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Breeding habitats of *Aedes aegypti* (vector of Chikungunya, dengue, Yellow fever and Zika) in Delhi and National Capital Region

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Abstract
The breeding habitat of *Aedes aegypti* is associated with inadequate water supply, unplanned urbanization, water storage practices and poor environmental management. Dengue is an emerging disease which has spread in urban and rural areas of India. It has been assessed that more than 390 million dengue infections occur annually, out of which India contributes one third of load of dengue infections. The larval indices varied from 5.6 to 37.2 in various schools and colleges of Delhi during 2016. While it varied from 5.9 to 67.9 in hospitals during 2017. The criteria for selection of study sites was based on the maximum number of dengue cases reported in 2015 outbreak in Delhi and National Capital Region (NCR).

Entomological survey was carried out in different educational institutions and hospitals of Delhi and NCR throughout the year from 2016 to 2017 in order to study the vector prevalence in Delhi-NCR and to identify high risk areas prone to dengue outbreak. House index (HI), container index (CI) and Breteau index (BI) are *Aedes* larval indices used to predict the degrees of larval prevalence. Plastic containers were the prominent habitats for larval breeding in Rohini and Najafgarh (Delhi) and Faridabad (NCR). Main breeding sites were coolers, flower vessels, earthen pot and plastic/tin containers. Desert coolers were the prominent habitats for larval breeding in Shahadara (Delhi) and Ghaziabad (NCR).

Keywords: *Aedes aegypti*, House index (HI), container index (CI) and Breteau index (BI), National Capital Region (NCR)

Introduction
Delhi NCR conveys high receptivity and weakness to *Ae. aegypti* as there is part of development of human populace from the circumscribing satellite towns of Noida, Ghaziabad (Uttar Pradesh) and Faridabad (Haryana). In addition, there is high worldwide traffic additionally which require an efficient and composed exertion to control the frequency of dengue in Delhi and NCR. Delhi have seen significant flare-up of dengue in 1996 which caused 425 passing with in excess of 10,000 cases. Preceding this flare-up, minor episodes of dengue happened in Delhi during 1967, 1968 and 1969. Dengue flare-ups were accounted for from Delhi in 1970, 1982, 1996, 2003, 2006, 2010, 2013 and 2015 [1-3]. In 2015, the city saw 15867 cases the most exceedingly awful emergencies in 20 years with the disease asserting 60 lives.

The breeding habitat of *Aedes aegypti* is associated with inadequate water supply, unplanned urbanization, water storage practices and poor environmental management WHO (2003) [4]. Dengue is an emerging disease which has spread in urban and rural areas of India [5]. It has been assessed that more than 390 million dengue infections occur annually, out of which India contributes one third of load of dengue infections.

Domestic containers play a crucial role in *Aedes* breeding especially during non-transmission season. Therefore, community should take initiative to clean their own breeding sources otherwise those will act as key containers in transmission season [6]. Such water storage practices promote *Aedes* mosquito breeding throughout the year [7, 8]. Such areas with persistent of *Aedes* breeding can act as foci for the next dengue outbreak. Entomological surveillance and vector control measures are essential to prevent devastating disease outbreaks.

Material method

The study sites were selected from both rural and urban areas based on the maximum number of dengue cases reported in 2015 outbreak and construction projects carried out by builders for multistory buildings in Delhi and NCR. Entomological survey was carried out in three localities of Delhi and 6 localities of NCR throughout the year from 2016 to 2017 with a view to study the prevalence of vector in Delhi-NCR with a view to identify high risk areas prone to dengue outbreak. House index (HI), container index (CI) and Breteau index (BI) are *Aedes* larval indices used to predict the degrees of larval prevalence. The information on larval review was investigated and determined as far as various parameters like Container Index (CI), House Index (HI) and Breteau Index (BI) according to WHO methodology (WHO-SEARO, 2011).

The adult collection comprises resting collection of mosquitoes inside the human dwellings. Resting assortment requires orderly scanning of these locales for grown-up mosquitoes with the help of electric lamp.

