International Journal of Mosquito Research

ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2018; 5(1): 101-105

Received: 07-11-2017
Accepted: 08-12-2017

A Daniel Reegan
National Vector Borne Disease Control Programme, ROH&FW, F-wing, Kendriya Sadan, Koramangala, Bengaluru, India

K Ravi Kumar
National Vector Borne Disease Control Programme, ROH&FW, F-wing, Kendriya Sadan, Koramangala, Bengaluru, India

L Devanand
National Vector Borne Disease Control Programme, ROH&FW, F-wing, Kendriya Sadan, Koramangala, Bengaluru, India

Correspondence
Dr. A Daniel Reegan
National Vector Borne Disease Control Programme, ROH&FW, F-wing, Kendriya Sadan, Koramangala, Bengaluru, India

Prevalence of dengue vectors in Bengaluru city, India: An entomological analysis

A Daniel Reegan, K Ravi Kumar and L Devanand

Abstract
Dengue is one of the major mosquito-borne diseases in India, posing a threat to human health. The mosquito *Aedes* (*Stegomyia*) *aegypti* (Linn.) and *Aedes* (*Stegomyia*) *albopictus* (Skuse) (Diptera: Culicidae), are serving as the primary and secondary vector of dengue virus, respectively. In this study, entomological survey was carried out in indoors and outdoors to record the actual breeding sites and distribution level of dengue vectors in 20 localities of Bengaluru city. A total of 4746 containers with water from 1520 houses were surveyed during the study period. *Ae. aegypti* was found in every location sampled, showing higher infestation rates in all the surveyed areas. Further, *Ae. albopictus* is recorded for the first time from South zone (wards 120 and 121) and Mahadevapura zone (ward-82) of Bengaluru city. The most frequently encountered breeding sites were unused grinding stones, flower pots, drums, barrels, rubber tyres and cement tanks etc.

Keywords: Entomological analysis, dengue vectors, *Aedes aegypti*, *Aedes albopictus*

1. Introduction
Dengue fever (DF) is an important mosquito-borne viral infectious disease, mostly distributed in tropical and subtropical regions of the world. DF has become an extremely significant public health problem threatening many lives [1, 2]. It is reported that 50 – 200 million clinical cases occur annually in over 125 countries in the world [3] and 50% of world's people are at risk of dengue fever [4-6].
Aedes aegypti L. and *Aedes albopictus* are day biting mosquitoes and both species are adapted to breed in domestic and peri-domestic areas. The major breeding of these two vector mosquitoes reported to be man-made containers [7]. The immature breeding of these two species is highly influenced by rapid urbanization, abiotic conditions and climate change [8]. Furthermore, stable coexistence of *Ae. aegypti* with *Ae. albopictus* in an area may lead to an expansion of both species and result in more dengue transmission.
Earlier, some investigators have surveyed the density of dengue vectors in Bengaluru city and reported the presence of *Ae. aegypti* [9, 10]. However, the actual geographical distribution and status of mixed breeding are not reported in Bengaluru city. The rise of dengue cases over the year in Bengaluru city urged us to conduct a detailed entomological survey to study the current status and prevalence of above said two dengue vectors in indoor and outdoor areas of Bengaluru city.

2. Materials and Methods
2.1 Study area
Bengaluru, the capital of Karnataka is a metropolitan city that lies in the southeast of the Indian state of Karnataka. The average elevation of the city is 900 meter (2,953 feet). The latitude and longitude of Bengaluru is 12.97°N and 77.59°E, respectively. The actual climate of Bengaluru is a tropical savanna climate with distinct rainy and summer seasons. Bengaluru is the fastest growing Indian metropolis with a population of 9. 59 million (2011 census) living in an area of 2190 square kilometers. A total of 17 ward areas were randomly selected for the present study.

2.2 *Aedes* immature surveys
Entomological surveys were conducted between May 2017 and November 2017 in 20 locations in Bengaluru city. Both indoor and outdoor larval surveys were carried out in selected wards of Bengaluru by using single larval technique [11].

The collected larvae and pupae were transported to the laboratory on the same day.

