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Behavioral Expression (Breeding and Feeding) of Mosquitoes in an Agro Ecosystem. (Athikulam, Virudhunagar District Tamil Nadu, India)

John wilson, J and S.P. Sevarkodiyone

Department of Zoology,Ayya Nadar Janaki Ammal College,
Sivakasi, Tamil Nadu, India, 626 125

Abstract: The study was conducted in Athikulam a typical rural and agro based area located in Srivilliputhur Taluk, Virudhunagar district, Tamil Nadu, India. The study was carried out for a period of 6 months from September 2011 to February 2012. The location of the study area was closely associated with water bodies which including fresh water, polluted water, pond and agricultural fields. Totally 10 species of mosquitoes are recorded during the larval collection from the study area. *Ae. aegypti, Ae. albopictus* and *Ae. vittatus* predominantly preferred to breed in containers. Stagnant pools were the preferred sites of *An. subpictus* and *Cx. gelidus*. The larvae of *Armigere subalbatus, Cx. pseudivishnui* and *Cx. quinquefasciatus* were predominantly breeding more in sewage water than other habitats. *Cx. vishnui* and *Cx. tritaeniorhynchus* were mainly noticed in paddy field. Most of the mosquitoes were zoo-anthropophilic, feed mainly on mammals and are known to enter houses and bite human beings. However, the mosquito species did not show variation in the biting pattern.

Key words: *Aedes aegypti*, *Aedes albopictus*, Paddy Field, Zoo-Anthropophilic, Biting Pattern

INTRODUCTION

Mosquitoes prefer to breed both in the standing and slowly running water bodies. The availability of these water bodies plays an important role in keeping the diversity of mosquito populations in a higher degree. The larva of mosquito feed on decomposing leaves and the associated microbial fauna. Tree holes are naturally occurring breeding sites that would allow population of some mosquito species, such as *Aedes triseriatus* [1]. Agriculture can cause sedimentation, which can slow or block streams and decrease the water depth [2]. This provides a larger number of mosquito habitats and increases the water temperature for vector development [3]. Knowledge of the blood-feeding preferences of a mosquito species provides important insight into the dynamics of virus transmission and allows vector control authorities to design and implement efficient strategies for vector control [4]. The choice of blood meal is influenced by several factors including host availability, nutritional requirements, intrinsic host preferences of the species and vector density [5].

MATERIALS AND METHODS

The study was conducted in Athikulam village, a typical rural area, located in Srivilliputhur Taluk, Virudhunagar district, Tamil Nadu, India. The study area comprised of well diversified ecological locations, such as, population rich residential site, more cultivated lands and non – cultivated lands. The adjoining area consists of more cultivated crops, stagnant water bodies, highly polluted sewage water bodies and other mosquitogenic conditions. The study area also comprised of various types of human settlement and varying number of cattle's and other animals that favour the mosquito population. The study was carried out for a period of 6 months from September 2011 to February 2012. The location of the study area was closely associated with water bodies which including fresh water, polluted water, pond and agricultural fields.

Breeding Behavior: Breeding behavior was analyzed by searching all the available larval habitats during the study period (Sep.2011-Feb.2012) for the presence of immature stages. The larval forms were collected with the help of a

Corresponding Author: John wilson, J, Department of Zoology, Ayya Nadar Janaki Ammal College, Sivakasi, Tamil Nadu, India- 626 125.

tea stainer and the teated pipettes from all the available water bodies, which may be both natural and artificial breeding sites. From the positive habitats, immature stages of mosquitoes were collected in a separate wide mouthed plastic jar, brought to the laboratory and reared to obtain the adults. The adults were identified by the Senior Entomologist Indian Council of Medical Research (ICMR), Madurai, Tamil Nadu, India.

Biting Behavior: The systemic weekly collection of adult female mosquitoes was made for twenty four hours at ground level in dim light the dark phase of the day. While one person was acting as bait by sitting motionless, another person collected the biting mosquitoes following the method adopted by Pandian and Chandrashekaran [6]. To minimize the damage of body parts and to collect the biting mosquitoes, a very thin and transparent (1x1 inch size) plastic vials were used and killed by ether, separated (hourswise) and preserved in the naphthalene filled vials for further studies and identification. Then the mid-points values were calculated to observe the peak period of biting activity of the mosquitoes and the results were tabulated. The variation in the biting pattern and temporal variation in between the species were also studied.

