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Survey of mosquito vector abundance in and around tribal residential areas

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Abstract
Mosquitoes are having high capacity to transmit pathogens (parasites and virus) to humans causing mosquito-borne diseases. This is a major public health problem in most of tropical and subtropical countries. Its control is becoming more and more difficult due to the spread of resistance of the vector. The study was conducted to estimate the mosquito larval density, diversity and preference breeding sites of *Aedes*, *Culex* and *Anopheles* mosquito species in Sitheri hills, Dharmapuri district, Tamil Nadu, India. Larval samples were collected by dipping method using pipette dipper depending on container types for all seasons of the year 2012. The collected larvae were raised to adults for identification. A total of 460 water containers were inspected in eight villages. The study confirm the presence of eight dominant mosquito species in the study area namely *Aedes aegypti* (45%), *Aedes vittatus* (23%) *Aedes albopictus* (15%), *Culex quinquefasciatus* (9%), *Anopheles subpictus* (4%), *Culex gelidus* (2%), *Culex nilgricus* (1%) and *Culex tritaeniorhynchus* (1%). It's observed that the major breeding sources are mud pot, grinding stone, cement cistern, metal vessels, tree hole, rocky hole, stagnant water lock area, rice field, waste tyre, cement tank, canal and plastic container. The present study concludes that the species of *Aedes aegypti* and *Aedes vittatus* was most predominant container breeding mosquitoes and the villages of Sitheri and Selur having more number of mosquito larvae populations in the study area. The study is useful for creating awareness and control of mosquito-borne diseases and its breeding sites.

Keywords: *Aedes aegypti*, *Aedes vittatus*, container survey, mosquito-borne diseases, mosquito larvae.

1. Introduction
Mosquitoes are not only a nuisance, but are also responsible for the spread of a wide range of diseases including Malaria, Yellow fever, Dengue, Chikungunya, West Nile virus and Rift Valley fever. These mosquito borne diseases are a leading health problem. Around the world more than 700 million people suffer from mosquito-borne diseases and approximately two million people die in every year [1]. Mosquitoes are unquestionably the most medically important arthropod vectors of disease. The maintenance and transmission of the pathogens are absolutely dependent on the availability of competent mosquito vectors.

Among the mosquito borne diseases dengue is a serious problem in India. Over 2.5 billion people are now at risk from dengue. WHO currently estimates there may be 50-100 million dengue infection worldwide every year [2]. In India, Dengue Fever (DF), Dengue Haemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS) have been documented in different parts of the country [3] including southern part of India [4, 5]. Among the thirteen genera of the family Culicidae, genus *Aedes* is considered dangerous because of their significant public health threat all over the world. One of the dominant species of *Aedes* showing wide geographic distribution and spanning both temperate and tropical climate zones is *Aedes aegypti* (L). It is a primary vector of dengue viruses. The *Ae. aegypti* is well adapted to living with people and in much of the world is predominantly found among human settlements. Immature *Ae. aegypti* develops in artificial and natural water-holding containers located in and around human habitations. The problem of dengue has now been extended to several rural areas [6]. In Tamil Nadu, among the 32 districts, dengue cases have been reported in 29 districts between the years of 1998 to 2005. Which includes, DSS /DHF outbreaks were presented in Chennai, [6] (2001) Nagercoil (2003) and Tiruchirappalli (2003). The DHF outbreaks presented in Krishnagiri and Dharmapuri districts during 2001[7]. In 2012, a total of 9,000 cases and 50 deaths were reported in Madurai, Tirunelveli and Kanyakumari districts [8].

A primary determinant of adult mosquito population density concerns the types and number of containers in a given environment. Adult production is unevenly distributed across potential larval development sites. In most cases, a few key types of containers are responsible for a

large proportion of the larval, pupal and thus adult, production [9]. According to the Land use and land cover changes, such as deforestation, agricultural expansion, infrastructure development, urbanization and human population growth contribute to the proliferation of breeding sites of mosquitoes [10]. These environmental or land-use modifications also affect climate processes that are likely to support rapid growth of mosquitoes and parasites in regions where there has previously been a low temperature restriction on transmission. The present study to investigate the species specific mosquito habitats and abundance of mosquitoes in sitheri hills.

