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Diversity of vector mosquitoes in selected areas of Sattur Taluk (Virudhunagar district, Tamil Nadu, India)

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Abstract
The present, study was undertaken to known the mosquito fauna with reference to diversity of selected area of Sattur Taluk, Four villages of Virudhunagar District, Tamilnadu, in India. The study period was undertaken for the period of eight months (September 2015 to April 2016). Twelve species belong to four genera was recorded. Gegion wise study on diversity of mosquitoes was almost similar with limited fluctuations. *Culex quinquefasciatus* was recorded as the major group of mosquitoes followed by *Culex tritaeniorhynchus.* The three species of mosquitoes were constantly present in the study period namely *Aedes aegypti, Culex quinquefasciatus* and *Armigeres subalbatus.* The biodiversity index and species richness was higher during the month of December 2015.

Keywords: Mosquito, Agriculture**,** Genera**,** Pattern of Occurrence

1. Introduction
Mosquito surveys provide valuable information on occurrence, distribution, prevalence and species composition of various mosquitoes in an area which assumes significance due to their public health importance. Among the various infectious diseases, vector borne diseases are the main burden today and may be expected to represent the highest proportionate disease burden in the near future. Mainly, the insect transmitted diseases remain a major cause of illness and death worldwide [1]. Mosquitoes are small insects belonging to the family Culicidae of the order Diptera and unquestionably the most important vectors of diseases [2]. They are important because of the effects on human and animal health and most of all due to the role they play in the transmission of protozoan and viral pathogens [3, 4]. Environmental changes have greatly affected the diversity and abundance of mosquito fauna. Biodiversity refers to the variability of both plants and animals. Broadly, it is the 'richness' of an ecological community. The diversity among insects has always been of keen interest, not only to Entomologist dealing with structure and function, but also to those who are engaged in different environmental programs [5]. Mosquito constitutes the most important single family of insects that affect the human health everywhere. In spite of several attempts to control them, these remarkably adapted mosquitoes continue to successfully coexist with man, feeding on him and his domesticated animals [6]. Besides the blood loss, they are capable of transmitting many diseases like filariasis, malaria, yellow fever, Japanese encephalitis, dengue etc, [7]. The voracious feeding habit high fecundity rate, dispersal potential and successful exploitation of environment are the causes for proliferation of these mosquitoes throughout the world [8].

2. Materials and Methods
2.1 Study Area
The study was conducted in Sattur, Elayirampannai, Sirukkulam, Nallanchettipatti, typical rural areas, located in Sattur Taluk, Viruthunager District, Tamilnadu, India. The study area comprised of well diversified ecological locations such as, cultivated lands and non-cultivated lands. The adjoining area consists of more cultivated crop, stagnated water bodies, highly polluted swage water bodies, cattle sheds, ponds, rivers and other mosquitogenic conditions. The study area also comprised of various types of human settlement and varying number of cattle and other animals that favours the mosquito population.

2.2 Study Period
The study was carried out for the period of eight months from September 2015 to April 2016. The location of the study area was closely associated with water bodies which including fresh water, polluted water and irrigated fields. Four site have has been selected for this study include cultivated / include stagnant water bodies barren lands and small scale industries.

2.3 Collection of Biting Adult Female Mosquitoes
For this study, biting mosquitoes were collected for a period of 24 hours continuously by man landing method, adopted by [9] to record the diversity of mosquitoes. Immature larvae obtained from different breeding sites were reared in laboratory and the newly emerged adults were preserved in plastic vials for identification. Adults were also collected while biting and swarming near the biting sites, cattle sheds and human dwellings [10].

2.4 Identification of Mosquito Species
The preserved wild caught mosquitoes were identified into species level by the Entomologist in Center for Research in Medical Entomology (CRME), Madurai, Tamil Nadu, India.

2.5 Data Analysis
Mosquitoes sampling resulted in enormous number of individuals, which was used to assess the diversity index and behavioural aspects including pattern of occurrence.

