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## Mosquito (Diptera: Culicidae) fauna in Alappuzha and Kottayam district of the Kerala state, south India

**R. Balasubramanian, Nikhil T.L.****ABSTRACT**

The study was conducted to look at the mosquito fauna in different sites of Alappuzha and Kottayam districts, Kerala state to generate information on the diversity of mosquitoes. A total of 44 species of mosquitoes belonging to 21 subgenera and 11 genera were recorded in Alappuzha district and 21 species of mosquitoes belonging to 14 subgenera and 9 genera were recorded in Kottayam districts. The genus *Aedes*, *Anopheles*, *Mansonia*, *Heizmannia*, *Culex*, *Ficalbia*, *Uranotaenia*, *Tripteroides*, *Armigeres*, *Coquillettidia*, and *Mimomyia* were recorded in Alappuzha district. *Aedes*, *Anopheles*, *Armigeres*, *Culex*, *Heizmannia*, *Tripteroides*, *Toxorhynchites* and *Uranotaenia* were recorded in Kottayam district. Species common to both districts were *Aedes aegypti* (Linnaeus), *Aedes albopictus* (Skuse), *Aedes vittatus* (Bigot), *Armigeres subalbatus* (Coquillett), *Culex fuscus* (Wiedemann), *Culex quinquefasciatus* (Say), *Culex tritaeniorhynchus* (Giles), *Heizmannia greenii* (Theobald), *Heizmannia indica* (Theobald) and *Toxorhynchites affinis* (Edwards). Paddy field, mud pools, fallow fields, man-made artificial containers were the common breeding area in Alappuzha district and in Kottayam district tree holes, coconut shells, artificial containers and leaf axils were the main breeding habitats.

**Keywords:** Mosquito fauna, Alappuzha, Kottayam, Aspirator.**1. Introduction**

Mosquitoes are small insects belonging to the family Culicidae of the order Diptera. Mosquitoes are unquestionably the most important vectors of diseases [1]. 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 [2, 3]. Environmental changes have greatly affected the diversity and abundance of mosquito fauna. For the last four decades, Kerala state has undergone numerous ecological changes in the form of water extraction and changes in water courses and construction of irrigation canals including habitat modification for the development of agriculture which has resulted in the vast expansion of water bodies that support mosquito breeding [4]. These environmental changes probably have altered the mosquito fauna as well as increased the relative abundance of certain mosquito species.

Kerala state is highly vulnerable to vector-borne diseases, because of conducive temperature throughout the year, significant annual rainfall, and presence of many sources for breeding of mosquitoes. In Kerala, mosquitoes play a major role as the carriers of various human and livestock pathogens in the wetland ecosystems and they are well adapted to survive in various habitats. Vector-borne diseases such as Malaria, Filariasis, Dengue, Japanese encephalitis and Chikungunya continues to be an important public health concern in the Kerala state, and understanding the complex transmission cycle of these disease will help to form the basis for surveillance, prevention, and control programs [4]. Agriculture being extensive in this area, and paddy and rubber plantations are the major crops which receive water from Back waters and various rivers. Earlier mosquito survey was done in Kerala state [5, 6]. Very meager information regarding mosquito fauna of Kerala was available. Keeping of this view, the present study was undertaken in the different sites of Alappuzha and Kottayam districts, Kerala to generate information on the diversity of mosquitoes.

**2. Materials and Methods****2.1. Study area**

Kerala lies at the southern end of Indian peninsula with a population of 31.83 million (2001 census).

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Alappuzha is a district with the Arabian Sea on the west, a vast network of backwaters, lagoons and fresh water rivers crisscrossing the land. The district lies between 9° 5' north latitude, 76° 17' and 76° 44' east longitudes. The total geographical area is 1414 Sq. Km. and the district has a coastline of 82 km. Kottayam district is located geographically at 9° 35' N and 76° 31' E. The district has a total area of 2208 sq. km bordered by the Western Ghats on the east and the Vembanad Lake. Both the districts are warm humid region with uniform temperature, which ranges from 21 to 35 °C. The area receives most of its rainfall (83%) from June to August under the influence of southwest monsoons and less rainfall from October to December under the influence of the northeast monsoons. The annual average rainfall is 300 cm.

## 2.2. Mosquito collection

Mosquito collections were made monthly twice in their natural breeding habitats in Alappuzha and Kottayam districts. The localities include Kainakary, Mankombu, Thumboly, Chettikadu, Thakazhy, Cherthala, Mavelikara and Chengannur in Alappuzha district and in Kottayam district, Erumely, Mundakayam, Koruthodu, Kalaketty and Kanjirapally were selected. Adult mosquitoes were collected from cattle sheds, outdoor bushes, indoor and outdoor dwellings by using aspirator and torch light. Sampling of larvae and pupae was made in a variety of breeding places, mainly from irrigated paddy fields, rainwater pools, mud pools, perennial ponds, swamps, tree hole, fallow field, rock holes, and leaf axils. Up to 25 dipper samples were taken at intervals along the edge of each larval breeding place using a standard mosquito dipper (350 ml). The larvae and pupae were reared to adults in the laboratory. Identification was based mainly on adult characters. Specimens were identified as adults using the morphology-based keys [7, 8, 9, 10].

## 3. Results

### 3.1. Alappuzha district

A total of 44 species of mosquitoes belonging to 12 genera were collected during the study period. The genus *Aedes* was represented by four species represented by 3 subgenera *Aedimorphus*, *Stegomyia*, *Fredwardsius* of the ten species of *Anopheles* belongs to two subgenera *Anopheles* and *Cellia*. The genus *Culex* was represented by 13 species in 4 subgenera *Culex*, *Eumelanomyia*, *Lutzia* and *Lophoceratomyia*. The genus *Ficalbia* was represented by four species in 3 subgenera *etorleptomomyia* *mimomyia*. The genus *Uranotaenia* was represented by 5 species in two subgenera *Pseudoficalbia* and *Uranotaenia*. The remaining genera such as *Tripteroides*, *Armigeres*, *Coquillettia*, *Mansonia*, and *Mimomyia* each were represented by single subgenera.

