SEASONAL FLUCTUATIONS OF DENGUE FEVER VECTOR, *AEDES AEGYPTI* (DIPTERA: CULICIDAE) IN DELHI, INDIA

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Abstract. Studies on the seasonal fluctuation of *Aedes aegypti* were undertaken in different localities of Delhi, during 2000. The *Aedes aegypti* population was found to be prevalent in all the localities in Delhi. Water coolers and tires were found to be the preferred breeding habitats of *Aedes* mosquitos in the city. *Aedes aegypti*, being hygroscopic, showed a phenomenon of annual pulsation. It tends to move to mother foci in the central areas of the city, which are humid in the dry season, and spread out during the wet season. Out of 103,778 houses surveyed, 20,513 houses and 3,547 containers were reported positive for *Aedes aegypti.* The house container, and Breteau indices were very high during the post-monsoon season. The container indicies was very high (17.7%) in the defence area in September 2000. The container index in the areas of the Municipal Corporation of Delhi (MCD) and the New Delhi Municipal Committee (NDMC) were found to be high during the same period. The house index for *Aedes aegypti* ranged from 0.1 to 7.4, 0.1 to 11.3, and 0.1 to 11.1 in the MCD, NDMC, and Defence areas, respectively.

INTRODUCTION

Dengue fever/dengue hemorrhagic fever (DHF) continues to be of major public health importance in countries of the Western Pacific and Southeast Asia. These regions are experiencing an increase in the frequency of epidemics. Since 1963, outbreaks of dengue/DHF have been recorded in almost all parts of India. In all the outbreaks, the main mosquito found to be involved in transmission was *Aedes aegypti.* The first outbreak of dengue fever in India with hemorrhagic manifestations was reported in Calcutta city. The increasing trend of dengue outbreaks accompanied by DHF is posing a problem of utmost importance to the public health of India (WHO, 1999). Dengue fever outbreaks have been reported from various parts of the country during the past 30-40 years (Yadava and Narsimham, 1992). An outbreak of DHF swept through the National Capital Territory of Delhi in 1996. There were more than 10,000 cases, with 450 deaths due to DHF recorded in various parts of Delhi (Kaul *et al,* 1998). Delhi has been endemic for dengue for the past several years. The first DHF outbreak was reported in 1988, with 33% mortality among children admitted to hospitals (Kabra *et al,* 1992). The principal vector for dengue fever, *Aedes aegypti,* is prevalent in all cities and towns in India. The Gangetic plain of North India is also infested with *Aedes aegypti* (Rao, 1967). Krishna Marthy *et al* (1965) and Katyal *et al* (1996) carried out comprehensive surveys of the *Aedes aegypti* population in Delhi. Although *Aedes aegypti* is known to be widely distributed in of Southeast Asia, and its importance as the dengue fever vector has long been recognized, information on its prevalence and the shifting trends of its breeding places is still fragmentary (Kalra *et al,* 1968). Vector surveillance is an important tool to generate entomological data needed for control strategies and to develop an early warning system (Pant and Self, 1993). A study on dengue incidence and *Aedes aegypti* prevalence was conducted in Delhi 2000.

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MATERIALS AND METHODS

Larval surveys

In the year 2000, larval surveys were carried out in all the localities of the city irrespective of the risk for dengue/DHF in each locality. Searches were made for *Aedes* breeding in different types of habitats in the areas covered by the MCD, NDMC, Railways and Delhi Can-

tonment. In the past, several outbreaks of dengue/DHF originated in hospitals and schools, wherever reservoirs of infection and population existed. Stratification of the different areas of Delhi was done according to types of *Aedes* breeding potential. Different schools and hospitals were surveyed in NCT-Delhi. The entomological indices: House Index (HI), Container Index (CI), and Breaeau Index (BI), were used for measuring the larval population.

$$\text{House Index} = \frac{\text{No. of houses positive (Larvae)}}{\text{No. of houses inspected}} \times 100$$

$$\text{Container Index} = \frac{\text{No. of containers positive}}{\text{No. of containers inspected}} \times 100$$

$$\text{Breteau Index} = \frac{\text{No. of containers positive}}{\text{No. of houses inspected}} \times 100$$

Study area

The National Capital Territory (NCT) of Delhi, The capital of the Republic of India, is situated on the banks of the river Yamuna at approximately. 77.15 E and 26.15 N. It occupies 1,485 km^2, of which 900 km^2 is classified as urban and the rest as rural. The city, being a center of economic opportunity, attracting migrants from near and far, has had phenomenal population growth. The population of Delhi is now estimated to be above 10 million. It grew at the rates of 64.2%, 54.6%, and 57.1% in the decades, 1951-1961, 1961-1971, and 1971-1981, respectively. In Delhi, three agencies, namely MCD, NDMC, and Defence are responsible for dengue control activities inside their own areas, of which the Municipal Corporation of Delhi, with its 12 zones, covers the largest part.