2. Materials and Methods

2.1 Study Area

The mosquito larval survey was carry out from January 2012 to December 2012 in Sitheri hills (also called as Chitteri).

The hills has an area about 654.52 sq.km which is located in Eastern Ghats of Tamil Nadu, within the geographical limit of 78°15'00'' - 78°45'00''E longitude and 11°44'00''-12°08'00''N latitude. The study area situated at Pappireddipatti Taluk in Dharmapuri district, Tamil Nadu, India. This is a hill area consists of 59 hamlets and four forest ranges such as Harur, Morappur, Theerthamalai and Kottapatti. The sitheri hills have six forest types are evergreen, semi-evergreen, riparian, dry mixed deciduous, dry deciduous scrub and southern thorn scrub forest classified by Champion and Seth (1968). The study area mean annual temperature are varies from 18 °C (in winter) to 40 °C (in summer) and maximum annual rainfall 900 mm respectively. Many narrow valleys (rivers) are presented such as Varattar, Kallar, Kambalai and Anaimaduvu. Topographically, altitude of the hills ranges from 1463 to 3187 ft. The location map of the study area is given in Fig. 1.

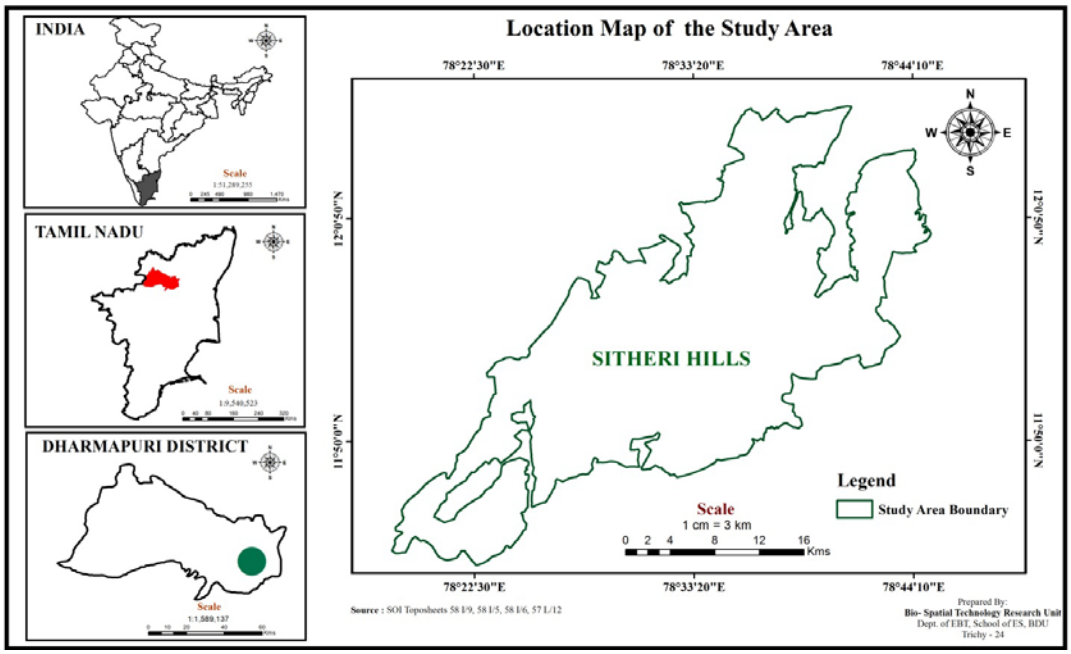

Fig 1: Study Area Map

2.2 Larval Collection

During the survey, larvae were collected in all the containers and accessible tree holes (Fig. 2). Larvae collection was carried outdoors by dipping method, using pipette dipper depending on container type and location. The number, type and water condition of containers which serve as a potential breeding site was examined and the following indexes are calculated. The collected larvae and pupae were kept in the laboratory for adult emergence at room temperature (27±2 °C). The emerged adult mosquitoes were then pinned and identified.

House index (Hl): Percentage of houses infected with larvae and/or pupae

HI = Number of Houses infected/Number of Houses inspected X100

Container Index (Cl): Percentage of water holding containers infected with larvae or pupae.

