gambusia holbrooki* is used to control *Aedes aegypti* larvae[12]. The Prevalence of *Aedes aegypti* larvae in the city of Agra during different seasons of the year, from different water collections was sampled, studied and statistically analysed here.

2. Material & Method

Various mosquitogenic sites of Agra city i. e. Bichpuri, Dayal Bagh, Kamla Nagar, St. John's area, Agra Cantt., Sikandra, Shaheed Nagar and Tajganj area were surveyed and the mosquito breeding sites were periodically observed from January, 2009 to December, 2010. The mosquito larvae were collected from the breeding sites using a net (6 cm.-width). Incidence of *Aedes aegypti* larval collections were recorded and the larval density was calculated using the following formula:

Larval density = Number of larvae collected / Number of dips made.

Samples of larvae brought to the laboratory and reared. Larvae and adults were preserved and identified[13]. The larval index at various months of the year were recorded and analysed.

Kruskal-Wallis one way analysis of variance (ANOVA) was employed to determine the significant difference among the readings of each month of 2009 and 2010 using Sigma

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plot software along with Standard deviation (SD).

3. Results

Aedes aegypti population density in Agra City is considerably more in the collected mosquito larval samples. *Aedes aegypti* larvae are found in water collections throughout the year. The larval collections made from the city during 2009 (Figure 1, Table 1) and 2010 (Figure 2, Table 1) show the variation in the larval density from 0.67 to 30.5 from the monthly collections. From December to February, the larval index is considerably low. It ranges from 5 to 2.2 in 2009 and 3 to 1.9 in 2010. *Aedes aegypti* larval development is found very slow in this season.

Table 1. The survey from January 2009 to December 2010 of *Aedes aegypti* larvae in Agra

Year	2009		2010	
Month	Number of samples	Larval Density ± SD	Number of samples	Larval density ± SD
January	9	1 ± 1.37^{a}	6	0.67 ± 1.15^{a}
February	12	2.2 ± 0.64^{b}	9	1.9 ± 2.29^{b}
March	12	2.57 ± 0.58^{c}	9	2.2 ± 1.46^{c}
April	9	4.85 ± 1.27^{d}	9	2.9 ± 0.91^{d}
May	10	9.28 ± 5.31^{e}	8	7.15 ± 2.09^{e}
June	9	13.14 ± 3.7^{f}	7	13.92 ± 4.61^{f}
July	8	17 ± 2^{g}	6	20.7 ± 7.13^{g}
August	8	13 ± 3.16^{h}	9	12.3 ± 4.07^{h}
September	8	30.5 ± 13.60^{i}	10	19.9 ± 5.85^{i}
October	9	24.5 ± 15.42^{j}	7	20.0 ± 5.79^{j}
November	6	16.7 ± 5.77^{k}	6	10.7 ± 1.15^{k}
December	7	5 ± 1^{l}	6	3 ± 2.65^{l}

The letters show comparison among values in the same row. The same letters present the values without significant difference, i. e., $p > 0.05$.

Aedes aegypti larval index starts increasing in April to 4.9 in 2009 and 2.9 in 2010 (Figure 1 and Figure 2). The larval density is high from May to July (from 9.28 to 17 in 2009 and 7.15 to 20.7 in 2010). The larval density of *Aedes aegypti* increased considerably during July to October (from 17 to 24.5 in 2009 and 20.7 to 20 in 2010) i.e. during rainy season and in humid weather.

The maximum larval index was noticed in 2009 in the month of September (30.5) and in 2010 in July (20.7). The larval density prevailed in the months of September (30.5) and October (24.5) in 2009 and in July (20.7), September (19.9) and October (20.0) in 2010. During this time, Dengue cases were also prevalent in Agra city. The larval index remained high till November (16.7 in 2009 and 10.7 in 2010) and it again decreased considerably in December. In August a decline in larval index (13 in 2009 and 12.3 in 2010) occurred and a fluctuation (Figure 1 and Figure 2) in larval prevalence was noticed. Due to extreme summer *Aedes aegypti* larval improper development and mortality was noticed. A considerable increase in larval population was noticed again in September (30.5 – 2009 and 19.9 – 2010). From the months of October in 2009 and November in 2010 the larval density again decreased.