2.3 Entomological indices

Entomological indices, namely, House index (HI), Container index (CI), and Breteau index (BI) were calculated from the field data after the survey using the following formulae.

$$\text{House index (HI)} = \frac{\text{Number of houses positive with } \textit{Aedes} \text{ larvae or pupae}}{\text{Total number of houses searched}} \times 100$$

$$\text{Container index (CI)} = \frac{\text{Number of wet containers found positive with } \textit{Aedes} \text{ larvae or pupae}}{\text{Total number of wet containers searched}} \times 100$$

$$\text{Breteau index (BI)} = \frac{\text{Number of wet containers found positive}}{\text{Total number of houses searched}} \times 100$$

2.4 Mosquito species identification

The collected larvae and pupae were reared at the laboratory, then identified to species level and counted. The larvae were fed with grinded powder of dog biscuits and yeast (60:40 ratio). The emerged adults were sacrificed without giving any food and they were identified to species with the morphological characters as reported in the literature [12].

2.5 Statistical analysis

The statistical analysis was carried out using excel spreadsheet.

3. Results

3.1 *Aedes* indices

In the present study, the calculated indices were high in the surveyed areas of Bengaluru (Table 1). Among the 20 places surveyed, ward-96 showed highest Breteau index of 78.43. Followed by, ward-120 recorded Breteau index of 62.74 and ward-2 recorded Breteau index of 61.33. The highest house index of 52.94 was recorded in the ward-120 of Bengaluru. The highest container index of 24.08 was recorded in the ward-2 of Bengaluru. The highest pupal index of 32.0 was recorded in the ward-117 of Bengaluru (Table 1).

Table 1: Detail on *Aedes* immature collection and their indices

S. No	Surveyed District	Area/ Ward No.	Month and year of collection	Number of larvae / pupae collected	No. of houses found positive / searched	House Index (HI)	No. of container found positive / searched	Container Index (CI)	Pupal Index (PI)	Breteau Index (BI)
1.	Bengaluru	1	07.07.17	41/08	13/75	17.33	23/152	15.13	10.66	30.66
2.		2	18-07-17	54/07	26/75	34.66	46/191	24.08	9.33	61.33
3.		8	25.07.17	82/07	16/78	20.51	18/136	13.25	8.97	23.07
4.		66	27.09.17	59/15	16/75	21.33	20/389	5.14	20.0	26.66
5.		117	10.10.17	73/24	26/75	34.66	40/190	21.05	32.0	53.33
6.		116	23.10.17	68/18	27/79	34.17	39/281	13.87	22.78	49.36
7.		120	08.08.17	106/11	54/102	52.94	64/373	17.15	10.78	62.74
8.		109	10.08.17	24/01	5/65	7.69	5/131	3.81	1.53	7.69
9.		122	01.08.17	36/03	13/89	14.60	16/294	5.44	3.37	17.97
10.		121	03.08.17	39/15	25/80	31.25	37/187	19.78	18.75	46.25
11.		123	13.09.17	73/09	20/75	26.66	26/268	9.70	12.0	34.66
12.		96	19.06.17	42/05	19/51	37.25	40/192	20.83	9.80	78.43
13.		95	20.07.17	18/03	08/57	14.03	13/114	11.40	5.26	22.80
14.		45	14.06.17	69/05	24/61	39.34	25/164	15.24	8.19	40.98
15.		17	14.06.17	53/12	17/67	25.37	19/162	11.72	17.91	28.35
16.		134	17.10.17	59/18	21/91	23.07	27/209	12.91	30.76	29.67
17.		132	03.11.17	15/18	7/82	8.53	7/301	2.32	21.95	8.53
18.		82	08.11.17	27/2	14/78	17.94	22/240	9.16	2.56	28.20
19.		57	10.11.17	34/7	19/75	25.33	23/405	5.67	9.33	30.66
20.		58	21.11.17	24/10	23/90	25.55	31/367	8.44	11.11	34.44

3.2 Proportion of immature collection in indoor and outdoor

Table 2 shows the total number of larvae and pupae collected from indoor and outdoor areas. A total of 823 *Ae. aegypti* and 367 *Ae. albopictus* immature were recorded from the field survey. All the immature collected from indoors (no = 185) were found to be *Ae. aegypti*. In outdoor areas, 638 *Ae. aegypti* and 367 *Ae. albopictus* immature were recorded. A non-vector *Ae. vittatus* (no = 4) was recorded only in outdoor areas.

