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A Survey Report on Baseline Data of Mosquito Distribution in Tree Holes of Discrete Ecosystem During Different Seasonal Patterns

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Abstract: A ground based survey of age old trees were monitored to determine the risk factor of mosquito vector distribution in phytotelmata [plant held water] for three constitutive monsoon seasons (2007-2009) in Bharathidasan University campus. The study area was about 450 acres and engaged with 154 age old trees, of which neem (n=2) and copper pods (n=15) are water holding (n=11) rots and (n=20) pans and providing nourishment to the mosquito vectors during rainy seasons. The structural and physico-chemical characteristics of water holdings shows divergence in angle of opening (truck/branch) and surface area, (4.1-21 length x 3-12 width cm x 3-32 cm depth), height from ground level (32-197 cm), water capacity (10- 2168 ml), total litter (1.3-234 g), pH (4.5-7.5), temperature (23-27°C) electrical conductivity (1.036-922.5 µS/cm) and (Total Dissolved solids) TDS (0.663-590.0 ppm) which empowers the entomological richness. During the course of study, mosquitoes were emerged out from pans (n=1107) and rots (n=523), among which *Aedes albopictus* (Skuse), 81.96 %, *Ae. aegypti* (Linnaeus), 4.53 %, *Ae. vittatus* (Bigot), 1.59 %, *Anopheles stephensi (*Liston) 2.76 %, *Culex. quinquefasciatus* (Say) 8.40 % and *Toxorhynchites splendens (*Wiedemann) 0.74 %. The baseline data emphasizes the high productivity of *Aedes* mosquitoes at risk for dengue and chikungunya fever in these surroundings. Moreover, the geographical study area was constrained for field model system for analyzing an eco-friendly approach for control programme.

Key words: *Aedes albopictus* · Phytotelmata · Structural Features · Physico-Chemical Properties

INTRODUCTION

Mosquito borne diseases such as malaria, chickungunya, filaria, yellow fever and dengue fever, pose a real threat to public health. Recently, the sudden eruptions of these diseases were re-emerging in many parts of the world with multiple foci owing to continuous circulation in nature amid wild birds or mammals [1]. Most mosquito -borne diseases are weather sensitive and exhibit distinct seasonal patterns such as rainfall, temperature and other factors influence that alter the transmission cycle [2, 3]. Dengue and chickungunya are transmitted by the bite of *Ae. aegypti* and to some extent *Ae. albopictus* and *Ae. vittatus* resulting in high morbidity and mortality [4, 5]. The World Health Organization [6] estimates about 2.5 billion people were at risk owing to dengue and chickungunya around the world [7]. Since 2005, in several states of Indian sub-continent, there were rapid outbursts of chickungunya fever, with wide spread and geographic overlap [8,9] and also extension of vector range and their increased incidence [10]. Niyas [11] report that *Ae*. *albopictus* facilitates rapid transmission of the new strains of CHIKV that had adaptive mutations in the viral genome. In India, more than 1.25 million cases have been reported attack rates have reached up to 45% [12]. Moreover, South India is panic for mosquito borne disease outbreak and more research is essential to fulfill the extensive knowledge gap regarding the ecology of culicids, surveillance and population monitoring and source reduction.

Mosquitoes prefer any aquatic habitats for breeding and the prevailing physicochemical parameters are vital factors for productivity establishments [13, 14]. *Ae. albopictus*, is indigenous of Asia, an ancestral

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phytotelma dweller, breeds extensively in any natural containers like tree-holes, plant axils, pitcher plants and bromeliads [13]. Rain dependent tree-holes communities are small, discrete and detritus based community provides nourishment for immatures [15].

The mosquito breeding sites provide a basic knowledge essential to evaluate for effective control measures [16]. The habitat reduction is the only way to curb the populations and its borne diseases than after arboviral eruptions with multiple magnitude effects. Earlier report in 1958 by Bonnet & Chapman [17], accounted for elimination of breeding sites will be more effective strategy to suppress disease transmittance. Since the surveillance was conducted in the university campus during monsoon seasons particularly tree-hole habitats for prevalence of mosquitoes. Moreover, no study has been conducted regarding mosquito ecology and its distribution in discrete ecosystem. In addition to that the geographical area was constrained for evaluation of mosquito control programme pertaining towards human and animal welfare and finally source reduction will be carried out in near future. Henceforth, the study focuses on survillaince and characterization of tree holes mosquito during different seasonal patterns from 2007- 2009 and to document the mosquito's diversity and habitation.

