Research Article

Distribution of Dengue Vectors during Pre- and Post-Monsoon Seasons in Higher Attitudes of Nilgiri Hills of Western Ghats, India

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Received 14 September 2013; Revised 6 November 2013; Accepted 6 November 2013

Academic Editor: Hans Merzendorfer

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Entomological survey was carried out to record dengue vectors during pre- and post-monsoon seasons in 2012 from different breeding places in residential and forested areas of different altitudes of the Nilgiris, namely, Mettupalayam (330 mts), Kallar (400 mts), Burliar (900 mts), Marapalam (1050 mts), and Coonoor (1800 mts). Results showed that maximum number of dengue vector breeding was recorded at Mettupalayam during pre-monsoon season followed by Kallar, Burliar, Coonoor, and Marapalam. The post-monsoon season survey also revealed that the maximum number of dengue vector breeding was found at Mettupalayam, followed by Burliar, Coonoor, and Kallar, and *Aedes* immature was not found in Marapalam. *Ae. aegypti* species was recorded in all the study areas during pre- and post-monsoon seasons. Whereas *Ae. albopictus* was recorded only at Mettupalayam, Kallar, and Burliar during pre- and post-monsoon seasons. Besides these two dengue vectors, a nonvector species *Ae. vittatus* ($n = 9$) was also recorded at Kallar and Burliar.

1. Introduction

Studies on taxonomy, biology, distribution, and ecology of haematophagous arthropods are of public importance. General reviews of the ecology and control of individual vector groups should be continued and revised from time to time to provide workers with update status [1]. Mosquitoes are haematophagous insects in terms of public health significance and they are remarkably adapted to coexist with man and domestic animals. There are 3490 species of mosquitoes recorded so far worldwide [2], among them, more than 100 species are recorded as vectors transmitting various diseases [3]. Increasing population, unplanned organization, rapid transportation, unreliable water supplies, and water storage practices of peoples are results in the rapid spreading of mosquito species [4].

The Nilgiri hills located in Tamil Nadu of south India are highly diverse in terms of ecology and culture. The terrain features and climatic conditions like temperature, humidity,

rainfall, the forest cover, and availability of breeding habitats render the area suitable for the existence of mosquitoes [5]. Rahman et al. [6] had done an intensive survey and reported the presence of 52 mosquito species in the Nilgiris. Balakrishnan et al. [5] reported the presence of *Aedes aegypti* mosquitoes in the Nilgiris and its adjoining areas with special reference to dengue fever survey. In view of uncertainty of the present remedial measures, a thorough study of human-environmental interrelation, climate wise distribution, and changing pattern of occupancy according to various altitudinal variances have to be studied with utmost priority before deciding control programs against mosquitoes in this ecologically fragile environment of the Nilgiris. In recent past, no information is available on the status of dengue vectors in these hilly areas. Keeping in view of these, the present study was aimed to understand the distribution and seasonal abundance (pre- and post-monsoons) and to identify the active breeding sites of dengue vectors in these higher altitude areas.

TABLE 1: Data on dengue vectors collected during pre- and post-monsoon seasons from different higher altitudes of the nilgiris.

Locality (Nilgiris)	Pre-monsoon		Post-monsoon	
	<i>Ae. aegypti</i>	<i>Ae. albopictus</i>	<i>Ae. aegypti</i>	<i>Ae. albopictus</i>
Mettupalayam (hilly terrain) (300 mts)	35	30	51	15
Kallar (400 mts)	3	10	3	27
Burliar (900 mts)	2	19	10	31
Marapalam (1050 mts)	2	0	5	0
Coonoor (1800 mts)	2	0	2	0
Total	44	59	71	73

2. Materials and Methods

2.1. Study Sites. The study was carried out in domestic premises and forest areas of the Nilgiri hills of Western Ghats, namely, Mettupalayam (hilly terrain, 330 mts), Kallar (400 mts), Burliar (900 mts), Marapalam (1050 mts), and Coonoor (1800 mts) during pre-monsoon and post-monsoon seasons. The survey was carried out in May-June (pre-monsoon) and November-December (post-monsoon). Houses/places were surveyed for *Aedes* breeding in water storage containers following the method of Sanchez et al. [7]. A total of 100 houses/places were surveyed from each study site and the larval density was expressed as house index (HI), container index (CI), and breteau index.

2.2. Specimen Collection. Random collection of larvae and pupae were made from different breeding water sources like grinding stones, cement tanks, discarded tin, earthen-pots, plastic container, coconut shells, tyres, tree holes, axils of leaves, drains canals, and so forth, by standard dipping method as reported earlier [8]. Immature stages of genus *Aedes* (Larvae and pupae) were collected in plastic containers (500 mL capacity) during pre-monsoon (May-June, 2012) and post-monsoon (November-December, 2012) covering all the five study areas and were transported to the laboratory.