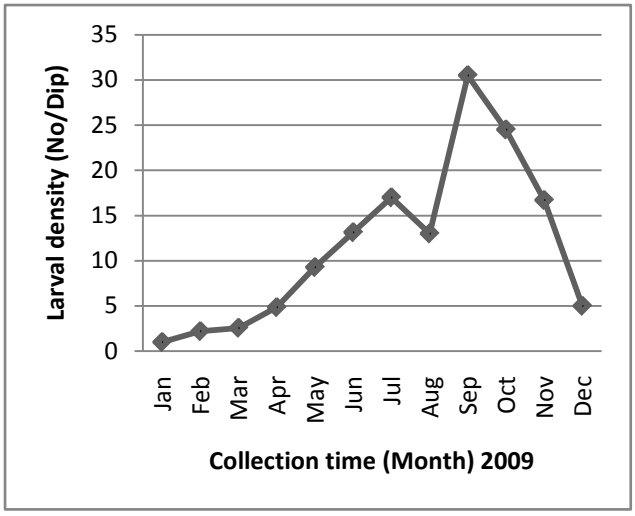

Figure 1. Larval density of *Aedes aegypti* in 2009

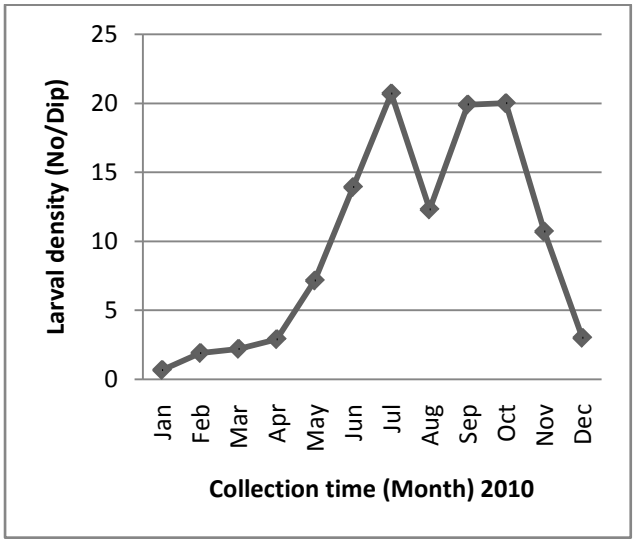

Figure 2. Larval density of *Aedes aegypti* in 2010

The Kruskal-Wallis one way analysis of variance (ANOVA) gives $0.052 \leq p \leq 0.792$, i. e., $p > 0.05$. From this observation of the value of p, it was clear that there is no significant difference between the larval densities of each month of the years 2009 and 2010.

4. Discussion

In India Dengue infections generally occur during or after rain along with the rise in the vector *Aedes aegypti* population[3]. In Agra, *Aedes aegypti* larval density is high from July (17) to October (24.5) in 2009 and from July (20.7) to October (20) in 2010. In the neighbouring city Delhi, *Aedes aegypti* larval density was high during July to October[14], whereas in Gorakhpur it was during June to

October[15]. In the neighbouring states, Rajasthan and Madhya Pradesh the larval density was also high during July to October[3].

In Vellore of the state of Tamilnadu *Aedes aegypti* larval density was high from September to December[15]. In coastal plains of Orissa, Rohilkhand and Avadh plains and Haryana the larval density is high in wet season whereas in Assam valley in dry season the larval population is high[16]. The rise in dengue incidence during the monsoon and the post-monsoon season is due to the increased larval density and in the increased number of potential breeding sites due to water loggings.