Results

Prevalence of *Aedes aegypti* in different Educational Institutions of Delhi and hospitals of Delhi and NCR during 2016 & 2017 The larval surveys were carried out for Aedes breeding in different educational institutions during 2016. It was observed that Frank Anthony Public School had highest Container Index (37.2) followed by Sarvodaya Kanya Vidhyalaya Ghitorni (26.1). Table 1. Searches were also made for Aedes breeding in different hospitals in Delhi and NCR during 2017.The highest Container Index was reported in Narender Mohan Hospital Mohan Nagar Ghaziabad (67.9) followed by Dr. Bheem Rao Ambedkar Hospital Sector 30 (48.8) Noida and Ch. Bhram Prakash Ayurvedic Sansthan, Khera Dabar (21.1), New Delhi. Table 2.

Table 1: Prevalence of *Aedes aegypti* in different Educational Institutions of Delhi during 2016

Educational Institutions	Total Container Checked	Total Container Positive	Container Index
The Frank Anthony Public School Lajpat Nagar	43	16	37.2
Sarvodaya Kanya Vidhyalaya, Ghitorni	46	12	26.1
Nehru International School Sect. 11, Noida	32	4	12.5
Govt. Boys Sr. Se. School, Gokulpur	36	4	11.11
Rajkiya SKV, Khajoori Khas	22	2	9.1
Sarvodaya Kanya Vidhyalaya No.2, Mandawali	24	2	8.3
NDMC Primary School, Kidwai nagar East	38	3	7.9
Deptt. Of Training Education, Manimaya Ram Marg Pitampura	41	3	7.3
MCD Nursery AD Block, Shalimar Bagh	43	3	7.0
Shyamlal College, Shahadara	64	4	6.3
Bal Bharti School, Old Rajinder Nagar	18	1	5.6
MCD Primary School, Aaya Nagar	18	1	5.6

Table 2: Prevalence of *Aedes aegypti* in different hospitals of Delhi and NCR during 2017

Hospital Location	Total Container Checked	Total Container Positive	Container Index
Narender Mohan Hospital Mohan Nagar, Ghaziabad (NCR)	53	36	67.9
Dr. Bheem Rao Ambedkar Hospital Sect. 30, Noida (NCR)	82	40	48.8
Ch. Brahm Prakash Ayurvedic Sansthan, Khera Dabar, Delhi	57	12	21.1
Lady Harding Hospital, Delhi	96	17	17.7
MMG Hospital, Ghaziabad (NCR)	64	11	17.2
Shahib Singh Verma Polyclinic, Bawana, Delhi	15	2	13.3
LNJP Hospital, Delhi	51	6	11.8
Mother Teresa Hospital, Tahirpur, Delhi	36	4	11.6
Babu Jagjivan Ram Hospital, Jahangirpuri, Delhi	52	6	11.5
B K Hospital, Faridabad (NCR)	62	7	11.3
NIH&FW Munirka, Delhi	54	6	11.1
Delhi ENT Multi specialty Hospital and Research, Jasola, Delhi	10	1	10.0
RML Hospital, Delhi ,	115	11	9.6
AIIMS, Delhi	118	7	5.9

All the three larval indices HI, CI and BI were in the range of 9.5-17.5, 10-14.6 & 14.2-17.5 respectively during the year 2016 in Noida. The maximum HI, CI and BI were recorded in G & E Block Sect-22, while HI, CI and BI were minimum in Village Harola. The total prevalence indices of Noida were 14.8, 13.2 and 16.5 respectively. Table 3.

Table 3: Prevalence Indices of *Aedes aegypti* in Noida (NCR) during 2016

Locality	Total House Checked	Total House Positive	Total Container Checked	Total Container Positive	House Index	Container Index	Breteau Index
G & E Block Sect-22	80	14	96	14	17.5	14.6	17.5
Village Harola, Noida	21	2	30	3	9.5	10.0	14.2
Village Bhangel, Phase-II Noida	20	2	25	3	10.0	12.0	15.0
Total Prevalence Indices	121	18	151	20	14.8	13.2	16.5

All the three larval indices HI, CI and BI were in the range of 14.3-16.9, 10-62.5 & 14.2-23 respectively during the year 2017 in Noida. The maximum House, Container and Breteau indices were recorded in Nithari, while HI, CI and BI were minimum in Sector 27. The total prevalence indices of Noida Total HI, CI and BI of Noida were 16.8, 26.6 and 29.4 respectively. Table 4.

