BREEDING PATTERNS OF *AEDES STEGOMYIA ALBOPICTUS* IN PERIURBAN AREAS OF CALICUT, KERALA, INDIA

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Abstract. *Aedes albopictus* has been shown to be a vector for diseases which have been on the increase, such as dengue fever and chikungunya infection. We conducted a study of 100 homes from 2006-2009 to determine the breeding sites for *Ae. albopictus* mosquitoes in Calicut, Kerala, India. We found the larvae of *Ae. albopictus* mosquitoes most often in coconut shells and plastic waste, followed by tires, flower pots, glass products, egg shells and dumped grinding stones. *Ae. albopictus* control programs in Calicut, Kerala, India should target these objects as part of a control program.

Key words: *Aedes albopictus*, breeding patterns, India

INTRODUCTION

Aedes albopictus was described as a banded mosquito of Bengal by Skuse (1894), which has now assumed global significance because of its invasive and adaptive nature. It has the ability to transmit 22 arboviruses and has a current prevalence which includes Southeast Asia, Africa, Europe and the Americas; it poses a threat to human health the world over (Sprenger and Wuihiranyagool, 1986; Adhumi and Murati, 1987; Linthicum *et al*, 2003; Romi, 2004). In many areas it has either displacing or is coexisting with *Ae. aegypti*. There is renewed interest in the biology and control of this mosquito due to the reemergence of chikungunya and dengue, for which it is a vector, in many parts of the developing and developed world (Gartz, 2004; Paupy *et al*, 2009; Stock, 2009).

Widespread epidemics of chikungunya have been reported in many parts of India starting in 2005 (WHO, 2006) following an outbreak in the southwestern Indian Ocean Islands (Cordel, 2006; Delatte, 2008). Dengue and chikungunya outbreaks have been reported in Kerala, South India (NVBDCP, 2009). In many Indian states *Ae. aegypti* plays a dominant role in the transmission of dengue and chikungunya viruses (Saxena *et al*, 2006). Studies in Kerala show *Ae. albopictus* is a major vector of these diseases, while *Ae. aegypti* is limited to some urban pockets (Das *et al*, 2004; Tyagi and Dash, 2006; Thenmozhi *et al*, 2007). Since 2006 chikungunya has been reported from many parts of Kerala, including Calicut. Thousands of cases were reported from this region in 2008 and 2009. In view of this, a study was conducted to detect the important breeding places of *Ae. albopictus*

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Table 1
Breeding sites of *Ae. albopictus* mosquitoes during 2006-2009 in %.

Breeding sites	2006 (*N*=599)	2007 (*N*=790)	2008 (*N*=796)	2009 (*N*=815)
Coconut	45.2	30.2	35.4	25.6
Plastic	36.6	36.5	28.1	31.7
Tires	7.0	6.2	7.5	3.6
Earthen ware	3.7	15.8	18.2	9.6
Glass	4.3	6.2	5.6	23.6
Grinding stone	0.7	1.0	1.9	0.7
Egg shell	2.5	4.0	3.1	5.3

Table 2
Positive breeding sites for *Ae. albopictus* recorded during 2006-2009 in %.

Positive breeding sites	2006 (*N*=101)	2007 (*N*=148)	2008 (*N*=102)	2009 (*N*=101)
Coconut	42.6	27.7	29.4	30.7
Plastic	33.7	30.4	30.4	21.8
Tires	17.8	11.5	13.7	11.0
Earthen ware	1.0	9.5	13.7	4.0
Glass	2.0	11.5	4.9	27.7
Grinding stone	1.0	1.3	5.9	3.0
Egg shell	2.0	8.1	2.0	2.0

in periurban areas of Calicut from 2006 to 2009, when dengue cases started being reported from this region.

MATERIALS AND METHODS

Calicut lies between 11.25°N longitude and 75.77°E latitude, and the topography is a combination of hills, plains and coastal areas experiencing a typical tropical climate with an average annual rainfall of 3,266 mm and a temperature ranging from 14°C to 39°C (Calicut District, 2009). Most of the area is covered with coconut plantations but the eastern hills, part of Western Ghats, consists of rubber, areca and cocoa plantations. The coastal area is mostly urban. The climatic patterns are similar throughout the district. One hundred households from suburban areas were randomly observed for four years during 2006-2009 during rainy season (May-October) and containers were evaluated for presence of *Ae.albopictus* larvae.

RESULTS

Tables 1, 2 and 3 and Figs 1, 2 and 3, show the results of the observations. Coconut shells and plastics comprised the majority of the containers in the area. These were followed by flower pots, glass waste, tires, grinding stones and egg shells. Natural breeding sites were negligible in suburban areas. Though fewer in number tires and grinding stones had a

Table 3
Positivity rates for *Ae. albopictus* in different locations during 2006-2009 in %.

Breeding sites	2006	2007	2008	2009
Coconut	15.9	17.1	10.6	14.8
Plastic	15.5	15.6	13.8	8.5
Tires	42.9	34.7	23.3	37.9
Earthen ware	4.5	11.2	9.7	5.1
Glass	7.7	34.7	11.1	14.6
Grinding stone	25.0	25.0	40.0	50.0
Egg shell	13.3	37.5	8.0	4.6

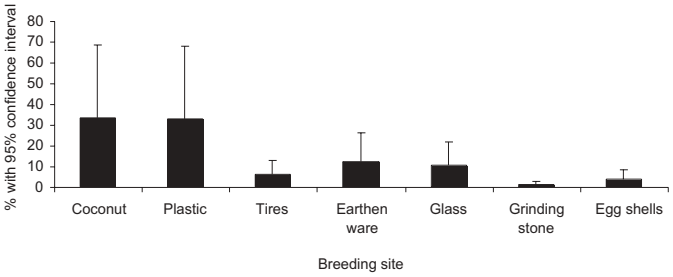

Fig 1–Composition of breeding sites for *Ae. albopictus* during 2006-2009.