3.3 Proportion of shared habitats in indoor and outdoor

Table 2 shows the percentage of habitats shared between *Ae. aegypti* and *Ae. albopictus* collected from indoor and outdoor containers. The habitat sharing was recorded only from outdoor containers (9.6%). The results clearly showed that 15.5% of the total *Ae. aegypti* was shared with *Ae. albopictus* in outdoor containers. Similarly, a total of 23.6% of the total *Ae. albopictus* was shared with *Ae. aegypti* in outdoor containers. Further, a non-vector *Ae. vittatus* (0.4%) was also recorded to breed with *Ae. aegypti* from outdoor habitat (Table 2).

Table 2: Shared habitats (*Ae. aegypti–Ae. albopictus*) in indoor and outdoor areas

Habitat	Indoor		Outdoor	
	Total no. of larvae and pupae collected	%	Total no. of larvae and pupae collected	%
Ae. aegypti	185	100	565	56.0
Ae. albopictus	0	0	336	33.3
Both *Aedes* species shared	0	0	104 (*Ae. aegypti*-73; *Ae. albopictus*-31)	10.3
Ae. vittatus	0	0	4	0.4
Total	185		1009	
% of *Ae. aegypti* shared habitats	0/185	0	104/669	15.5
% of *Ae. albopictus* shared habitats	0/0	0	104/440	23.6

3.4 Major breeding habitats

In the present study, a total of 4746 wet containers were surveyed. Among them, 545 containers were found to be positive for *Aedes* breeding (table 3 and 4). The highest number of water holding container surveyed was uncovered drums and barrels (17.30%) and followed by flower pots (16.92%). The unused grinding stones accounted for 10.62% (Table 3). All the other type containers surveyed were accounted less (Table 3).

3.5 Types of shared breeding habitats

The infestation and breeding preference ratio of *Ae. aegypti* and *Ae. albopictus* are given in table 3 and 4. In the present study *Ae. albopictus* was recorded from Bengaluru South (ward-120 and 121) and Mahadevapura (ward-82) zones and found to share breeding habitat with *Ae. aegypti* (Tables 3 and 4). The tub flower pots and were found to be mixed breeding site for *Ae. aegypti* and *Ae. albopictus* during the present survey (Table 4). The mixed breeding of *Ae. aegypti* and *Ae. albopictus* was recorded from gardening areas. *Ae. albopictus* was also recorded from tree holes. Similarly, *Ae. vittatus* was found to share the habitat with *Ae. aegypti* in a cement cistern (Table 3).

Table 3: Infestation and breeding preference ratio of *Aedes aegypti*

Type of containers	Number of containers surveyed with water		Percentage Positive	Breeding Preference Ratio (BPR) (y%/x%)
	Examined Ratio (x%)	With *Ae. aegypti* larvae / pupae (y%)		
Tubs	271 (5.71)	42 (7.88)	15.49	1.38
Tins	94 (1.98)	13 (2.44)	13.82	1.23
flower pots (both plastic and earthen type)	803 (16.92)	103* (19.32)	12.82	1.14
Rubber tyres	412 (8.68)	28 (5.25)	6.79	0.60
Unused grinding stones	504 (10.62)	73 (13.70)	14.48	1.29
Uncovered drums/barrels	821 (17.30)	105 (19.70)	12.78	1.13
Tap pits	149 (3.14)	18 (3.38)	12.08	1.07
Ant traps	17 (0.36)	02 (0.38)	11.76	1.05
Uncovered cement cisterns/tanks	242 (5.10)	37** (6.94)	15.28	1.36
paper cups	119 (2.51)	6 (1.13)	5.04	0.45
broken bottles	33 (0.69)	04 (0.75)	12.12	1.08
Fountains	16 (0.34)	02 (0.38)	12.5	1.11
Overhead tanks	210 (4.42)	12 (2.25)	5.71	0.50
Bird pots	31 (0.66)	03 (0.56)	9.67	0.84
Coconut shells	138 (2.91)	15 (2.81)	10.86	0.96
Scrap materials	107 (2.25)	17 (3.19)	15.88	1.41
Solid wastes	218 (4.59)	24 (4.50)	11.01	0.98
Fridge/Air cooler	430 (9.06)	19 (3.56)	4.41	0.39
tree holes / bamboo sticks	25 (0.53)	01 (0.19)	4.0	0.35
Others	106 (2.23)	09 (1.69)	8.49	0.75
Total	4746	533		