Host Seeking Behavior: Collection of blood engorged female mosquitoes and blood meal identification. An intensive collection of blood engorged female mosquitoes was done between 07^{00} h and 08^{00} h and 17^{00} h and 18^{00} h to identify the blood of their hosts and confirm their host preference behavior in order to verify their changing pattern of feeding behavior in an area during the specified period of study. The blood-fed *Aedes aegypti, Aedes albopictus, Anopheles subpictus, Armigeres subalbatus, Culex gelidus* and *Culex quinquefasciatus* were collected from human settlement area, cattle sheds and fowl houses etc. After identification of the species, the abdomens of the mosquitoes were squashed on a Whatman No.1 filter paper and a thin smear of blood was prepared. By following the method of Rao [7], the agar gel diffusion technique was used to identify the feeding pattern or host preference behavior exhibited by vectors. Positive results were obtained by observing the formation of precipitin line against the blood serum of host.

RESULTS AND DISCUSSION

Breeding Behavior: The chosen habitats by the larvae of mosquitoes such as, sewage water, paddy field, stagnant water pool and pond and well were categorized under "on the ground" breeding habitats and tank, stone grinder, plastic bucket categorized under "above the ground" breeding habitats. Totally ten species of mosquitoes were recorded during the larval collection from the study area. (Table 1). *Ae. aegypti, Ae. albopictus* and *Ae. vittatus* predominantly preferred to breed in containers. Similar observation was reported by Isaac [8] that *Ae. aegypti* preferred 68 percentage of stone grinder and *Ae. albopictus* preferred 21% of stone grinder to lay their eggs. Stagnant pools were the preferred sites of *An. subpictus* and *Cx. gelidus*. The larvae of *Armigere subalbatus, Cx. pseudivishnui* and *Cx. quinquefasciatus* were predominantly bred more in sewage water than other habitats. *Culex quinquefasciatus* is predominantly associated with urban areas but occurring also in rural. This Cosmo-tropical urban mosquito *Cx. quinquefasciatus* preferentially breeds in organically rich water. Stagnant pools were the preferred sites of *An. subpictus* and *Cx. gelidus*. The larvae of *Armigeres subalbatus* were predominantly breeding more in sewage water [9]. *Cx. vishnui* and *Cx. tritaeniorhynchus* were mainly noticed in paddy field. The rice fields provide suitable breeding places for various mosquitoes and rice

Table 1: Preferential habitat selection behavior of mosquitoes in the study area recorded during the study period (September 2011 - February 2012).

	On the ground- breeding habitats				Above the ground- breeding habitats		
Name of the Species	Stagnant water pool	Pond	Sewage water	Irrigation Field	Tank	Stone Grinder	Plastic bucket
Ae. aegypti	+	+	-	-	+	+	+
Ae. albopictus	-	-	-	-	+	+	+
Ae. vittatus	-	-	+	-	+	+	+
An. subpictus	+	-	+	-	-	-	-
Ar. subalbatus	+	-	+	-	-	-	-
Cx. pseudovishnui	-	-	+	+	-	-	-
Cx. tritaeniorhynchus	-	-	+	+	-	-	-
Cx. Vishnui	-	-	-	+	-	-	-
Cx. quinquefasciatus	-	-	+	-	-	-	-
Cx. Gelidus	+	-	-	-	-	-	-

Table 2: Biting behaviour of mosquito species recorded in study area during the study period (September 2011-February 2012)

S.No	Name of the species	Biting pattern	
		Rhythmic	Arrhythmic
1	*Aedes aegypti*	-	+
2	*Anopheles subictus*	+	-
3	*Armigeres subalbatus*	+	-
4	*Culex gelidus*	+	-
5	*Culex quinquefasciatus*	+	-
6	*Culex tritaeniorhynchus*	+	-
7	*Culex vishnui*	+	-

Table 3: Pattern biting behavior of mosquito species recorded in the study area during the study period (September 2011-February 2012)

S.No	Name of the species	Pattern of biting behavior		
		Nocturnal	Diurnal	Crepuscular
1	*Aedes aegypti*	-	+	-
2	*Anopheles subictus*	+	-	-
3	*Armigeres subalbatus*	-	-	+
4	*Culex gelidus*	+	-	-
5	*Culex quinquefasciatus*	+	-	-
6	*Culex tritaeniorhynchus*	+	-	-
7	*Culex vishnui*	+	-	-

Table 4: Midpoint values of the biting rhythm of the mosquitoes collected in the study area during the study period (September 2011 - February 2012)

S.No	Name of the species	Midpoint value
1.	*Aedes aegypti*	06^{21}
2.	*Anopheles subictus*	20^{02}
3.	*Armigeres subalbatus*	19^{09}
4.	*Culex gelidus*	19^{06}
6.	*Culex quinquefasciatus*	22^{35}
5.	*Culex tritaeniorhynchus*	18^{08}
7.	*Culex vishnui*	21^{08}

cultivation leads to an increase in the biting rates but they were definitely differ in their vectorial capacity [10]. Among these two categories of breeding habitats reported in the study area, sewage water was the most predominant habitat mostly preferred by many of the mosquitoes.