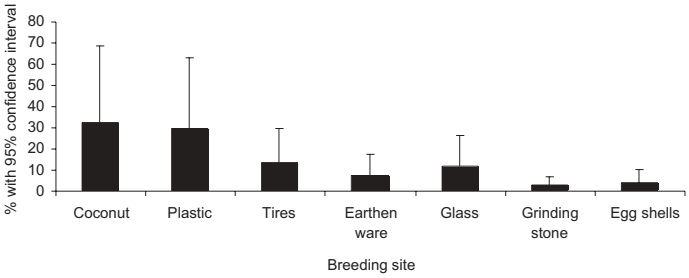

Fig 2–Composition of positive breeding sites for *Ae. albopictus* during 2006-2009.

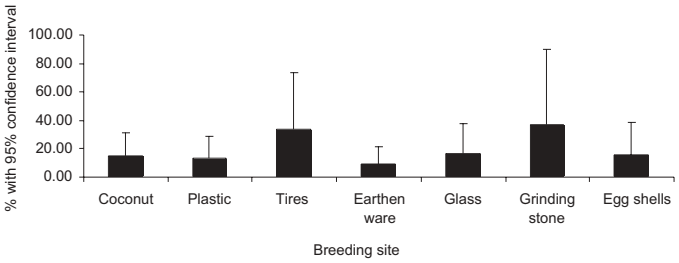

Fig 3–Positive rates breeding sites for *Ae. albopictus* during 2006-2009.

significantly higher larvae positivity rate than plastics (Odds ratio, 95% CI, tires 3.25, 2.23-4.73; $p<0.001$, grinding stones 3.71, 1.67-8.12, $p<0.001$; coconut shells 1.1,0.85-1.43, $p>0.46$). Flower pots showed significantly less breeding of albopictus (OR-0.64, 95% CI -0.42-0.97, $p<0.026$). Positivity in the other breeding sites was comparable to plastic and coconut shells.

DISCUSSION

Ae. albopictus was originally a wild species breeding mainly in natural containers, such as bamboo, tree holes, leaf axils, rock pools etc (Hawley, 1988; Mouchet and Canavale, 1997; Juliano and Lounibos, 2005). Regu *et al* (2008) observed areca leaves as a major breeding source for *Ae. albopictus* in hilly regions of Calicut District. Coconut shells, which are used for collecting rubber sap, also play a major role in the population dynamics of this mosquito in

hilly terrains (Sumodan, 2008). There has been a tremendous expansion in plantation crops in Kerala over the years. This, coupled with population migration to fragile ecosystems, created a congenial atmosphere for the establishment of this mosquito. Ecological changes, deforestation and tampering with nature, caused invasion of *Ae. albopictus* in new habitats (Gubier *et al,* 2001). Increased usage of plastics the world over has created innumerable non-biodegradable habitats for this ecologically adaptive mosquito (Mouchet and Carnavale, 1997). Lack of proper disposal mechanisms for plastic waste, and indiscriminate dumping practices, aggravate the problem in developing countries. Replacing plastics with ecofriendly materials, recycling and discouraging their use by proper health awareness programs should be helpful in reducing breeding sites.

Coconut shells discarded after using the kernel for cooking, collect water during monsoons (Tyagi and Dash, 2006). A positivity rate of approximately 15% was seen in coconut shells. Burning and or using for handicrafts and locally acceptable products, would help reduce coconut shells.

Tires were instrumental in the spread of *Ae. albopictus* to the Americas, Australia, Africa and Europe, even displacing *Ae. aegypti* in some areas of America (Romi, 1995; Rodham, 1996). Discarded tires had a high positivity for *Ae. albopictus* in this study. Tires as breeding ground for mosquitoes, is not given enough attention; water collects inside but is not readily observable. Unlike plastics and coconut shells which are vulnerable to natural and human disturbance, tires harbor larvae undisturbed and secure. Humidity, cool temperature and reduced light inside it makes it an ideal source for *Ae. albopictus*. A similar situation is observed with dumped grinding stones used for grinding cooking ingredients which were used prior to the advent of electric appliances. Tires should be targeted in any *Ae. albopictus* control program. Removing tires is essential to prevent reproduction and spread. Eggs attached to tires also play a role in the maintenance of the mosquito population throughout the off season.

Other breeding sites recorded in the area were glass wastes, egg shells and flower pots. The numbers and positivities of these sources fluctuated over the observation period. These sites should also be given attention in control programs. Like plastics, glass is also non-biodegradable and tends to accumulate in the environment. Effective recycling would address this issue to some extent. Frequent handling of flower pots reduces breeding to a large extent and egg shells, though serving as breeding sites, are prone to destruction and thus have a shorter life span.

Ae. albopictus has impacted health systems in many developing countries. Eradication of this mosquito is difficult to achieve as evidenced in America (Gartz, 2004). Applying too much pressure can encourage a change in ecological niche to semi-domestic and domestic habitats. Maintaining a low acceptable level may be more effective in tackling this health threat. Control programs should target tires, coconut shells and plastic items to effectively tackle the *Ae. albopictus* problem.

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