2.6 Biodiversity Index
Mosquitoes diversity was evaluated using species richness index or alpha diversity (Southwood, 1978) to assess the degree of biodiversity by the by following the formula.

$$\alpha = 1\text{-}£(x1/t)^2\,(x2/t)^2\,(x3/t)^2 + \ldots\ldots\ldots(Xn/t)^2$$

Where,
α = Species richness index
t = Total number of mosquitoes of all species
x = Number of each species

2.7 Pattern of Occurrence
Knowledge on the pattern of occurrence of mosquitoes reveals the dimension of spatial distribution and the rate of existence in the selective study sites. Based on the biting, the pattern of occurrence of the mosquitoes was classified into five categories. This pattern of mosquitoes was analyzed by applying the method adopted by [11].

The formula was,

$$C = nNx100$$

Where,
C = Pattern of occurrence
N = Number of sites positive for the occurrence of mosquitoes
N = Total number of sites studies
If C is = 0-20%, the distribution pattern of occurrence is sporadic
= 20.1-40, % the distribution pattern of occurrence is in frequent
= 40.1-60, % the distribution pattern of occurrence is moderate
= 60.1-80, % the distribution pattern of occurrence is frequent and
= 80.1-100, % the distribution pattern of occurrence is constant.

3. Results and Discussion
Diversity of mosquitoes recorded in the study area showed the twelve species of mosquito belong to four genera namely; *Aedes, Anopheles, Armigeres*, and *Culex*. These comprised of three species of *Aedes,* five species of *Anopheles,* one species of *Armigeres,* and three species of *Culex* (Table 1).
A proper study on mosquito fauna in this biosphere reserve will help finding the distribution pattern of different mosquito species including the disease vectors in different seasons as well as in different ecological conditions. It will also provide a database of the mosquitoes of this biosphere reserve area [12]. Among the four village of the study area, Nallanchettipatti (12 species) and Sirukkulam (12 species) exhibited high diversity of mosquitoes followed by Elayairampannai (9 species) and Sattur (4 species) respectively (Table 2).
The dynamics of changing mosquito populations provides significant information for evaluating risk potential for the transmission of mosquito-borne diseases [13, 14]. The pattern of occurrence mosquitoes was also studied in the study area. The three species of mosquitoes were constantly present during the study period namely *Aedes aegypti, Culex quinquefasciatus*, and *Armigeres subalbatus. Aedes albopictus* and *Anopheles vegus* were frequently present in the study area. *Aedes scatophagoides* showed moderate diversity during the study period. Four species namely *Anopheles pallidus, Culex tritaeniorhynchus, Culex vishuni, Anopheles barbirostris* were infrequently present in the study area and the remaining two species *Anopheles peditaeniatus, and Anopheles stephensi* showed sporadically in pattern of occerence in the study area (Table 3).
Pattern of occurrence of mosquitoes in the study area was also calculated. Among the twelve species recorded *Aedes aegypti, Culex quinquefasciatus* and *Armigeres subalbatus* were exhibited constant of occurrence, two species with frequent status whereas one species are moderate where as the remaining four species were recorded as infrequent and the two species are sporadic species. This is mainly due to the availability of exiting breeding habitats in all season and information of new breeding habitats. This result is constant with the observation where diversity of mosquitoes increased with introduction of new irrigation project and rain fall [15, 16].
The difference in the diversity may be due to the availability of different types of habitats due to mismanagement of ecosystem and application of agricultural practices [17]. During the present investigation the species richness was found to be maximum during the month of November 2015 (12 species) followed by December 2015 (11 species), species richness was moderate during October 2015 (7 species), January 2016 (7 species), February 2016 (6 species), and March 2016 (6 species) and minimum number of species has been recorded in the month of September 2015 (4 Species) and April 2016 (3 species) (Table 4).
Several studies suggest that the lower the biodiversity, the higher the potential of transmission of diseases. The decline of biodiversity might lead to a faster rate of emergence and re-emergence of infectious diseases and, therefore, the infection of a greater proportion of the human population [18, 19]. In other words, there are links between high biodiversity and reduced risk of vector-borne diseases [20]. Studies in the past few years

showed an inverse relationship between the species richness and the increased risk of infections [21].

Although, most of these studies did not include mosquito species, however, there are evidence that diversity, in the form of species richness can play an important role in determining diseases risk to humans (Dilution Effect model) [22, 23]. [24] also reported that available anthropogenic condition, existence of irrigation channels and low humidity were the main parameters in maintain diversity of mosquitoes Garhwval region, Uttrahand state, india.

Hence, the diversity of mosquitoes was found to be higher in residential sites and moderate in both cultivated site and low in industrial sites. Similar results were observed by [25] in the southern region Brazil.