* Among 103, four were shared with *Ae. albopictus*; ** Among 37, one were shared with *Ae. vittatus*

Table 4: Infestation and breeding preference ratio of *Aedes albopictus*

Type of containers	Number of containers surveyed with water		Percentage Positive	Breeding Preference Ratio (BPR) (y%/x%)
	Examined Ratio (x%)	With *Ae. albopictus* larvae / pupae (y%)		
Tubs	271 (5.71)	1 (8.33)	0.36	1.45
Tins	94 (1.98)	0	-	-
flower pots (both plastic and earthen type)	803 (16.92)	10* (83.33)	1.24	4.92
Rubber tyres	412 (8.68)	0	-	-
Unused grinding stones	504 (10.62)	0	-	-
Uncovered drums/barrels	821 (17.30)	0	-	-
Tap pits	149 (3.14)	0	-	-
Ant traps	17 (0.36)	0	-	-
Uncovered cement cisterns/tanks	242 (5.10)	0	-	-
paper cups	119 (2.51)	0	-	-

broken bottles	33 (0.69)	0	-	-
Fountains	16 (0.34)	0	-	-
Overhead tanks	210 (4.42)	0	-	-
Bird pots	31 (0.66)	0	-	-
Coconut shells	138 (2.91)	0	-	-
Scrap materials	107 (2.25)	0	-	-
Solid wastes	218 (4.59)	0	-	-
Fridge/Air cooler	430 (9.06)	0	-	-
tree holes / bamboo sticks	25 (0.53)	1 (8.33)	4.0	15.71
Others	106 (2.23)	0	-	-
Total	4746	12		

* Among 10, four were shared with *Ae. aegypti*

4. Discussion

Manmade containers are primary factors that contribute more *Aedes* breading habitats in both urban, rural areas and thus *Aedes* mosquito density increase every year. Unplanned urbanization and global warming are biggest threat and are associated factors in steady increase of *Ae. aegypti* and *Ae. albopictus* mosquitoes.

In the present study, *Aedes aegypti* was more abundant than *Aedes albopictus* in all the surveyed areas. Most of the water storing drums and barrels were not properly closed and cleaned by the owner of the house. Further, *Aedes aegypti* larvae and pupae were found to be infested with indoor and outdoor domestic containers. *Aedes albopictus* larvae and pupae were collected only from outdoor flower pots, tub and tree hole in the garden area (Table 4). Similar to our result, *Ae. albopictus* was reported to oviposit preferably in outdoor manmade containers that contain a high amount of organic debris while *Ae. aegypti* was observed to prefer to oviposit in and around human dwelling [13]. Further, we recorded 15.5% and 23.6% shared breeding habitats of *Ae. aegypti* and *Ae. albopictus*, respectively from outdoor containers (Table 2). Our finding corroborates with the earlier report of Thangamathi *et al*. [14], who reported that, the *Ae. aegypti* and *Ae. albopictus* breeds in the same sites with regard to pH, turbidity, chloride phosphate and alkalinity levels.

The calculated indices are high as this reflects the abundance of *Aedes* mosquito in surveyed area (table 1). The highest number of positive containers for *Aedes* larvae was recorded from ward-2. Recently, Madzlan *et al*. [15] reported that the abundance of *Aedes* mosquito may lead to higher dengue virus transmission and decrease the quality of life in the particular area.

