Anopheles maculatus (Theobald) and *Anopheles elegans* (James) breeding in water storage containers in Kandy, Sri Lanka

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Abstract

A three month survey was carried out from August to October 2001 to identify anopheline mosquito breeding in artificial water storage containers in the Kandy District, Sri Lanka. Water storage tanks and barrels in 28 study sites covering 57 villages in 11 Divisional Director of Health Services (DDHS) areas were examined for mosquito immatures (larval instars and pupae). *Anopheles maculatus* (Theobald) and *A. elegans* (James) were shown to breed in these containers. Although these species are not known vectors of human malaria in Sri Lanka *A. maculatus* is a vector in neighboring countres. Also this species has been shown to support the sporogonic cycle of *P. falciparum*, in the laboratory; thus is considered as a potential vector of human malaria in Sri Lanka. With the impending water shortages, water storage in containers is bound to increase in the future. Thus condidering water storage containers as breeding places of potential vectors of human malaria is important in malaria control in Sri Lanka.

Introduction

Anopheles mosquitoes are important globally as the mosquito genus responsible for the transmission of human malaria. Of the 400 known anopheline species, over 60 have been proven to be natural vectors of human malaria (1). In Sri Lanka, 22 anopheline species have been recorded (2). Of these, 13 have been shown to support the sporogonic cycle of human malaria in the laboratory, thus they are considered as "potential" vectors (3,4). However, to date in the country, the only known major vector is *Anopheles culicifacies (A. culicifacies)*, while *A. annularis* and *A. subpictus* have been recorded as vectors of local importance (5,6). In Sri Lanka, the breeding of anopheline species is primarily in the river and stream bed pools while other natural habitats such as temporary rain water pools, irrigation channels, pits, edges of slow flowing rivers, wells, brick fields, quarries, puddles, and abandoned gem pits serve as secondary breeding sites (7,8,9,10,11). However, in 1999, during an investigation of an outbreak of malaria in a suburb of Colombo, it was significant that *A. culicifacies* was seen breeding in cemented fish breeding tanks. This clearly indicates the possibilty of habitat deviation (12).

In India, *A. stephensi*, one of the major vectors of malaria, breeds in artificial containers such as overhead tanks and barrels in urban areas (13). Therefore this study was carried out to identify anopheline mosquitoes breeding in artificial water storage containers in the Kandy District, Sri Lanka.

The area is traditionally non-malarious, but is subjected to malaria outbreaks and epidemics. Many of these malaria outbreaks/epidemics were associated with its river systems, the Mahaweli *ganga*, Rambukkan *oya* and their tributaries. The riverbed pools have been identified as the vector breeding places during these outbreaks/epidemics (14).

The area receives rain from both North-East and South-West monsoons. Failure of monsoonal rains results in pool formation and drying up of the rivers and streams.

Objective

To identify anopheline mosquitoes breeding in water storage containers in the Kandy District, Sri Lanka.

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Methods

The study area

The study was carried out in the Kandy District which comprises 18 Divisional Director of Health Services (DDHS) areas. The mid year population for the year 2001 was 1.27 millon (Chief Secretariat, Planning and Monitoring Division, Kandy).

The study sites

Twenty-eight study sites comprising 57 villages in 11 DDHS areas were selected based on the availability of water storage cement tanks and iron barrels in the area (Figure 1). The study sites and the DDHS areas from which the study sites were selected are shown in Table 1.

Figure 1. DDHS areas in Kandy district selected to study anopheline breeding in water storage containers, August – October 2001.

