Breeding habitats of *Aedes aegypti* Linnaeus and *Ae.albopictus* Skuse in a dengue transmission area in Kandy, Sri Lanka

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Abstract

Breeding habitats of *Ae.aegypti* and *Ae.albopictus* were studied from July 2002 to August 2003 in Kandy District, Sri Lanka. Dengue fever (DF) and dengue haemorrhagic fever (DHF) cases were identified and details of patients were collected in consultation with Regional Epidemiologist, Kandy. Entomological investigations were carried out around 347 DF/DHF cases in 120 study sites, covering an area of 100 m radius around each case and including a minimum of 100 houses per site. All possible breeding places were examined, *Aedes* larvae were collected in labelled containers using pipetting, dipping and siphoning techniques. Larvae were identified in the laboratory.

884 containers positive for *Ae.aegypti* and *Ae.albopicus* were encountered around 12,470 houses. The majority (51.36%) of positive containers for *Aedes* breeding were the water storage tanks and barrels. Water storage containers have constituted 66.66% breeding habitats of *Ae.aegypti*. Other important containers positive for *Aedes* breeding were tyres (11.88%), discarded plastic containers (11.31%), earthen pots (10.07%), and metal ware (3.17%). For all types of containers (except for roof gutters), number of containers positive for *Ae.albopictus* was higher than that for *Ae.aegypti*.

In spite of mechanical and biological larval control measures, 10.01%water storage containers were found positive for *Aedes* breeding. This indicates that mechanical and biological measures alone are not sufficient for preventing *Aedes* breeding and the necessity of a supplementary chemical method for *Aedes* larval control in water storage containers in the study area. Furthermore, effective garbage collection and proper disposal by the local government bodies, commitment of individuals and communities in source reduction, and law enforcement against occupants of premises with *Aedes* mosquito breeding are necessary for DF and DHF control in the Kandy District.

Key Words : Breeding habitats, Ae. aegypti Ae. albopictus

Introduction

Dengue is an arboviral disease complex which includes dengue fever (DF) and dengue haemorrhagic fever (DHF) and subsequent dengue shock syndrome (DSS). The disease is transmitted mainly by *Aedes aegypti* Linnaeus. *Ae.albopictus* Skuse is considered as a secondary vector of dengue in South-East Asia and the Western Pacific (1).

Dengue and DHF is prevalent in most tropical and sub tropical areas in the world. In Sri Lanka, dengue fever has first been reported in early 1960s. Its presence in all the major towns situated below 1200m elevation has been established in 1966 and in 1976-78 (2). At present, DF and DHF is prevalent in many urban and semi urban areas of Sri Lanka with seasonal and periodic epidemics and has become one of the major public health problems in the country.

In the absence of a vaccine or a special treatment for DF and DHF, the preventive measures of the disease aim at reducing the population density of the vectors, *Ae.aegypti* and *Ae.albopictus*. In order to achieve a sustained vector control, large-scale prevention and elimination of vector breeding habitats is necessary. For effective

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elimination of the disease information on vector breeding habitats is necessary Therefore, this study was carried out to study the breeding habitats of *Ae.aegypti* and *Ae.albopictus* in a DF and DHF transmission area in the Kandy District, Sri Lanka.

Objective

To study the breeding habitats of *Ae.aegypti* and *Ae.albopictus* in a dengue transmission area in Kandy District, Sri Lanka.

Methodology

The study area

The present study was carried out from July 2002 to August 2003 in the Kandy District. The land area of the District is 1939.5km^2 and the estimated mid year population for the year 2003 is 1.29 million (Chief Secretariat, Planning and Monitoring Division, Kandy). There is an increase of DF/DHF cases in the District since 1998, from 80 cases in 1998 to 875 cases in 2002. The highest number of DF/DHF cases were reported from the Kandy Municipal Council area with prevalence rates of 11 and 22 per 10,000 population, for the years 2001 and 2002 respectively. The Divisional Directors of Health Services (DDHS) areas with high DF/DHF prevalence in the District were Gangawatakorale, Harispattuwa, Kundasale, Pathadumbara, Pathahewaheta, Yatinuwara, Udunuwara, Akurana, Medadumbara, Poojapitiya, Tumpane and Udapalatha (Ministry of Health, Central Provincial Council). For the present study Kandy Municipal Council area and ten adjoining DDHS areas were selected based on the higher prevalence of DF/DHF for the years 2001 and 2002 (Fig 1).