2.3. Preservation and Identification. Transported immature samples were allowed to emerge into adults that were killed with chloroform soaked cotton swabs and identified up to species level following the mosquito identification keys provided by Barraud [9, 10].

3. Results

3.1. Dengue Vector Abundance in before Monsoon. A total of 105 immature specimens (larvae and pupae) were collected from five places of Nilgiri hills namely Mettupalayam, Kallar, Burliar, Marapalam, and Coonoor before monsoon (Table 1). The results showed that Mettupalayam recorded the highest collection of *Ae. aegypti* ($n = 35$) and *Ae. albopictus* ($n = 30$) before monsoon. In Burliar region, *Ae. albopictus* ($n = 19$) was higher than *Ae. aegypti* ($n = 2$). Likewise, in Kallar also, *Ae. albopictus* ($n = 10$) was higher than *Ae. aegypti* ($n = 3$). Two larvae from Marapalam and two larvae from Coonoor were identified as *Ae. aegypti* and there were no *Ae. albopictus*. Overall, *Ae. albopictus* (56.19%) was found to be

higher than *Ae. aegypti* (41.90%) before monsoon. Other than these vectors, 2 larvae of nonvector species *Ae. vittatus* were also recorded (1.90%) at Kallar ($n = 2$) during pre-monsoon season (Table 2).

3.2. Dengue Vector Abundance after Monsoon. A total of 151 immature specimens (larvae and pupae) were collected from five places of Nilgiri hills during post-monsoon season, which was higher than the pre-monsoon collection. Mettupalayam recorded the highest number of *Ae. aegypti* ($n = 51$) followed by Burliar ($n = 10$), Marapalam ($n = 5$), Kallar ($n = 3$) and Coonoor ($n = 2$), respectively. Likewise, *Ae. albopictus* was found to be high in Burliar ($n = 31$), followed by Kallar ($n = 27$) and Mettupalayam ($n = 15$), respectively. The container mosquito, *Ae. albopictus* larvae (48.34%) was found to be almost equal to *Ae. aegypti* larvae (47.01%) after monsoon. There were 7 larvae of *Ae. vittatus*, (4.63%) was also recorded during post-monsoon collection at Burliar (Table 2). The main breeding source was found to be discarded tins, plastic containers, earthen pots, grinding stones, and tyres for both *Ae. aegypti* and *Ae. albopictus* after monsoon (Table 2, Figure 1).

3.3. Pre- and Post-Monsoon Aedes Indices. The house index (HI) of Mettupalayam for *Aedes* was 9.00; CI and BI were 12.38 and 13.00, respectively, during pre-monsoon season. The post-monsoon HI, CI, and BI indices of Mettupalayam were 14.00, 31.30, and 36.00, respectively. The house index (HI) of Kallar for *Aedes* was 6.00; CI and BI were 13.48 and 12.00, respectively, during the pre-monsoon season. The post-monsoon HI, CI, and BI indices of Kallar were 9.00, 15.00 and 12.00, respectively.

The house index (HI) of Burliar for *Aedes* was 2.00; CI and BI were 8.33 and 5.00, respectively, during the pre-monsoon season. The post-monsoon HI, CI, and BI indices of Burliar were 10.00, 15.05, and 14.00, respectively. The pre- and post-monsoon HI and BI indices of Marapalam for *Aedes* were found to similar and showed 2.00 and 2.00, respectively. The pre- and post-monsoon HI and BI indices of Coonoor for *Aedes* were also found to be similar and showed 1.00 and 2.00, respectively (Tables 3 and 4).

3.4. Altitude and Dengue Vector Distribution. Mettupalayam, the hilly terrain area, recorded highest number of dengue vectors in both pre- and post-monsoon seasons followed by Kallar (400 mts) and Burliar (900 mts) recorded high

TABLE 2: Details of different habitat collection of dengue vectors from Nilgiris of Western Ghats.