Cl = Number of positive containers/Number of containers inspected X100

Breteau Index (Bl): Number of positive containers per 100 houses inspected

Bl = Number of positive containers/Number of houses inspected X100

Pupae Index (Pl): Number of pupae per 100 houses

Pl = Number of pupae/Number of houses inspected X100

2.3 Identification of Collected Larvae

The collected specimens were preserved in plastic vials for further identification. Immature forms of mosquito larvae were collected by dipper method, reared in metal trays in the laboratory and fed with larval feed. The emerged adults were collected and stored in vials and all the collected mosquitoes were identified in Centre for Research in Medical Entomology (CRME), Madurai using the standard keys [11].

Fig 2: Sources of mosquito larvae breeding habitats. a). Mud pot, b). Grinding stone, c). Cement cistern, d). Metal vessels, e). Tree hole, f) Rocky hole, g). Stagnant water lock area, h). Rice field, i).Waste tyre, j.) Cement tank. k). Canal, l.) Plastic container.

3. Results

A total of 368, both artificial and natural containers were surveyed as potential mosquito larvae breeding habitats in Sitheri hills, presented in Table 1. The morphology and taxonomy of the collected adult mosquitoes were identified based on the examination of the taxonomic keys. In the present study the dominant mosquito species *Ae. aegypti* adult mosquito has mesonotum marked with a pair of lateral curved white lines, and usually also with a pair of submedian yellowish lines and tibiae without white rings. The *Ae. vittatus* exposed 4-6 small white spots on the mesonotum and tibiae with white rings. *Ae. albopictus* is another important dengue vector in the study area. These species showed a narrow median silvery white line in mesonotum. The pleurae were arranged in irregular patches with white lines and tibiae without white line. A silvery basal band is presented in abdomen of *Ae. albopictus.*

Another important mosquito in the study area is *Culex species.* The Cx. *quinquefasciatus* species is a highly presented. It is a filariasis vector and the external morphology was observed by following characters. The proboscis and tarsi were without pale rings. The pleuron has without striking pattern of dark and pale stripes. The abdominal terga have basal pale bands. These characters confirm the species *Cx. quinquefasciatus.* In the species of *Cx. gelidus* anterior surface of fore and mid femora having without speckling of pale scales and scales on prescutellar space, behind wing base and on scutellum entirely dark. The pale band is presented in proboscis narrow and less than length of basal dark area.

The *An. subpictus* is a Japanese encephalitis vector in India

and morphological characters are femur and tibia not speckled, hind tarsomere is 5 and not in a white colour. The broad pale bands in the fore tarsi and the palpi with subapical dark band equal to the apical pale band. From the morphological observation a total of 460 specimens, the eight mosquito species are identified at various percentages (Fig.3) in the study area are namely *Ae. aegypti* (45%), *Ae. vittatus* (23%) *Ae. albopictus* (15%), C*x. quinquefasciatus* (9%), *An. subpictus* (4%), C*x. gelidus* (2%), C*x. nilgricus* (1%) and C*x. tritaeniorhynchus* (1%). The details of the village wise larval survey presented in Table 1. In Fig.3 the percentage of collected different mosquito larvae were clearly shown. This gives the details of predominant mosquitoes in the study area.

From the container survey, a total of 76 containers were found positive for mosquito larvae. Which includes mud pot (18), grinding stone (15), cement cistern (8), metal vessels (4), tree hole (3), rocky hole (4), stagnant water lock area (1), rice field (2), waste tyre (4), cement tank (6), canal (1) and plastic container (10) the details given in Table. 1. The outdoor environment was found to be the best breeding sites for mosquito species because of filling of the containers with the rain water and storage of water in cement cisterns, and plastic drums by the tribal people. In study area area many of the tribes are used peridomestic containers such as mud pot, grinding stones, metal container, tyre and unused well, which should be surveyed well. Because there are predominant mosquito breeding habitats.