Detection of DF and DHF cases

Dengue fever and DHF cases were identified on serological/ clinical basis, and details of patients were collected in consultation with the Regional Epidemiologist, Kandy, who receives regular notifications of DF/DHF cases from medical institutions, specially from Teaching Hospitals Kandy and Peradeniya.

Entomological investigations carried out in the study sites

There were 635 DF/DHF cases in the study area during the study period. A sample of 347 DF/ DHF cases was randomly selected from 120 study sites for entomological investigations. Larval surveys were carried out to study the breeding habitats of *Ae.aegypti* and *Ae.albopictus*. Each survey included a minimum of 100 houses and covered an area of 100m radius around the DF/ DHF case. During the surveys, house to house visits were made, all possible *Aedes* breeding habitats were examined, 10 *Aedes* larvae from each container were collected in separate containers (one container per one habitat) and identified in the laboratory using standard keys (3,4). If a container had less than 10 larvae, all larvae were collected. Pipetting, siphoning and dipping techniques were used for larval collection, depending on the nature of the breeding habitat.

Results

A total of 8,520 possible breeding sites of *Aedes* mosquitoes (containers with water) in 12,470 premises were examined. 884 containers were found positive for *Ae.aegypti* and *Ae.albopictus* breeding. A wide variety of containers, both natural and man-made, were found positive for *Ae.aegypti* and *Ae.albopictus* larvae. Of the positive containers, the majority (51.36%) were water storage containers (cement tanks, 32.92%; barrels, 18.44%). The other containers with comparatively high percentage of larval breeding were tyres (11.88%), discarded plastic containers (11.31%), earthen pots (10.07%) and metal ware including the animal feeding trays (3.17%). It was also observed that water storage tanks and barrels constituted 66.66% (tanks 44.95%, barrels 21.71%) of *Ae.aegypti* breeding habitats. For all types of containers (except roof gutters), number of containers positive for *Ae.albopictus* was higher than that for *Ae.aegypti* (Table 1).

Water storage tanks and barrels with *Ae.aegypti* and *Ae.albopictus* breeding were found in all study sites in the study area. Water storage containers (tanks and barrels) have contributed significantly (23.53%-79.49%) to the Container Indices and Breteau Indices of the study sites. Very high contributions from water storage containers to the Container Indices and Breteau Indices were seen in

DDHS areas Medadumbara, Udapalatha, Pathahewaheta, Pathadumbara, Gangawatakorale, Kundasale and Akurana (Table 2).

During the entomological surveys, it was also found that there were 13-67 water storage containers (average 36) per 100 houses in the study area. The number of such containers was very high in DDHS areas Medadumbara (67), Kundasale (64), Gangawatakorale (47), Akurana (44) Udapalatha (42) and Pathahewaheta (42) (Table 3).

Discussion

Aedes mosquitoes are primarily container breeders and they thrive in both clean and organically rich water in both natural and artificial containers. Hence container management to reduce the breeding habitats is one of the best approaches for controlling *Ae.aegypti* and *Ae.albopictus*.

In the present study, it was observed that *Ae.aegypti* and *Ae.albopictus* are breeding in a wide variety of natural and man made containers. The most preferred breeding habitats of *Ae.aegypti*, the principal vector of dengue and dengue haemorrhagic fever, were the water storage containers (tanks 44.95%; barrels, 21.71%). Water storage tanks and barrels have been identified as the most productive breeding sites of *Ae.aegypti* and *Ae.albopictus* in Matale Municipal Council area (5) and as the major breeding places of *Ae.aegypti* during the DF/DHF epidemic in Tangalle in 2001 (6). Some other countries like India (7,8), Thailand (9), Malaysia (10) Cambodia (11) and Indonesia (12) in South East Asia and in the Western Pacific (4) have reported water storage containers as the major breeding habitats of *Ae.aegypti* and *Ae.albopictus*.