Table 1: Diversity of mosquito species recorded in study area (Sattur Taluk, Virudhunagar district) during the study period (September 2015-April 2016).

S. No	Species name
1	*Aedes aegypti (Linn.)*
2	*Aedes albopictus (Skuse)*
3	*Aedes scatophagoides (Theobald)*
4	*Anopheles barbirostris (Vander wulp)*
5	*Anopheles pallidus (Theobald)*
6	*Anopheles peditaeniatus (Leicester)*
7	*Anopheles stephensi Liston*
8	*Anopheles vegus*
9	*Armigeres subalbatus (Coquillett)*
10	*Culex tritaeniorhynchus (Giles)*
11	*Culex quinquefasciatus (Say)*
12	*Culex vishuni (Theobald)*

Table 2: Diversity and Relative abundance of mosquito species recorded in study area (Sattur Taluk, Virudhunagar District) during the study period (September 2015- April 2016).

S. No	Species name	Sattur	Elayairampannai	Nallanchettipatti	Sirukkulam	Total
1	*Aedes aegypti*	86	109	74	62	331
2	*Aedes albopictus*	36	44	22	28	130
3	*Aedes scatophagoides*	0	3	8	2	13
4	*Anopheles barbirostris*	0	0	42	18	60
5	*Anopheles pallidus*	0	19	42	13	74
6	*Anopheles peditaeniatus*	0	4	53	39	96
7	*Anopheles stephensi*	0	62	86	43	191
8	*Anopheles vegus*	0	28	15	12	55
9	*Armigeres subalbatus*	123	98	122	88	431
10	*Culex tritaeniorhynchus*	0	0	69	106	175
11	*Culex quinquefasciatus*	116	183	162	123	584
12	*Culex vishuni*	0	0	42	13	55
	No. of species	4	9	12	12	
Total		361	550	737	547	2195

Table 3: The pattern of occurrence of mosquitoes collected in the study area (Sattur Taluk, Virudhunagar District) during the study period (September 2015-April 2016).

Name of the species	Pattern of distribution	Percentage of occurrence	Total number of the species
Aedes aegypti	Constant	100	3 Species
Culex quinquefasciatus		*100*	
Armigeres subalbatus		*93.75*	
Aedes albopictus	Frequent	68.75	2 Species
Anopheles vegus		***62.5***	
Aedes scatophagoides	Moderate	43.75	1 Species
Anopheles pallidaus	In frequent	37.5	4 Species
Culex tritaeniorhynchus		*37.5*	
Culex vishuni		31.25	
Anopheles barbirostris		***25***	
Anopheles peditaeniatus	Sporadic	18.75	2 Species
Anopheles stephensi		12.5	

Table 4: Monthly variation in the divesity of mosquitoes recorded in study area (Sattur Taluk, Virudhunagar District) during the study period (September 2015- April 2016).

S.no	Species name	Species diversity								Total
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
1	*Aedes aegypti*	69	86	41	64	43	0	17	11	331
2	*Aedes albopictus*	0	0	17	53	36	24	0	0	130
3	*Aedes scatophagoides*	0	0	8	5	0	0	0	0	13
4	*Anopheles barbirostris*	0	13	29	0	0	9	4	5	60
5	*Anopheles pallidus*	0	12	43	19	0	0	0	0	74
6	*Anopheles peditaeniatus*	0	0	25	43	16	0	12	0	96
7	*Anopheles stephensi*	19	26	46	68	32	0	0	0	191
8	*Anopheles vegus*	0	0	12	43	0	0	0	0	55
9	*Armigeres subalbatus*	86	61	79	96	62	29	18	0	431
10	*Culex tritaeniorhynchus*	0	16	35	27	32	41	24	0	175
11	*Culex quinquefasciatus*	77	85	98	133	102	56	19	14	584
12	*Culex vishuni*	0	0	14	35	0	6	0	0	55
Total No. of Individuals		251	299	448	586	323	165	94	30	2195
Species Richness		4	7	12	11	7	6	6	3	
Biodiversity index		0.71	0.79	0.91	0.88	0.81	0.77	0.81	0.63	

4. Conclusion

The present investigation indicates that the biodiversity index and species richness was higher (0.91) during the month of December 2015 and twelve species belong to four genera have been recorded.

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