Among all type of containers survey, the percentages of mosquito larvae presence in the container were calculated. The values are 27% in mud pot, 19% in grinding stone, 5% in cement cistern, 3% in metal vessels, 2% in tree hole, 3% in rocky hole, 4% in stagnant water lock area, 2% in rice field, 11% in waste tyre, 8% in cement tank, 2% in canal and 14% in plastic container (Fig. 4). The vector surveillance index of container index, house index, breteau index and pupae index of the study area is given in Table 2. From indexes and other results, the disease risk predicted villages are Sitheri and Sellur due to highest number of mosquito larvae occurrence (Fig. 5).

The results clearly indicates that the breeding habitats of *Ae. aegypti* and *Ae. vittatus* larvae were in wide range in artificial containers like grinding stone, tree hole, plastic container and mud pot etc. *Cx. quinquefa*sciatus were collected from natural water lock area, plastic container and mud pot containing high organic matter and *Ae. albopictus* were highly found in the waste tyre, plastic drum, cement cistern and grinding stone. *An. subpictus* was mostly presented in the rice fields.

Table 1: Village wise larval survey in the study area.

S. No	Hamlets	Larval Habitats / Species Name	*An. subpictus*	*Cx. gelidus*	*Cx. nilgricus*	*Cx. tritaeniorhynchus*	*Cx. quinquefasciatus*	*Ae. vittatus*	*Ae. aegypti*	*Ae. albopictus*	Total
1.	Sitheri	Mud pot					15		10	14	**39**
		Natural water lock area	5			4	10				**19**
		Cement cistern									**0**
		Cement tank							9		**9**
		Plastic container							9		**9**
		Tree hole							10		**10**
		Metal container						5	9		**14**
2.	Pereri	Mud pot			1				28		**29**
		Rice field	11								**11**
3.	Nochikuttai	Cement cistern						4			**4**
		Grinding stone						3	9		**12**
		Rocky hole							8	4	**12**
		Mudpot						3	13		**16**
4.	Suriyakadai	Grinding stone						8	11	10	**29**
		Mud pot						1	11	4	**16**
5.	Selur	Tyre					1		3	25	**29**
		Grinding stone							12		**12**
		Canal		8							**8**
		Plastic container						11	18		**29**
		Mud pot					10				**10**
6.	Thadhukkan Halli	Cement cistern						7			**7**
		Plastic drum	1					8	11	4	**24**
7.	Thekkal patti	Grinding stone						1	10	3	**14**
		Mud pot					6			8	**14**
		Cement tank						8	21		**29**
		Cement cistern						11			**11**
8.	Ammapalayam	Tyre						18	5		**23**
		Grinding stone						21			**21**
	Total		**17**	**8**	**1**	**4**	**42**	**109**	**207**	**72**	**460**

Table 2: Mosquito species surveillance index in Sitheri hills (2012).

S. No	Hamlets	No. of houses		No. of containers		No. of Pupae	House Index	Container Index	Breteau Index	Pupae Index
		Examined	Positive	Examined	Positive					
1.	**Sitheri**	20	9	51	9	36	45.00	17.65	45.00	70.59
2.	**Pereri**	8	1	16	1	0	12.50	6.25	12.50	0.00
3.	**Nochikuttai**	12	6	45	6	14	50.00	13.33	50.00	31.11
4.	**Suriyakadai**	10	4	15	4	49	40.00	26.67	40.00	32.67
5.	**Selur**	10	6	18	6	0	60.00	33.33	60.00	0.00
6.	**Thadukkan Halli**	8	2	9	2	7	25.00	22.22	25.00	77.78
7.	**Thekkalpatti**	10	6	33	6	14	40.00	18.18	40.00	42.42
8.	**Ammapalayam**	10	4	20	4	0	40.00	20.00	40.00	0.00
	Total	114	38	254	38	120	33.33	14.96	33.33	47.24