Water storage tanks and barrels were found to harbour large populations of *Aedes* larvae, depending on the volume of water and the duration of water storage. Thus, water storage containers contribute to a large proportion of adult *Aedes* mosquito density in the areas where such containers are present. This shows that prevention of *Ae. Aegypti* and *Ae.albopictus* breeding in water storage containers would help a great deal to control DF and DHF. Therefore, the dengue control programmes should pay more attention to control *Aedes* breeding in water storage containers.

In our study, it was also observed that the number of containers positive for *Ae.albopictus* was higher than that of *Ae.aegypti*, for all types of containers, except for roof gutters. Recent studies carried out in dengue prone areas in Sri Lanka too have shown that *Ae.abopictus* was the main species found in some localities from which dengue cases were reported (13). Also, dengue cases have been encountered in areas where there were no *Ae.aegypti* breeding, but with *Ae.albopictus* breeding (14). Furthermore, *Ae.albopictus* has been reported to be susceptible for all 4 serotypes of dengue virus when inoculated in the laboratory, and dengue 3 serotype has been detected in wild caught *Ae.albopictus* specimens (15). Therefore, the areas with high *Ae.albopictus* breeding has to be considered as DF/DHF transmission risk areas in the DF/DHF control programmes.

In spite of available mechanical and biological efforts through individual and community action to prevent/control *Aedes* mosquito breeding in water storage containers, 10.01% of water storage containers (9.7% tanks; 10.62% barrels) were found positive for *Ae.aegypti* and *Ae.albopictus* breeding in the study area. This indicates that the available biological and mechanical measures alone are not sufficient for successful control of DF and DHF and the necessity of a supplementary chemical larval control method for successful DF/DHF control in the study area. Countries like Thailand, Malaysia and Cambodia (11) have attempted Temephos for preventing *Aedes* breeding in domestic water storage jars and other water storage containers. Application of Temephos sand granules to domestic water storage containers in a field trial in Bangkok at a dosage of 1ppm had given more than 95% reduction in adult *Aedes* mosquito density (7). Such a chemical vector control method is necessary for prevention of *Aedes* breeding in water storage containers and for successful DF/DHF control in the Kandy District.

In addition to water storage containers, there were other *Ae.aegypti* and *Ae.albopictus* breeding habitats in the area. These include tyres, discarded plastic containers, earthen pots, metal ware including animal feeding trays, refrigerator trays, cement ornamental ponds, gutters, tin and other miscellaneous containers. Strengthening of garbage collection and disposal systems in the local government bodies, law enforcement against occupants of premises with *Aedes* mosquito breeding and commitment of individuals and communities in destroying possible breeding sites of *Aedes* mosquitoes is of utmost importance in the control of DF and DHF in the Kandy District, Sri Lanka.