Utilization of waste water for irrigation also favours the occurrence of new mosquito species and causes new kind of diseases that are not seen ever. Such habitats formed by the stagnation of waste water for the usage of agricultural purpose and livelihood could contribute to vector-borne diseases risk for human communities. Thus, waste water disposal and irrigation systems for agriculture provide perennial source of water for vector mosquitoes in semi-arid countries. Vector mosquitoes exploit these sites if alternative breeding sites with better biological, physical and chemical conditions are not abundant.

Feeding Behavior: The pattern of biting of seven species of adult female mosquitoes was shown in Table 2. However, the mosquito species did not show variation in the biting pattern. Among species *Aedes aegypti* only showed the Arrhythmic pattern of feeding behavior and *Anopheles subictus, Armigeres subalbatus, Culex gelidus, Cx quinquefasciatus*, *Cx tritaeniorhynchus* and *Cx vishnui,* showed rhythmic pattern of feeding behavior (Table 2).

Different feeding behaviours of mosquitoes were also noticed *Aedes aegypti* showed diurnal activity, *Anopheles subictus, Cx gelidus, Cx quinquefasciatus*, *Cx tritaeniorhynchus, Cx vishnui* showed nocturnal activity and, the *Armigeres subalbatus* exhibited crepuscular activity of feeding behaviour (Table 3). The similar result was suggested by Chadee and Martinez [11] that the periodicity of female *Ae. aegypti* was diurnal (90%) and nocturnal (10%) and varying biting pattern was observed *Anopheles subpictus* showed nocturnal peak. This finding was coincided with the work done by Achee *et al*. [12] whereas the *An. darlingi* exhibited all night peak. The peak of biting activity was observed at different time *i.e.,* the midpoint value for *Aedes aegypti, Anopheles subictus, Armigeres subalbatus, Culex gelidus, Culex quinquefasciatus*, *Culex tritaeniorhynchus* and *Culex vishnui,* were 06^{21}, 20^{02}, 19^{09}, 19^{06}, 22^{35}, 18^{08} and 21^{08} respectively (Table 4). The peak of biting activity seen for these species during the present study coincided with that of the findings reported by Pandian and Senthilkumar [13].

Generally, the host seeking activity of mosquitoes is not uniform; instead most species show a pronounced biting rhythm characteristic for each species. The daily activity of mosquitoes is regulated by an endogenous circadian rhythm [14] and also by certain exogenous factors like light and dark cycle and light intensity [15]. The analyses of blood meals of wild caught mosquitoes indicated that and *Aedes aegypti* and *Armigeres subalbatus* exclusively preferred to feed on human indicating anthropophilic pattern. These findings were similar to the findings of Scott *et al*. [16] and it was reported that *Ae. aegypti* showed multiple blood feeding behavior on human at higher feeding rates. *Armigeres subalbatus* exhibited a typical anthropophilic pattern. *Anopheles subpictus* and *Culex quinquefasciatus* showed preference to human as well as animals. *An. subpictus* preferred to feed more on animals than humans and *Cx. quinquefasciatus* showed predominantly anthropophilic pattern. The *Culex quinquefasciatus* showed a zoophilic pattern that feed both mammals and

Table 5: Preferential host selection behavior of mosquitoes in the study area during the study period (September 2011 - February 2012)

S. No	Mosquito species	Host selection pattern					Total	Host preference pattern
		Buffalo	Cow	Goat	Fowl	Human		
1.	*Ae. aegypti*	-	-	-	-	17	17	a
2.	*An. barbirostris*	-	2	-	-	4	6	a>z
3.	*An. subpictus*	4	7	2	-	5	18	a<z
4.	*Ar. subalbatus*	-	1	-	-	3	4	a>z
5.	*Cx. gelidus*	6	9	2	-	3	20	a<z
6.	*Cx. quinquefasciatus*	7	8	3	2	8	28	a<z
Total	17	27	7	2	40	93		

a = anthropophilic pattern z = zoophilic pattern

birds. The similar observations were reported by Niebylski *et al*. [17] that the *Culex quinquefasciatus* was the opportunistic feeders that feed readily on humans or birds. *An. barbirostris* also showed anthropophilic pattern and the *Cx. gelidus* showed predominantly zoophilic pattern. *Culex gelidus* and *Anopheles subpictus* preferred mainly to feed on animals than man. The similar observation were reported by Zimmerman *et al*. (2006) [5] on the anthropophilic nature of *An. darlingi*, zoophilic and crepuscular nature of *An. nuneztovari* (on pig) and zoophilic pattern of *An. marajoara* (on bovines).

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