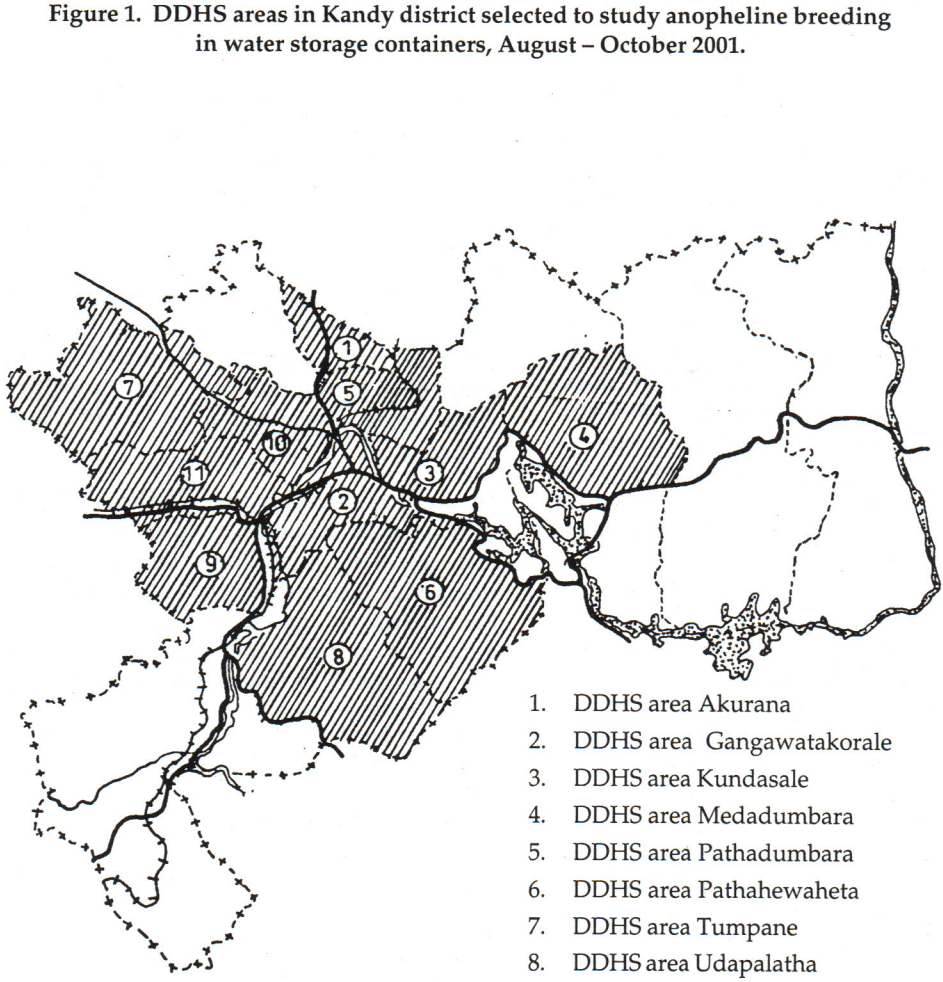

Table 1. DDHS areas and study sites selected to identify anopheline mosquitoes breeding in water storage containers in Kandy district

DDHS area	Study sites
Akurana	Akurana, Kurugoda, Alawatugoda and Delgastenna
Gangawatakorale	Wewatenna
Kundasale	Ahaspokuna, Kengalla, Balagolla, Rajawella, Sirimalwatta and Diyabubula
Medadumbara	Udispattuwa and Mahaberiyatenna
Pathadumbara	Doragamuwa and Meegammana
Pathahewaheta	Ankelipitiya and Talatuoya
Tumpane	Aludeniya, Muddeniya and Niyangoda
Udapalatha	Gampola
Udunuwara	Boyagama and Udunuwara
Werallagama	Pallemulla and Gohagoda
Yatinuwara	Kotaligoda, Doluwa and Gannoruwa

Majority of the people in these areas use pipe borne water. During the period of study a drought prevailed. Therefore water was supplied intermittently at 5-10 day intervals making a need for storing water in artificial containers such as tanks and barrels. These were refilled without emptying resulting in water stagnation over a period of weeks or months in the containers.