In India, all dengue/DHF outbreaks are associated with a higher container index of more than 20 *Aedes Aegypti* larvae[2]. *Aedes aegypti* larval density in Agra reach to a peak in the month of September in 2009 and in the months of July and October in 2010. In Gurgaon the maximum larval density was observed in the month of August in 1991 and in May in 1992[17]. In Delhi the maximum larval density was noticed from August and September[2], and July to September[18]. In Gorakhpur[15] the maximum larval density was observed during August, in Vellore[15] during September and in Kolkata[15] during August and November. Maximum larval density above 20 was observed in 2009 in the months of September and October and in 2010 in July, September and October. Prevalence of the maximum larval density of *Aedes aegypti* in Agra city had a direct impact over the incidence of Dengue cases.

In extremes of weather in winter and summer *Aedes aegypti* larvae die because of low and high temperature. The larval development also varies at different temperatures in different larval stages.

Aedes aegypti is sensitive to low temperature[19]. Some growth takes place at 10^0C but development is not complete. Above 14^0C growth becomes increasingly rapid with rising temperature reaching the optimum at 32^0C[20]. Whereas Christopher, 1960 described the optimal temperature for *Aedes aegypti* larva is 28^0C. In Agra, in extreme winter from November to February, the larval index is very low (from 5 to 2.2 in 2009 and 3 to 1.9 in 2010) and the larval development is also very slow. At Gorakhpur during November larval density is the lowest in November and in December it is nil due to extreme winter[15]. In high altitude areas of Assam, Arunachal Pradesh, Meghalaya and Nagaland also, during severe winter, the breeding of the mosquitoes ceases[21].

In Agra, in the month of August (Figure 1 and Figure 2) a fluctuation (reduction from peak larval density) was noticed in *Aedes aegypti* larval population due to extreme heat in the summer months (June, July) irrespective of the availability of coolers and other water collections.[14] Katyal et al., 2003 also observed that in Delhi, the container index reduced in August which is lower than July and September. Sharma et al., 2005 studied the prevalence of *Aedes aegypti* in defense area of Delhi Cantt. The data shows that the total containers positive in August is lower than July and September. High rates of adult mortality causing severe reduction of mosquito densities have frequently been associated with a rise in temperature. Above 36^0C the larval development is not complete[5]. Extreme hot and dry weather may kill most of the eggs[6] and render adult vectors inactive[7]. In *Aedes aegypti* reduction in egg production and variation in oviposition was observed with an increase in temperature[22]. In Vellore the larval density is lowest in March in 1964-1965 and in Kolkata in May the density is very low[18]. In Gurgaon in the year 1991during June, July and August, in 1992 during April the larval density was nil[17].

Because of the variation in the incidence of temperature and rainfall, fluctuation in larval density happens. In the months of October in 2009 and November in 2010 the larval density again decreases. Pandya in 1982 described that one of the possible reason for the seasonal aberration could be the fluctuating breeding habitat of *Aedes aegypti* in different types of containers e.g. dumped and moist tyres or earthen-wares used for storing water during summers[3].

Agra is a very popular tourist city, situated close to the capital city New Delhi. The prevalence of *Aedes aegypti* ultimately resulting in causing dengue is mainly due to the pressure of urbanization, improper management of the domestic and other neglected water collections and water coolers. They are the causative factors for the budding up of enormous breeding sites of *Aedes aegypti* larvae. Organizing literacy programs and making awareness among the people regarding the need of the control of vectors and vector borne diseases is the primary need in mosquito control. The larvivorous predators like Gambusia, Guppy, Dragon fly nymph and other predators also die from the water collections in the extremes of temperatures. Artificial rearing of predators and their release during larval prevalent seasons can be an alternative for *Aedes* control.

5. Conclusions

Aedes aegypti population density in Agra city is considerably more in the collected mosquito larval samples. The maximum larval index was observed in 2009 in the month of September (30.5) and in July (20.7) 2010 and the larval density prevailed high during the months of September (30.5) and October (24.5) in 2009 and in July (20.7), September (19.9) and October (20.0) in 2010 reveals the presence of high vector density. During this time, Dengue cases were also prevalent in Agra city. Due to the pressure of urbanization, improper management of the domestic and other neglected water collections occur. Construction sites in the city and excessive usage of water coolers in summer also are the sources of *Aedes aegypti* breeding. Release of larvivorous predators in the water collections and organising literacy campaigns can be an useful remedy.

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