MATERIALS AND METHODS

Geography of Study Area: The study area, Bharathidasan University campus, Tiruchirappalli, Tamil Nadu, India, lies between 10° 00' and 11° 30' Northern latitude, 74.858 of the Eastern longitude; Altitude is about 78 m and occupied about 450 acres surrounded with human interference More over vegetation rich with age old trees such as *Azadirachta indica* (AI), copper pods *Peltophorum pterocarpum*, *Pongamia pinnata*, (PP), *Eucalyptus*, mango(*Mangifera indica*) (MI), banyan (*Ficus benghalensis)*(FB), peepal (*Ficus religiosa)* (FR) The region has a dry climatic condition [mean annual rainfall and temperature of 746.8 mm and 34 °C, respectively] and seasonal monsoons extend from June to December. (National Climate Data Center, India).

Survey of Tree-Holes: The entomological survey was conducted for three consecutive monsoon seasons during 2007-2009. Totally 154 age old trees were recorded, from the survey area of 17 trees namely neem and copper pods were accounted for providing nourishment as rots (rotting cavity penetrating into the heartwood) and pans (branches grow together at a crotch) as defined by Kitching, [18]. The structural measurements of different water holding capacities were measured from angle of tree-holes, aspect of direction (N, S, E or W), height from ground level (cm), height location (branch, trunk or fork) and their surface area (dbh; cm) [19]. The water volume and presence of mosquito juveniles were recorded as "potential vectors containers" and with larvae were recorded as "positive containers" [15]. The entire content of the tree-hole was aspirated using a glass pipette, water volume measured and its properties such as temperature, pH, electrical conductivity, total litter and total dissolved solids were determined [20]. During seasonal monsoons, daily entomological survey was performed and every fortnight water samples were collected for detection of mosquito immature. The entire collected mosquito juveniles were counted, reared, maintained in the laboratory (21) and identified using taxonomic keys with catalogues of Knight (22).

RESULTS

The study area was elevated on 1982 for university campus earlier it was an cultivated land, after university established the plantations were raised of about 450 acres, now 154 varieties of trees such as neem, copper pods, pongamia, eucalyptus, banyan, peepul and mango etc., were recorded as age old trees. Among the trees, two trees belonging to family Meliaceae (*Azadirachta indica*) and Fabaceae (*Peltophorum pterocarpum)* were identified as harbouring for mosquito development. Yet majority of the tree-holes were very small (< 3cm), dry and damp containers. Only potential vector containers were 69, of which 64 to PP and 5 for AI. Under screening only 15 PP (9 rot and 20 pan) were positive and productive sites while AI have only 2 trees that to 2 rots. Tree-holes were not uniformly distributed among trees with 2 or more wet containers occurred in PP while in AI rots were single per tree (Fig. 1).

In Table 1, the structural features of water holding capacities were observed in all directions but rots were located only towards road due to pruning, more over situated in vertical position of the trunk /branch either below 2 feet (32-58 cm in trunk, n=5) or above (119-197 cm in branch, n=6) with water quality was clear and brown coloured. But pan holes (PP, n=20) were positioned from ground level above 2 feet, are about 105-187 cm present in crotch of the branch, shaded, horizontal in position and water quality was turbid to clear and straw coloured.

Table 1: Structural characteristic of breeding tree-hole habitats

Tree/ type	Ground level [cm]	Aspect direction/ shade	Location branch/ trunk/crotch	Angle of opening vertical/ horizontal/ narrow	Surface area lxb [cm]	Depth [cm]	Max. Vol [l]	Total litter [g]	Water quality Turbid/clear- straw/brown
AI Rot	32-119	South-East	trunk	vertical	5.3-6 x 5.3-7.9	6-18	0.3-0.9	112.0-234.0	clear-brown
PP Rot	42-197	E,W,S	trunk-branch	vertical	4.1-10 x 3-12	3-32	0.2-1.8	1.3-165.7	clear-brown
PP Pan	105-187	Shade	crotch	horizontal/ narrow	4-21 x 3-12	3-25	0.1-2.5	1.2-234.0	turbid/ clear-straw

E- East, W-West, S-South. PP *(Pongamia pinnata)*

Table 2: Physico-chemical characteristics of different water capacities during seasonal monsoon [2007-2009]

		SWM [June-Sept]				NEM [Oct-Dec]			
Habitat Type	Water measured [ml]	Temp °C	pH	Ec [µS/cm]	TDS ppm	Temp °C	pH	Ec [µS/cm]	TDS ppm
AI Rot	30-100	23-26	5.0-6.7	7.096-86.22	4.57-55.2	22-24	5.0-7.3	12.45-102.7	7.97-65.7
PP Rot	10-1640	23-26	4.5.7.5	6.807- 41.2	4.36-282	22-24	5.5-7.1	7.759-922.5	4.96-590
PP Pan	10-2300	23-27	5.0-7.5	1.036-18.3	0.663-75.6	23-25	5.1-7.5	23.46-387.3	15.0-248