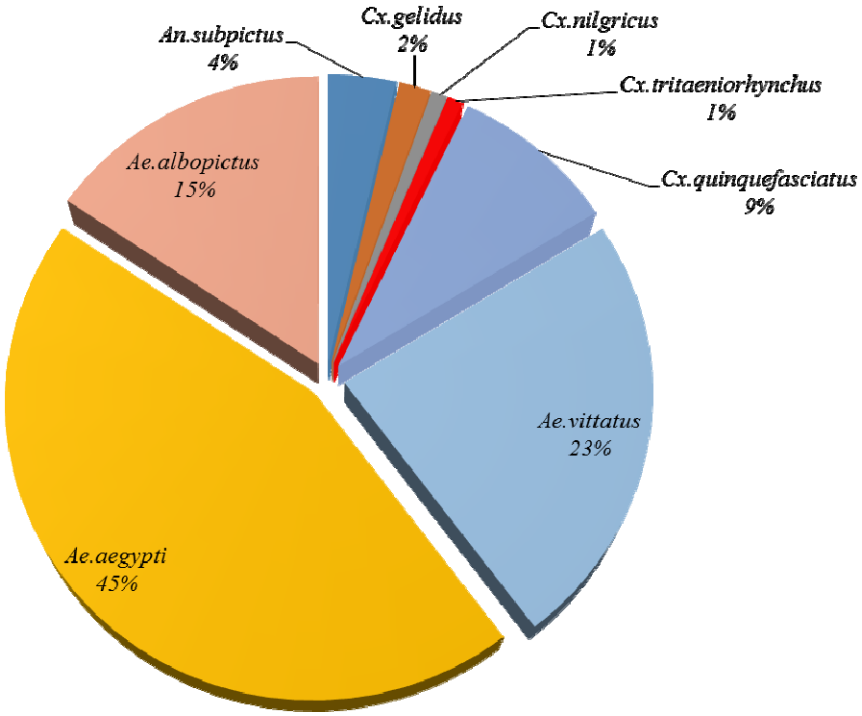

Fig 3: Species wise distribution of mosquito population in the study area.

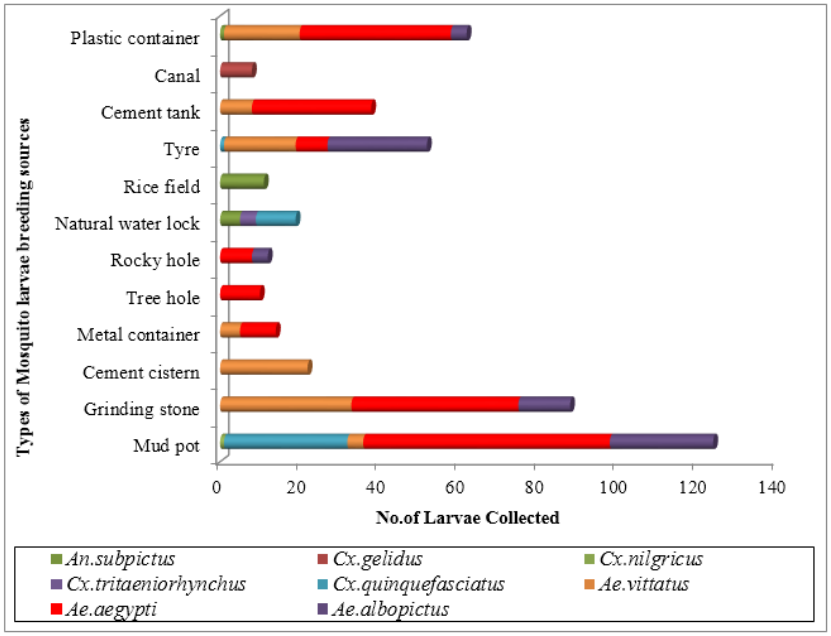

Fig 4: Different types of containers supporting breeding of various mosquito species.