Table 4: Prevalence Indices of *Aedes aegypti* in Noida (NCR) during 2017

Locality	Total House Checked	Total House Positive	Total Container Checked	Total Container Positive	House Index	Container Index	Breteau Index
Sector 27, Noida	23	4	40	4	14.3	10	14.2
Village Nithari, Noida	65	11	24	15	16.9	62.5	23.0
Village Baraula, Noida	31	5	58	16	16.1	27.5	16.3
Total Prevalence Indices	119	20	122	35	16.8	26.6	29.4

All the three larval indices HI, CI and BI were in the range of 0-33.3, 20.8-46.31 & 0-41.7 respectively during the year 2016 in Faridabad. The maximum House and Breteau indices were recorded in Sihi Village and Container Index is maximum in SRS construction site. The HI, CI and BI were minimum in SRS construction site and Container index is minimum in Sainik colony. Total House Index, container index and Breteau index of Faridabad were 27.2, 20.8 and 116.3 respectively. Table 5.

Table 5: Prevalence Indices of *Aedes aegypti* in Faridabad (NCR) during 2016

Locality	Total House Checked	Total House Positive	Total Container Checked	Total Container Positive	House Index	Container Index	Breteau Index
Sihi Village Faridabad	36	12	42	15	33.3	35.7	41.7
SRS construction site (Gr. Faridabad)	0	0	95	44	0.0	46.31	0.0
Sainik Colony, Faridabad	19	3	24	5	15.8	20.8	26.3
Total Prevalence Indices	55	15	161	64	27.2	20.8	116.3

All the three larval indices HI, CI and BI were in the range of 15-26.6, 12.5-28.5 & 15-46.6 during the year 2017 in Faridabad. The maximum House and Breteau indices were recorded in Canal colony and Container Index is maximum in Sainik colony. The House, Container and Breteau indices were minimum in Rahul colony. Total House Index, container index and Breteau index of Faridabad were 18, 19.6 and 26 respectively. Table 6.

Table 6: Prevalence Indices of *Aedes aegypti* in Faridabad (NCR) during 2017

Locality	Total House Checked	Total House Positive	Total Container Checked	Total Container Positive	House Index	Container Index	Breteau Index
Rahul Colony, Faridabad	60	9	72	9	15.0	12.5	15.0
Canal colony Sector - 16 Faridabad	15	4	25	7	26.6	28.0	46.6
Sainik colony, Faridabad	25	5	35	10	20.0	28.5	40.0
Total Prevalence Indices	100	18	132	26	18	19.6	26

All the three larval indices HI, CI and BI were in the range of 9-79, 8.3-61.4 & 15.6-87.1 during the year 2016 in Ghaziabad. The maximum House, Container and Breteau indices were recorded in Railway Colony Punjab Line. The House and Container Indices recorded minimum in Raj Nagar and Breteau index was minimum in Sect. 12, Pratap Vihar. Total House Index, container index and Breteau index of Ghaziabad were 38.5, 31.7 and 45.9 respectively. Table 7.

Table 7: Prevalence Indices of *Aedes aegypti* in Ghaziabad (NCR) during 2016

Locality	Total House Checked	Total House Positive	Total Container Checked	Total Container Positive	House Index	Container Index	Breteau Index
Railway Colony Punjab Line Ghaziabad	62	49	88	54	79.0	61.4	87.1
Sect. 12, Pratap Vihar, Ghaziabad	64	6	78	10	9.4	12.8	15.6
Raj Nagar, Ghaziabad	22	2	48	4	9.0	8.3	18.1
Total Prevalence Indices	148	57	214	68	38.5	31.7	45.9

All the three larval indices HI, CI and BI were in the range of 11.1-36.6, 18.4-30.2 & 35.5-68 during the year 2017 in Ghaziabad. The maximum House and Container indices were recorded in Kavi Nagar While maximum Breteau index was recorded in Lohia Nagar. The House and Breteau Indices recorded minimum in Pratap Vihar and Container index was minimum in Lohia Nagar. Total House Index, container index and Breteau index of Ghaziabad were 20, 21.3 and 46 respectively. Table 8.