Anopheline immature survey

During the survey each house in the selected study sites was visited and water storage cement tanks and barrels were examined thoroughly for anopheline immatures (1st, 2nd, 3rd and 4th instar larvae and pupae). Larval dips were taken irrespective of presence or absence of anopheline immatures at 6 dips per m^2 surface area of water. The larvae were staged and identified at its 3rd and 4th stages using the key developed by Amerasinghe (2). The 1st and 2nd stage larvae were allowed to develop to their 3rd and 4th stages and identified. A sample of the larvae were allowed to develop to adults and identified at the adult stage by using the key developed by the Anti Malaria Campaign, Sri Lanka. The surface area and the depth of water were recorded in every container in the DDHS area that showed an inital high prevalance of anopheline breeding. Rainfall data for the period of study was obtained from the Agro-Meteorology Unit, Department of Agriculture, Peradeniya.

Results

Each DDHS area had both cement tanks and iron barrels for storing water. In 4473 houses visited, a total of 2613 water storage containers were encountered. Variation of the number of containers was 15-125 per 100 houses with a mean of 58 (Table 2).

The surface area of water varied from $0.5m^2$ to $3.0\ m^2$ with a mode of $1.5m^2$ for the tanks, and $0.5m^2$ for the barrels. Of the 2613 containers examined 10 were positive for anopheline species, *A. maculatus* and *A. elegans* (Table 3.)

All the anopheline immatures were encountered in shallow waters, of a depth less than 0.5m. The DDHS areas which had containers breeding anophelines were Gangawatakorale, Kundasale, Medadumbara and Pathahewaheta.

Table 2. Number of houses visited and containers encountered in each DDHS area under study in Kandy district

DDHS area	Number of houses visited	Number of containers encountered			Number of containers per 100 houses
		Tanks	Barrels	Total	
Akurana	539	111	81	192	36
Gangawatakorale	400	134	101	235	59
Kundasale	1100	366	512	878	80
Medadumbara	200	44	57	101	51
Pathadumbara	300	32	14	46	15
Pathahewaheta	300	79	71	150	50
Tumpane	501	130	59	189	38
Udapalatha	468	261	162	423	90
Udunuwara	260	30	34	64	25
Werallagama	165	22	14	36	22
Yatinuwara	240	172	127	299	125
Total	4473	1381	1232	2613	58

Table 3. Anopheline species breeding in water storage containers in the study area, Kandy District

Container type	Number of containers			
	Examined	Positive for		
		A. elegans	*A. maculatus*	Total
Tanks	1381	00	05	5
Barrels	1232	03	02	5
Total	2613	03	07	10

The stored water appeared clean and was used for domestic activities and construction work.

During the period of study the district received less rainfall resulting in complete drying up of some streams in the area.

Discussion

Anopheles maculatus is a species with wide occurrence in the oriental region. Although it occurs in a wide variety of natural breeding places (1) it is primarily a stream breeder (13). Rao, has reported its occurrence in artificial containers in India (13.) *Anopheles maculatus* is a major and important vector of human malaria in Malaysia and Singapore. It is a vector of local importance in Nepal, and of some importance in Thailand, Viatnam, Indonesia, Philippines and Cambodia (15). *Anopheles elegans* is found in India and in Sri Lanka. In India, it breeds in deeply shaded stagnant waters. In Southern India *A. elegans* has been found in tree holes also (13). Although *A. elegans* has been recorded as the vector of monkey malaria in India (16) and in Sri Lanka (17), there is no evidence of *A. elegans* being involved in transmission of human malaria.

In the study area, anopheline species including *A. maculatus* and *A. elegans* are primarily found to breed in riverbed pools (8,14). Therefore breeding of these species in artificial water storage containers is significant.

With the impending water shortages, water storage in containers is bound to increase in future. Drying up of small streams due to drought before and during the study period may have deviated the river breeding anopheline species to alternative breeding places such as water storage cement tanks and barrels. Therefore, it is important to consider water storage containers as breeding places of potential vectors of malaria. This finding could have relevance in planning malaria control activities in Sri Lanka.

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