Locality (Nilgiris)	Altitude (in metres)	Habitat	<i>Ae. aegypti</i>	<i>Ae. albopictus</i>	<i>Ae. vittatus</i>	Total
Mettupalayam hilly terrain	300	Discarded tin	23	4	—	27
		Plastic container	25	16	—	41
		Earthen pots	15	9	—	24
		Grinding stones	12	11	—	23
		Tyres	8	5	—	13
		Coconut shells	3	—	—	3
		Drains canals	—	—	—	0
		Cement tanks	—	—	—	0
Kallar	400	Tyres	3	13	—	16
		Axils of leaves	—	—	1	1
		Plastic container	3	24	—	27
		Tree holes	—	—	1	1
		Canals	—	—	—	0
Burliar	900	Plastic container	8	44	—	52
		Earthen pots	4	6	—	10
		Tree holes	—	—	4	4
		Axils of leaves	—	—	3	3
Marapalam	1050	Discarded tin	4	—	—	4
		Plastic container	3	—	—	3
		Axils of leaves	—	—	—	0
Coonoor	1800	Earthen pots	2	—	—	2
		Tree holes	—	—	—	0
		Plastic container	2	—	—	2
		Axil of leaves	—	—	—	0
Total			115	132	9	256

TABLE 3: Index profile for dengue vectors during pre-monsoon collection.

Study site	No. of containers surveyed (positive containers)	Indices (%)		
		HI ^a	CI ^b	BI ^c
Mettupalayam	105 (13)	9	12.38	13
Kallar	89 (12)	6	13.48	12
Burliar	60 (5)	2	8.33	5
Marapalam	30 (2)	2	6.66	2
Coonoor	70 (2)	1	2.85	2

^aThe % of houses positive for *Aedes* larvae.^bThe % of containers positive for *Aedes* larvae.^cThe number of positive containers per 100 houses.

TABLE 4: Index profile for dengue vectors during post-monsoon collection.

Study site	No. of containers surveyed (positive containers)	Indices (%)		
		HI ^a	CI ^b	BI ^c
Mettupalayam	115 (36)	14	31.30	36
Kallar	80 (12)	9	15	12
Burliar	93 (14)	10	15.05	14
Marapalam	52 (2)	2	3.84	2
Coonoor	70 (2)	1	2.56	2

^aThe % of houses positive for *Aedes* larvae.^bThe % of containers positive for *Aedes* larvae.^cThe number of positive containers per 100 houses.

number. We recorded very few number of *Ae. aegypti* above 1000 mts in Marapalam (1050 mts), Coonoor (1800 mts) and there were no *Ae. albopictus* recorded in our collection in both pre- and post-monsoon in these regions (Table 1).

4. Discussion

A total of 256 immature specimens were collected from different habitats and reared in the lab up to adult stages. The

diversity of dengue vector fauna differed among these hilly areas, indicating the existence of variation in the spatial distribution pattern. The variation in the diversity and distribution are mainly associated with altitude and specific ecological condition of the selected sites. Altogether 3 species were recorded from total emerged adults ($n = 256$) that belong to the genera *Aedes*. Among the three recorded species, two were dengue/DHF vectors, namely, *Ae. aegypti*, *Ae. albopictus* and one nonvector was *Ae. vittatus*. There were no mortality

FIGURE 1: Surveyed breeding sites of dengue vectors. Positive (a), (b), (c), and (d) and negative (e) and (f). (Note: (a) grinding stone, (b) coconut shells, (c) plastic container, (d) tyre, (e) cement tank, and (f) Kallar canal).

recorded during the transport of larvae/pupae to the laboratory. Plastic containers and discarded tins have contributed to maximum number of dengue vector specimens. The number of *Ae. aegypti* immature recorded was higher ($n = 71$) during post-monsoon season than pre-monsoon season ($n = 44$). Likewise, *Ae. albopictus* collection was also higher during post-monsoon ($n = 73$) than pre-monsoon collection ($n = 59$). In total, *Ae. albopictus* ($n = 132$) was dominant followed by *Ae. aegypti* ($n = 115$).

The highest *Aedes* indices were found at Mettupalayam in post-monsoon season, where HI was 14.00, CI was 34.28, and BI was 32.00. In Mettupalayam, the main breeding sources for *Ae. aegypti* and *Ae. albopictus* were found to be discarded tins, plastic containers, earthen pots, grinding stones, and tyres (Table 2, Figure 1).

These results support the previous studies, in which dengue vectors are being reported as major in other parts

of Tamil Nadu [11, 12]. In conclusion, occurrence of dengue vectors *Ae. aegypti* and *Ae. albopictus* in both pre- and post-monsoon seasons at higher altitudes of Western Ghats may be of no epidemiological importance, but there would be an emergence of dengue fever at higher altitudes in the global warming scenarios either by migration of human carrier or mosquitoes transovarian mode.

Abbreviation

mts: Metres.

Conflict of Interests

The authors do not have any conflict of interests.

Acknowledgment

The authors are thankful to Dr. R. Sanil, Department of Zoology & Wild Life Biology, Govt. Arts College, Ooty, Tamil Nadu, India, for his assistance during field collections.

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