SWM South West Monsoon .NEM North East Monsoon Ec Electrical conductivity
PP *(Pongamia Pinnata*)

Table 3: Relative abundance, species specificity and percentage of mosquito immatures occurrence in the tree-holes during three consecutive monsoons [2007-2009]

	S.W.M 2007-09			N.E.M 2007-09				
Mosquito species	AI rot	PP Rot	PP Pan	AI rot	PP Rot	PP Pan	Total	%
Ae.albopictus	22	132	334	57	282	509	1336	81.96
Ae. Aegypti	0	11	25	0	11	27	74	4.54
Ae.vittatus	0	0	17	0	4	5	26	1.6
An. Stephensi	0	0	26	0	4	15	45	2.76
Cx.quinquefasciatus	0	0	0	0	0	137	137	8.40
Tx. Splendens	0	0	0	0	0	12	12	0.74
Total	22	143	402	57	301	705	1630	100

SWM South West Monsoon, NEM – North East Monsoon
PP *(Pongamia Pinnata*) AI – *Azadirachta indica*

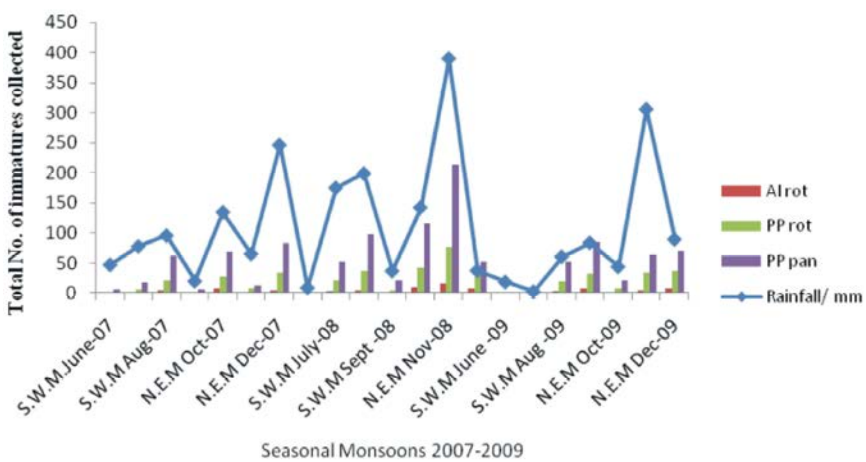

Fig. 1: Rainfall data of larval abundance in tree-hole types of AI & PP trees during the study [2007-2009] PP *(Pongamia Pinnata*) AI – *Azadirachta indica*

The surface area of containers varies in size, AI rots ranging from 5.3-6 (*l*) x 5.3-7.9 (b) cm with a depth of 6-18 cm, PP rots 4.1-10 (*l*) x 2-12 (b) cm and 3-32 cm depth and PP pans with 4-21 (*l*) x 2-12 (b) cm and depth of about 3-25 cm. The volume of the water, physico-chemical characters and leaf litter also depends on the size and location of the tree-hole container, AI rots (0.3-0.9 ml, 12.0-234.0 g), PP rots (0.2-1.8 ml, 1.3-165.7 g) and PP pans (0.1-2.5 ml, 1.2-234.0 g). The collected water ranges from 10-2300 ml, temperature between 23-27°C, pH 4.5-7.5, electrical conductivity 1.036-922.5 µS/cm and TDS were 0.663-590 ppm respectively (Table 2).