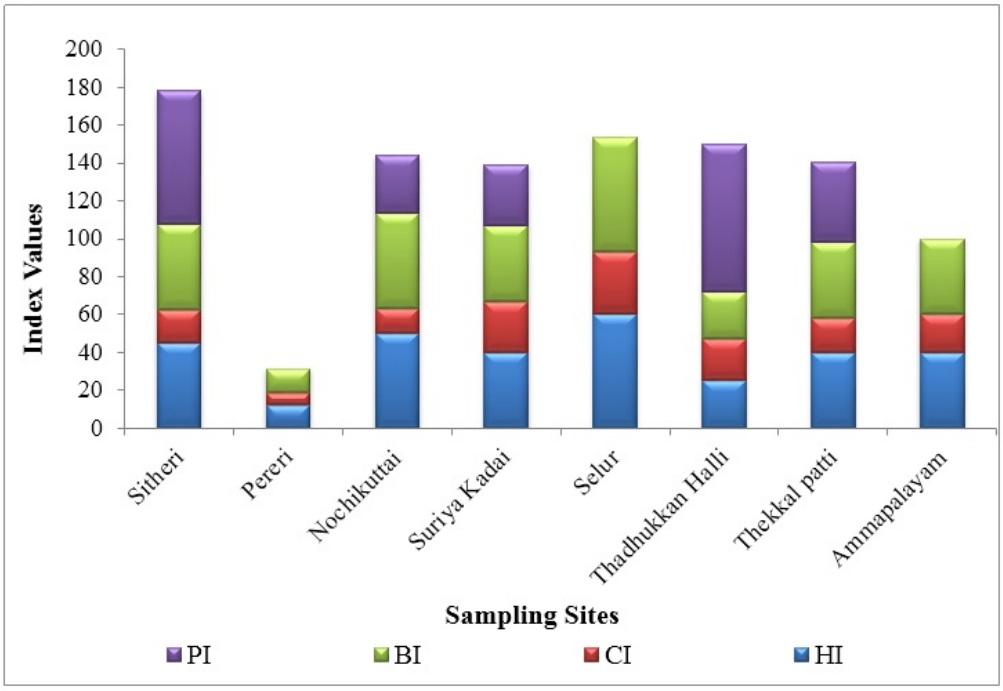

Fig 5: Mosquito species surveillance index in various sampling sites.

4. Discussion

The mosquito-borne diseases are huge public health problem need to be addressed in the study area. In recent years, low rainfall in the study area that's why people facing the problem of water shortage. So there are storing the water in different containers. These containers, if not properly covered, could serve as breeding sites for disease vectors [16]. In the present study larval survey was done because it is the most widely used method for entomological surveillance, for practical reasons when compared to egg, pupae and adult surveys. The water-holding containers are the main larval habitats for *Aedes* mosquito. The quality of water as well as conditions of water containers seemed to contribute to the abundance of *Aedes* species in the study site [15]. Besides, water chemistry of aquatic habitats may also play a critical role in determining the survival rate of mosquitoes. *Aedes albopictus* was found to be the most common species distributed equally in urban and rural areas, while *Ae. aegypti* was predominantly distributed in urban areas. In semi-arid areas of India, it is documented that *Ae. aegypti* is an urban vector and populations fluctuate with rainfall and other water storage practices [12]. The larvae of *Cx. quinquefasciatus* were collected more in number and they usually breed in stagnant and organic polluted water which placed *Cx. quinquefasciatus* as a non-forest species and anthropophilic nature [13, 14, 15]. The rapid spread of *Aedes* species in study area was due to the storage of water in cement tanks and plastic container. These habitats were either man-made or associated with anthropogenic activities. The *Aedes* species habitats especially hoof prints, are very small, they are very abundant in the environment. Increasing human population in the catchment resulted in increased anthropogenic activities including deforestation, agricultural expansion, livestock rearing and brick making which could create suitable habitats for mosquito larvae [6]. In tribal area, the agricultural expansion creates favorable habitats for mosquitoes especially *Anopheles* species, thereby increasing malaria transmission [1]. In addition, agriculture can cause increased sedimentation due to erosion, which can slow or block streams and decrease the water depth, creating shallow waters ideal for mosquito breeding [12]. From this investigation, it is clear that there are many chances of vector borne diseases spreading in the sampling location. It is a serious health hazard for tribes who are living in remote areas where there is no and less transportation and medical facilities. So control is one of the best methods to provide protection from several diseases.

5. Conclusion

It is a baseline survey for further studies about mosquito abundance, distribution in a variety of habitats. The study reveals that unavailability of proper water storage system presented among the tribes. The water storage containers are acting as breeding habitats of mosquitoes, which are vectors for the mosquito-borne diseases. From the result, the study concludes that the peoples need of intensive training and awareness programmes about the vector ecology and vector borne-diseases. It will help to control mosquitoes from breeding sites by themselves.

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