RESULTS

During 2000, dengue cases were reported from different zones of Delhi (Table 1). The seasonal occurrence surveys showed that the post-monsoon period was the most affected period (96.75%), followed by the monsoon period (2.16%) and the pre-monsoon period (1.08%) (Table 2)

Out of 185 cases, 133 (71.8%) (105 males and 28 females) were in the 15 years+ age group (Table 3).

Table 1
Dengue cases and deaths in Delhi.

Year	Cases	Deaths
1996	10,252	423
1997	273	1
1998	332	5
1999	168	2
2000	180	2

Table 2
Seasonal occurrence of dengue cases in 2000.

Period	No. of positive samples	%
Pre-monsoon	2	1.08
Monsoon	4	2.16
Post-monsoon	179	96.75

Table 3
Sex distribution of dengue cases in 2000.

Age group	Male	Female	Frequency (%)
1 to <5	3	3	3.2
5 to <10	5	16	11.3
10- <15	13	12	13.5
15+	105	28	71.8

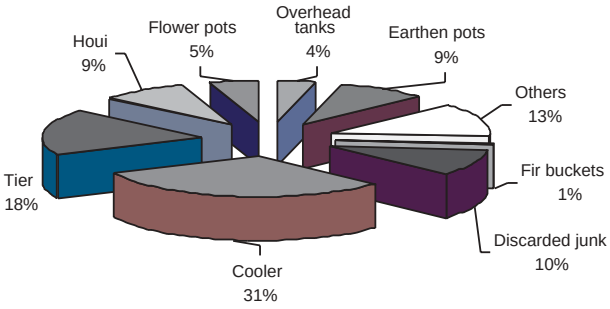

Fig 1–Key breeding sites for *Aedes aegypti* in NCT Delhi-2000.

The different breeding habitats and percentages are shown in Fig 1. The breeding sites of *Aedes aegypti* larvae differ from one area to another. *Aedes aegypti* larvae were mainly found in coolers (31%), tires (18%), and discarded junk (10%).

Table 4
Data for *Aedes aegypti* in NDMC.

Month	THC	THP	TCC	TCP	HI	CI	BI
January	1,252	2	1,497	2	0.1	0.1	0.1
February	1,172	2	1,369	3	0.1	0.2	0.2
March	921	-	1,087	-	-	-	-
April	618	4	760	5	0.6	0.6	0.8
May	819	10	1,063	15	1.2	1.4	1.8
June	1,026	35	1,381	42	3.4	3.0	4.0
July	811	51	1,305	91	6.2	6.9	11.2
August	964	47	1,339	75	4.8	5.6	7.7
September	860	97	1,121	117	11.3	10.4	13.6
October	1,030	28	1,336	33	2.7	2.4	2.8
November	1,473	4	1,792	5	0.2	0.2	0.2
December	1,041	3	1,265	3	0.2	0.2	0.2
Total	11,987	283	16,812	391	2.3	2.3	3.2

THC = Total houses checked; THP = Total houses positive; TCC = Total containers checked; TCP = Total containers positive; HI = House Index; CI = Container Index

Table 5
Data for *Aedes aegypti* in Defence (Delhi Cantt).

Month	THC	THP	TCC	TCP	HI	CI	BI
January	782	1	1,254	2	0.1	0.0	0.1
February	850	3	1,368	3	0.3	0.2	0.3
March	709	2	1,074	3	0.2	0.2	0.4
April	772	2	1,201	2	0.2	0.1	0.2
May	914	4	1,289	5	0.4	0.3	0.4
June	953	9	1,415	19	0.9	1.3	1.9
July	904	72	1,610	180	7.9	11.1	19.9
August	717	28	1,071	36	3.9	3.3	5.0
September	801	89	1,359	242	11.1	17.7	30.2
October	719	16	998	18	2.2	1.8	2.5
November	919	9	1,389	9	0.9	0.6	0.9
December	734	3	1,134	3	0.4	0.2	0.4
Total				523	2.4	3.4	5.3

THC = Total houses checked; THP = Total houses positive; TCC = Total containers checked; TCP = Total containers positive; HI = House Index; CI = Container Index

The data for *Aedes aegypti* in the different zones is shown in Tables 4, 5 and 6. Almost all the hospitals surveyed had the presence of *Aedes aegypti* (Table 7). Bara Hindu Rao hospital had a very high container index (11.6%). The house index was below the critical level of 10% in 5 hospitals out of the 7 surveyed. Two hospitals, Bara Hindu Rao and Mool Chand, had a house index of 10%. Given the number of dengue cases reported for each hospital, vector control measures should be strengthened in all the hospitals to interrupt disease transmission.

During the pre-monsoon season, overhead tanks and cement tanks served as breeding foci for *Aedes aegypti*. With the onset of the monsoon season, the breeding of *Aedes aegypti* spreads to other habitats, such as tires and coolers. Tires provide prolific *Aedes* breeding habitats during the monsoon and post-monsoon seasons.

Table 6
Data for *Aedes aegypti* in MCD 2000.