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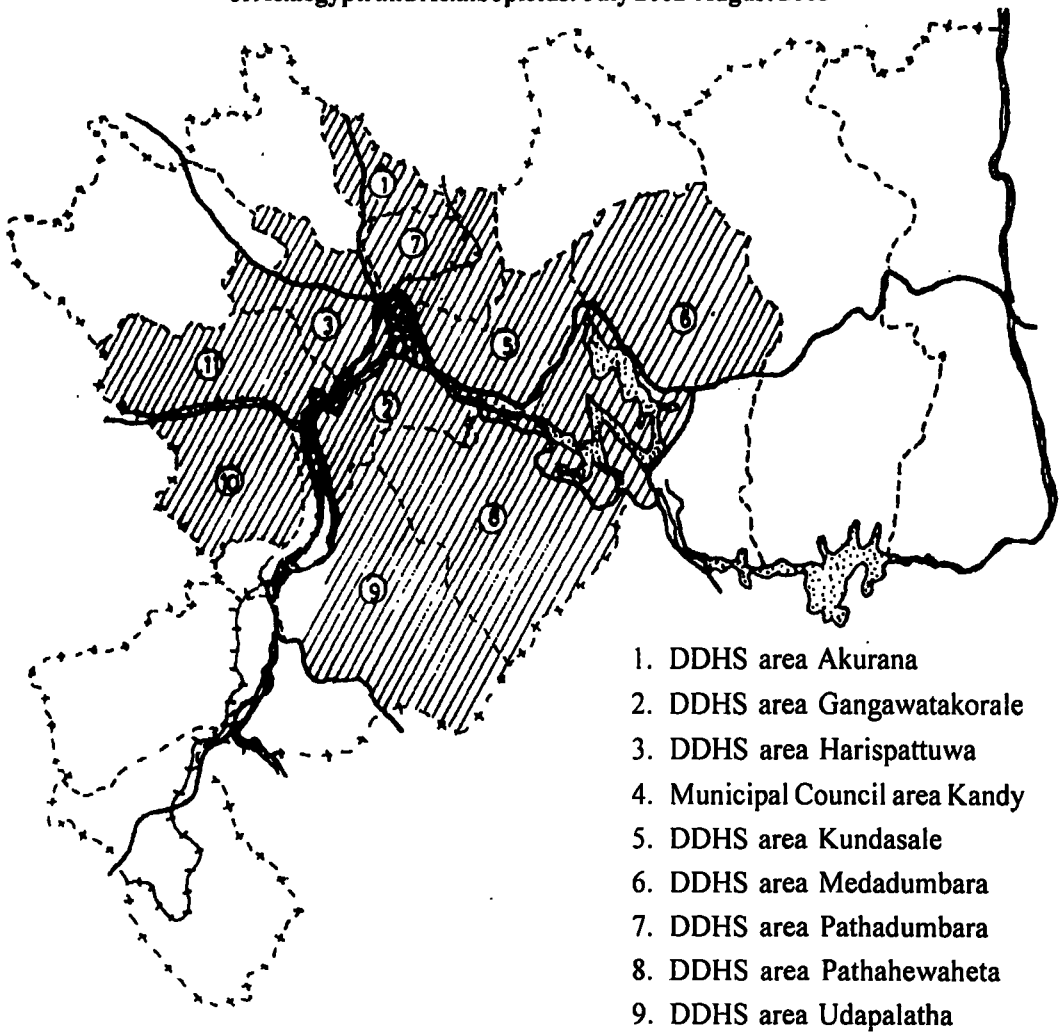
Fig. 1. DDHS areas in Kandy District selected to study the breeding habitats of Ae.aegypti and Ae.albopictus: July 2002-August 2003



1. DDHS area Akurana
2. DDHS area Gangawatakorale
3. DDHS area Harispattuwa
4. Municipal Council area Kandy
5. DDHS area Kundasale
6. DDHS area Medadumbara
7. DDHS area Pathadumbara
8. DDHS area Pathahewaheta
9. DDHS area Udapalatha
10. DDHS area Udunuwara
11. DDHS area Yatinuwara

Table 1. Breeding habitats of *Ae.aegypti* and *Ae.albopictus* in the study areas: July 2002- August 2003

Type of container	Number of containers Examined	Number (%)of containers positive for		Total number (%) of containers positive for
		Ae.aegypti	*Ae.albopictus*	*Ae.ageypti* and/or *Ae.albopictus*
Water storage cement tanks	3000	147 (44.95)	151 (25.68)	291 (32.92)
Water storage barrels	1535	71 (21.71)	106 (18.03)	163 (18.44)
Tyre	477	41 (12.54)	69 (11.73)	105 (11.88)
Discarded plastic containers	672	26 (7.95)	75 (12.76)	100 (11.31)
Earthen pots	343	11 (3.36)	80 (13.61)	89 (10.07)
Metal ware	106	12 (3.67)	17 (2.89)	28 (3.17)
Tin	222	3 (0.92)	19 (3.23)	22 (2.49)
Refrigerator tray	186	3 (0.92)	11 (1.87)	14 (1.59)
Ornamental cement ponds	147	4 (1.22)	7 (1.19)	10 (1.13)
Flower vases	41	1 (0.31)	9 (1.53)	10 (1.13)
Leafaxile	821	0 (0.00)	10 (1.70)	10 (1.13)

Table 1 cont.