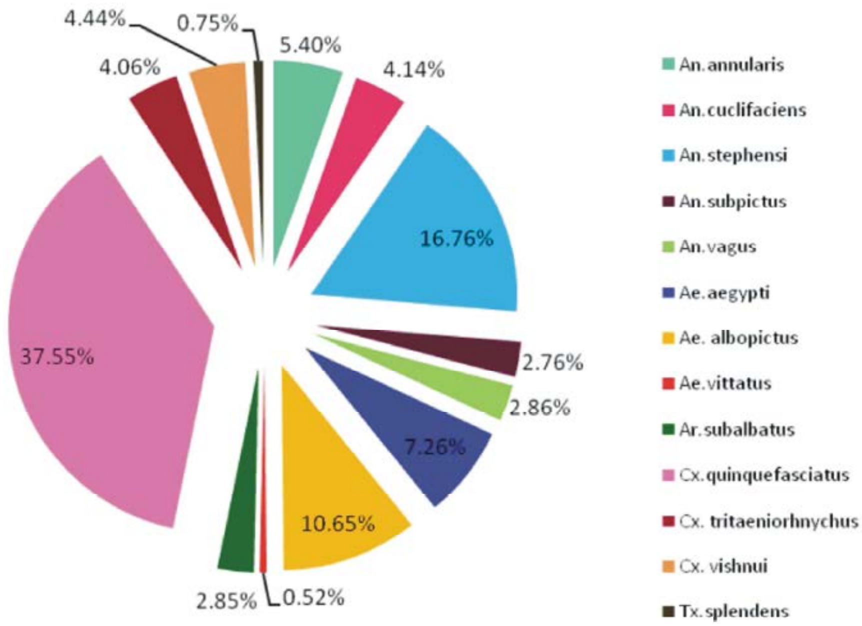

Fig. 2: Total mosquito larvae collected and their species diversity (%) during 2007-2009

Table 3 Mosquito immature were accounted for three consecutive monsoon seasons showed the maximum during NEMs in 2008 (n=564) and lowest population density at SWM in 2007 (n=125). The PP pans were the highest producers in all three monsoons ranges from 0-287, but during NEM in 2009, the PP pans were reduced due to predatory species *Tx. splendens*. The rots of AI and PP were less and ranges from 0-10 and 0-60 respectively (Fig. 2).

In the overall study about 1630 mosquito immatures were collected and identified. *Ae.albopictus* were the most common, accounting for 81.96 % (n=1336) followed by 8.4 % *Cx. quinquefasciatus* (n=137). *Ae. aegypti* and *Ae.vittatus* recorded 4.54%, (n=74) and1.6%, (n=26) respectively. *An.stephensi* was about 2.76 % (n=45) and finally the predatory species *Tx. splendens* recorded as 0.74%. (n=12) (Fig. 2).

In our observations the larval populations were observed within a week after rainfall particularly *An. stephensi* and *Ae. albopictus*. Interestingly, in early SWM (June –July) containers were recorded empty due to high wind and RH, even with moderate to heavy pour of rainfall. In the overall study mosquito females prefers to oviposit according to the elevation and ground based level *Ae.albopictus* to oviposit in all the containers without any restrictions but *Cx. quinquefasciatus* prefers only pans that too less than 2 feet lower to ground level when high organic content is more. But in *Ae. aegypti, Ae. vittatus* and *Anopheles* prefer open and shallow pan type. Oviposition preference also in one or more habitats and their co-existence were noticed and reveals their risk factors for a future outbreak of vector borne diseases.

DISCUSSION

In the present study mosquito productivity was determined in temporary water holdings in a small, discrete ecosystem of institution campus and depends on the tree-hole numbers its factors. Blakely [19] reported that age old trees have vital role for the abundance and distribution of tree-holes. Similarly in our observation *P. pterocarpum* and *A. indica* trees have copious tree-hole containers, ephemeral reservoirs, most productive pan than rots for mosquito pre-adults [04]. In the study, *Ae. Albopictus* oviposit in all the containers at high elevations but *An. stephensi* and *Cx. quinquefasciatus* prefers only pans lower to ground level. Similar form of study was also conducted by Adebote [23]. Prevalence of mosquitoes immature varies between pans and rots, coincides with rainfall and other extrinsic factors. During course of study four genera of mosquitoes and one wild type predator species were identified and documented which a risk factor is causing disease like dengue, malaria and filaria.

The physico-chemical variations in tree-holes supports in ovipositing mosquitoes [24]. *Anopheles* and *Aedes* mosquitoes evades small and highly temporary tree-hole, [25] while high organic content in container favors opportunistic users, *Cx. quinquefasciatus*, [26]. *Aedes* mosquitoes prefer more vertical rots, while *Cx quinquefasciatus*, *An. stephensi*, *Tx.splendens* colonize narrow pans [27]. *Ae. albopictus* are predominant tree-dwellers occupying both types, more vertical rot holes with high conductivity and low leaf litter and dark colored water due to tannin-lignin content [24].

The Asian tiger mosquito *Ae. albopictus,* an aggressive daytime human-biter*,* was found exclusively in water filled tree-holes, currently invasive and fastest spreading mosquito species and possibility to serve as a rural, maintenance vector of arboviruses in tree-holes [28]. In this study six species encountered in phytotelmata like *Ae. albopictus, Ae. aegypti*, *Ae. vittatus*, *An. stephensi* and *Cx. quinquefasciatus* are known for their anthropogenic activity and transmit some of harmful and persistent of human diseases. Frequent incidence of chickungunya was observed due to migration of the mosquitoes from these tree-holes.

CONCLUSION

Hence, the study documents the seasonal distribution and prevalence of mosquito immature in the year 2007-2009. Moreover, the output of the study warns immediate control strategy measures to avoid the outbreak of vector borne diseases in discrete ecosystem.

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