In general, immature surveillance and indices reflects the abundance of *Aedes* in a particular locality. Further, it is a primary step in vector surveillance under vector borne disease control programme. The present study revealed the presence of *Aedes* vectors, their abundance, distribution, breeding habitats, breeding preference ratio and level of mixed breeding. Thus, routine *Aedes* surveillance would enable to identify high risk areas and thereby to initiate source reduction and other suitable vector control measures.

5. Conclusion

The present entomological survey recorded the presence of dengue vectors *Ae. aegypti* and *Ae. albopictus* in Bengaluru city. *Ae. albopictus* was recorded for the first time from Bengaluru city to the best of our knowledge. Our study revealed that *Ae. aegypti* infestation and density was very high than *Aedes albopictus* in all the surveyed areas of Bengaluru city. In addition, the status of mixed breeding was also revealed. This baseline data will be helpful for the control of the dengue vector mosquitoes.

6. References

1. Gubler DJ. Epidemic dengue/dengue hemorrhagic fever as a public health, social and economic problem in the 21st century. Trends Microbiol. 2002; 10(2):100-103.
2. Gubler DJ. The global emergence/resurgence of arboviral diseases as public health problems. Arch. Med. Res. 2002; 33(4):330-342.
3. Murray ANE, Quam MB, Wilder-Smith A. Epidemiology of dengue: past, present and future prospects. Clin. Epidemiol. 2013; 5:299-309.
4. Gubler DJ. Dengue, Urbanization and Globalization: The Unholy Trinity of the 21(st) Century. Trop. Med. Health. 2011; 39(4):3-11.
5. WHO. Global Strategy for Dengue Prevention and Control, 2012–2020. Geneva: World Health Organization Press, 2012.
6. WHO. TDR Global Alert and Repsonse Dengue/Dengue Haemorrhagic Fever, Geneva: World Health Organization, 2013.
7. Vanek MJ, Shoo B, Mtasiwa D, Kiama M, Lindsay SW, Fillinger U, *et al*. Community based surveillance of malaria vector larval habitats: a baseline study in urban Dar es Salaam, Tanzania. Biomedical Central Public Health. 2006; 6:15.
8. Jansen, CC, Beebe NW. The dengue vector *Aedes aegypti*: What comes next. Microbes Infect. 2010; 12:272-279.
9. Soman RS. Studies on *Aedes aegypti* in Bangalore city. Indian J Med. Res. 1977; 65(1):8-16.
10. Balakrishnan N, Katyal R, Mittal V, Chauhan LS. Prevalence of *Aedes aegypti* - The vector of Dengue/ Chikungunya fevers in Bangalore City, Urban and Kolar districts of Karnataka state. J Commun. Dis. 2015; 47(4):19-23.
11. Rao RT, Trpis M, Gillett JD, Teesdale C, Tonn RJ. Breeding places and seasonal incidence of *Aedes aegypti*, as assessed by the single-larva survey method. Bull. World Health Organization. 1973; 48:615-622.
12. Rueda LM. Pictorial keys for the identification of mosquitoes (Diptera: Culicidae) associated with Dengue Virus Transmission. Zoo Taxa. 2004; 589(1):1-60.
13. Nazri CD, Abu HA, Rodziah I. Habitat characterization of *Aedes* sp. breeding in urban hotspot area. Proc. Soc. Behav. Sci. 2013; 85:100-109.
14. Thangamathi P, Ananth S, Kala N, Maheshwari R, Gnanasoundrai A, Nagamani N. Seasonal variations and physicochemical characteristics of the habitats in relation to the density of dengue vector *Aedes aegypti* in

Thanjavur, Tamil Nadu, India. Int. J Sci. Nat. 2014; 5(2):271-276.
15. Madzlan F, Dom NC, Tiong CS, Zakaria N. Breeding characteristics of *Aedes* mosquitoes in dengue risk area. Proc. Soc. Behav. Sci. 2016; 234:164-172.