Table 8: Prevalence Indices of *Aedes aegypti* in Ghaziabad (NCR) during 2017

Locality	Total House Checked	Total House Positive	Total Container Checked	Total Container Positive	House Index	Container Index	Breteau Index
Kavi Nagar, Ghaziabad	30	11	43	13	36.6	30.2	43.3
Pratap Vihar, Colony Ghaziabad	45	5	80	16	11.1	20.0	35.5
Lohia Nagar Huts, Ghaziabad	25	4	92	17	16.0	18.4	68.0
Total Prevalence Indices	100	20	215	46	20	21.3	46

Proportionate increase in containers in monsoon season in NCR during 2016 & 2017. The proportionate increase in containers in monsoon season was maximum in Noida (1:14) followed by Ghaziabad (1:7.7) and Faridabad (1:2) during 2016. Table 9. The proportionate increase in containers in monsoon season was maximum in Ghaziabad (1:7.2) followed by Noida (1:5.9) and Faridabad (1:2.4). Table 10.

Table 9: Diversity of breeding habitats in NCR in Pre monsoon and monsoon season 2016

Locality	Season	Desert Cooler	Cement Tank	Plastic Container	Earthen Pot	Iron Container	Tyre	Flower Pot	Over Head Tank	Total	Proportionate Increase in containers in monsoon season
Noida	PM	1	0	2	0	1	0	0	0	4	1:14
	M	12	4	16	2	10	2	6	4	56	
Ghaziabad	PM	3	0	3	1	1	0	1	1	10	1:7.7
	M	14	6	15	3	18	3	8	10	77	
Faridabad	PM	12	4	15	1	5	1	6	6	50	1:2
	M	22	6	24	3	20	6	8	11	100	

Table 10: Diversity of breeding habitats in NCR in Pre monsoon and monsoon season 2017

Locality	Season	Desert Cooler	Cement Tank	Plastic Container	Earthen Pot	Iron Container	Tyre	Flower Pot	Over Head Tank	Total Containers	Proportionate Increase in containers in monsoon season
Noida	PM	3	1	5	1	4	1	2	2	19	1:5.9
	M	22	6	28	4	18	7	18	10	113	
Ghaziabad	PM	7	2	5	1	2	0	2	2	23	1:7.2
	M	36	12	30	6	27	5	24	25	165	
Faridabad	PM	2	0	1	0	2	0	2	2	9	1:2.4
	M	6	2	3	2	2	0	4	4	22	

Discussion

During entomological surveillance it was observed that *Ae. aegypti* colonized in variety of breeding habitats. In the present study it was found that Cement tanks, Desert coolers, Plastic Containers, Iron Containers, Tyres, Flower pots, Overhead tanks, earthen pots etc. are the most common larval habitats for *Ae. aegypti*. Plastic containers are the major habitats for Aedes breeding in contrast with the studies carried out in Dehradun, Uttrakhand [9] in which higher income groups had coolers and tyres as major breeding habitats. The highest positivity of *Aedes* breeding was recorded in houses or outdoor in cemented tank left in open spaces, followed by Mud pots for drinking of birds, domestic desert coolers, fountains, flower pots, Junk materials and discarded tyres during Zika outbreak in 2018. *Ae. aegypti* breeding was detected in all the localities, where Zika cases were recorded [10].

Overhead tanks, Flower pots and earthen pots for birds are the only containers that showed *Ae. aegypti* breeding throughout the year. These containers are important risk factors by virtue of its location, water storage capacity and vector breeding potential. In which surveying should be carried out during non-transmission season for management of dengue. *Ae. aegypti* breeds in water stored containers that are being used regularly. The residents store water in different containers because of irregular water supply and such practices of residents cause high vector breeding [11].

The vector breeding in various schools and colleges of Delhi showed that the container index varied from 5.6 to 37.2 during 2016. While it varied from 5.9 to 67.9 in hospitals during 2017 which is consistent with the previous studies in Delhi. *Ae. aegypti* was prevalent in the domestic and peri domestic habitats as reported earlier also in Delhi [12].

Plastic containers were the prominent habitats of Aedes breeding in NCR, consistent with other previous studies [13]. Main breeding sites were coolers, flower vessels, earthen pot and plastic/tin containers in Ludhiana, Punjab [14]. Desert coolers were also the prominent habitats for Aedes breeding in NCR which is consistent with the previous studies [15]. Iron Container, OHT and Flower pot were the main breeding habitats of dengue vector in NCR which is consistent with previous studies in Venezuela and Jamaica [16, 17].

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