Month	THC	THP	TCC	TCP	HI	CI	BI
January	7,207	9	11,221	9	0.1	0.0	0.1
February	7,536	11	12,378	12	0.1	0.0	0.1
March	6,573	31	10,748	31	0.4	0.2	0.4
April	5,433	33	9,110	33	0.6	0.3	0.6
May	7,670	43	12,812	45	0.5	0.3	0.5
June	7,432	148	12,430	240	1.9	1.9	3.2
July	6,975	437	12,357	644	6.2	5.2	9.1
August	7,327	546	13,274	727	7.4	5.4	9.9
September	7,290	453	12,672	580	6.2	4.5	7.9
October	6,202	180	10,260	201	2.9	1.9	3.2
November	6,783	84	11,114	93	1.2	0.8	1.3
December	5,589	17	9,057	17	0.3	0.1	0.3
Total	82,017	1,992	137,433	2,633	2.4	1.9	3.2

THC = Total houses checked; THP = Total houses positive; TCC = Total containers checked; TCP = Total containers positive; HI = House Index; CI = Container Index

Table 7
Dengue cases and larval indices in different hospitals in NCT-Delhi.

Date	Locality	THC	THP	TCC	TCP	HI	CI	BI	Dengue cases
08.06.00	RML Hospital	28	2	38	2	7.1	5.5	7.1	12
09.06.00	Sucheta Kirpalani Hospital	45	2	75	2	4.4	2.6	4.4	06
20.07.00	GTB Hospital	30	2	40	2	6.6	5.0	6.6	17
19.07.00	LNJP Hospital	25	2	42	4	8.0	9.5	8.0	15
03.08.00	Bara Hindu Rao Hospital	20	2	50	10	10.0	20.0	50.0	21
19.07.00	LNJP Hospital	25	2	42	4	8.0	9.5	8.0	15
17.07.00	Mool Chand Kharati Lal Hospital	40	4	85	4	10.0	4.7	10.0	01

THC = Total houses checked; THP = Total houses positive; TCC = Total containers checked; TCP = Total containers positive; HI = House Index; CI = Container Index

DISCUSSION

In our study, the majority of cases (71.8%) were in the 15-year age group while Nguyen *et al* (1999) reported that 90% of the cases were under 5 years of age in Vietnam. Amim *et al* (1999) reported the maximum number of dengue cases were in the 5-10-year age group in Bangladesh.

The entomological indices HI, CI, and BI for *Aedes aegypti* increase from July to October, and thereafter declined. CI, BI, and HI remained very high during the months of August and September. The rise in breeding indices during the post-monsoon season was due to the increased number of potential breeding sites due to the rains in the preceding months. Dewan Chand *et al* (1961), Krishna Marthy *et al* (1965) and Katyal *et al* (1996) also reported higher densities of *Aedes aegypti* in the month of October, corresponding to the monsoons months in Delhi. In Southeast Asia, a strong association between dengue vectors and rainfall has been well established (Gould *et al* 1970). Apart from *Aedes aegypti, Ae. albopictus* and *Ae. vittatus* were also found in NCT Delhi. The most important problem in Delhi, so far as *Aedes* surveillance is concerned, is attributed to high-rise

buildings, including those owned by the Central and State Governments. Room collers in the upper floors are inaccessible and thereby constitute as an important impediment in *Aedes* surveillance activities. Hospitals and schools, being highly vulnerable areas, should be monitored regularly to check for vectors to reduce the threat of DHF. This study showed that coolers and tires constituted 48% of *Aedes* larval breeding sites. These containers should be surveyed weekly, particularly in the post-monsoon season followed by anti-larval measures. In NDNC, Sanjay camp, adjoining the Bhutan embassy, has high breeding potential for *Aedes aegypti* due to storage containers. Health education in these situations is the only answer for the elimination of *Aedes* breeding sites.

In India, all dengue/DHF outbreaks are associated with *Aedes aegypti* having a container index of more than 20. Pant and Self (1993) cited several references showing the relationship of the 'larval house index' with outbreaks of dengue. In only one situation, Singapore, was the house index only 9% during an outbreak of dengue/DHF in 1996. An *Aedes* control program has been initiated in NCT Delhi through anti-larval methods.

The community was advised to de-water containers at least once a week. Wherever *Aedes* breeding was detected the residents was advised to apply a spoon of kerosene or diesel to such breeding sites. In the coolers, *Aedes* breeding was controlled by weekly application of Abate 50% or by observing one 'dry day' (drying all coolers on a particular day) per week. In the Defence area, one 'dry day' per week was strictly observed. Health education measures have been strengthened by holding periodical meetings with the Resident Welfare and Market Associations. Dengue has been declared a dangerous disease by a Delhi Municipal Act, which enjoins all medical practitioners and other persons to give information to the Municipal Health Officer and National Anti-malaria program, which is the nodal agency for the monitoring of dengue at the national level. The measure states that no person shall keep or maintain within his premises any water collection sites or flowing water in which mosquitos are likely to breed.

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