Table 1. Breeding habitats of *Ae.aegypti* and *Ae.albopictus* in the study areas: July 2002- August 2003

Type of container	Number of containers Examined	Number (%)of containers positive for		Total number (%) of containers positive for
		Ae.aegypti	*Ae.albopictus*	*Ae.ageypti* and/or *Ae.albopictus*
Bottle	256	2 (0.61)	7 (1.19)	9 (1.02)
Coconut shell	322	1 (0.31)	6 (1.02)	7 (0.79)
Bamboo stump	93	0 (0.00)	6 (1.02)	6 (0.68)
Concrete roofs	101	1 (0.31)	5 (0.85)	6 (0.68)
Roof gutters	34	4 (1.22)	0 (0.00)	4 (0.45)
Rock pools	9	0 (0.00)	3 (0.51)	3 (0.34)
Discarded polythine	117	0 (0.00)	2 (0.34)	2 (0.23)
Drains	2	0 (0.00)	1 (0.17)	1 (0.11)
Pits	20	0 (0.00)	1 (0.17)	1 (0.11)
Regiform	4	0 (0.00)	1 (0.17)	1 (0.11)
Metal pipes	10	0 (0.00)	1 (0.17)	1 (0.11)
Tree holes	2	0 (0.00)	1 (0.17)	1 (0.11)
Total	8520	327 (100.00)	588 (100.00)	884 (100.00)

Table 2. Contribution of water storage containers (WSC) to the Container Indices and Breteau Indices in different DDHS areas in the Kandy District: July 2002- August 2003

DDHS area	Number of houses Visited	Number of containers examined	Number (%) of positive containers for *Ae.aegypti* and/or *Ae.albopictus*			Container Index	Breteau Index
			WSC	Others	Total		
Akurana	706	496	28 (53.85%)	24	52	10.48	7.37
Gangawatakorale	1384	1104	81 (59.12%)	56	137	12.41	9.90
Harispattuwa	1300	966	28 (49.12%)	29	57	5.90	4.38
Kandy MC	4360	2158	59 (28.64%)	147	206	9.55	4.72
Kundasale	1007	1110	53 (56.99%)	40	93	8.38	9.23
Medadumbara	513	483	62 (79.49%)	16	78	16.15	15.20
Pathadumbara	800	552	29 (59.18%)	20	49	8.88	6.13
Pathahewaheta	700	493	44 (61.97%)	27	71	14.40	10.14
Udapalatha	600	503	44 (66.67%)	22	66	13.12	11.00
Udunuwara	200	115	4 (23.53%)	13	17	14.78	8.50
Yatinuwara	900	540	22 (37.93%)	36	58	10.74	6.44
Total	12470	8520	454 (51.36%)	430	884	10.38	7.09

Table 3. Number of water storage containers (WSC) per 100 houses in study sites in different DDHS areas in the Kandy District-July 2002-August 2003

DDHS area	Number of Houses Visited	Number of WSCs encountered			Number of WSCs per 100 houses
		Tanks	Barrels	Total	
Akurana	706	251	60	311	44
Gangawatakorale	1384	404	252	656	47
Harispattuwa	1300	317	181	498	38
Kandy MC	4360	628	269	897	21
Kundasale	1007	395	252	647	64
Medadumbara	513	204	141	345	67
Pathadumbara	800	259	95	354	44
Pathahewaheta	700	160	131	291	42
Udapalatha	600	207	43	250	42
Udunuwara	200	20	6	26	13
Yatinuwara	900	187	73	260	29
Total	12470	3032	1503	4535	36