Of 44 culicine species, 3 species were collected only adult such as *Fi. luzonensis* (Ludlow), *Co. crassipes* (Van der Wulp), and *Ur. atra* (Theobald) were obtained only as adults, whereas other species were collected as larvae or as larvae and adults. Paddy fields and dirty water pools were formed the predominant larval habitat from which larvae of *Ae. vexans* (Meigen), *An. barbirostris* (Van der Wulp), *An. jamesii* (Theobald), *An. peditaeniatus* (Leicester), *An. pallidus* (Theobald), *An. subpictus* (Grassi), *An. vagus* (Doenitz), *Ar. subalbatus* (Armigeres), *Cx. bitaeniorhynchus* (Giles), *Cx. (Lutzia) fuscanus*, (Wiedemann), *Cx. gelidus* (Theobald), *Cx. infula* (Theobald), *Cx. pseudovishnui* (Colless), *Cx. quinquefasciatus* (Say), *Cx. tritaeniorhynchus* (Giles), were collected. Larvae of *He. indica* were obtained from bamboo tree holes. Larvae of *Tp. affinis* was

found in the Pine apple leaf axils. Larvae of *Ae. aegypti* (Linnaeus), *Ae. albopictus* (Skuse), *Ae. vittatus* (Bigot), *Cx. quinquefasciatus* (Say), and *Ar. subalbatus* (Armigers) occurred in coconut shells, discarded tyre, tree holes and discarded man made artificial containers.

### 3.2. Kottayam district

A total of 21 species of mosquitoes belonging to 9 genera with 15 subgenera were collected during the study period. The genus *Aedes* was represented by 6 species represented by 3 subgenera *Finlaya*, *Fredwardsius* and *Stegomyia*. The genus *Culex* was represented by 7 species in 5 subgenera *Culex*, *Lophoceratomyia*, *Culiciomyia*, *Lutzia* and *Eumelanomyia*. The genus *Armigeres* represented two subgenera such as *Armigeres* and *Leicester*. The remaining genera such as *Anopheles*, *Tripteroides* and *Toxorhynchites* each were represented by single subgenera and single species were recorded.

Of 21 culicine species, single species of *Ae. w- albus* was collected only adult whereas other species were collected as larvae or as larvae and adults. Discarded containers, coconut shells and dirty water pools were formed the predominant larval habitat from which larvae of

*Ae. albopictus* (Skuse), *Ae. chrysolineatus* (Theobald), *Ae. greeni* (Theobald), *Ae. vittatus* (Bigot), *Ae. aegypti* (Linnaeus), *Ar. aureolineatus* (Leicester), *Ar. subalbatus* (Armigers), *Cx. mimuloides* (Barraud), *Cx. quinquefasciatus* (Say), *He. greeni* (Theobald), and *Tx. splendens* (Wiedemann) were collected. *An. dirus* (Peyton and Harrison), *Cx. malayi* (Leicester), larvae were obtained from shallow wells contained debris and vegetation and shaded by trees inside a dense rubber forest. Larvae of *He. greeni* (Theobald) were obtained from bamboo tree holes only. Larvae of *Tr. affinis* (Edwards) was found in Pine apple leaf axils.

## 4. Discussion

Our collections showed that mosquito species diversity differed with the location and nature of the land. Of the 65 species recorded in the present survey, 22 species are incriminated vectors of different diseases such as malaria, dengue, Japanese encephalitis and filariasis. Among the disease vectors, the potential vector of Japanese encephalitis viz, *Cx. tritaeniorhynchus*, *Cx. gelidus*, *Cx. vishnui*, *Cx. pseudovishnui*, were captured during the epidemic season, suggesting that all of these species may play an important role in epidemiology of JE in Alappuzha district [6, 11]. *An. barbirostris* and *An. nigerrimus* were distributed in Alappuzha district. This species is a vector for human filariasis in India Thailand, Sri Lanka and Indonesia [11] and also a vector for malaria in Indonesia and Malaysia [12, 13, 14] *An. subpictus* is a human filariasis vector [15] and also suspected vector for malaria in India [16] and main malaria vector in Sri Lanka [17]. *An. jamesii*, *An. pallidus* and *An. vagus* are considered as non-vectors [15]. Among the collected species, *An. culicifacies*, *An. fluviatilis*, *An. dirus*, *An. vagus*, are known malaria vectors in India [16].

Among the culicine mosquito species recorded in the present study, *Cx. quinquefasciatus* is a vector for Bancroftian filariasis; *Cx. tritaeniorhynchus*, *Cx. gelidus*, *Ma. annulifera*, *Ma. indiana* and *Mn. uniformis* are vectors for Japanese encephalitis [18, 19]. With regard to Dengue and Chikungunya, both the vectors viz., *Ae. aegypti* and *Ae. albopictus* are widely distributed [4, 20], whereas *bitaeniorhynchus*, *Cx. mimuloides*, *Ae. vittatus* and *Ar. subalbatus* are considered non-vectors. *Cx. gelidus* and *Cx. tritaeniorhynchus* were found in all seasons and widely distributed in the Alappuzha district [6]. Rest of the culicine species were sparsely distributed.

## 5. Conclusions

The present survey provides useful information on the prevalence of breeding habitats of mosquito species in the two districts of Kerala state. Species under genus *Culex*, *Uranotaenia*, *Ficalbia* and *Mansonia* are ground water habitat breeders. Most of the potential vectors of Japanese encephalitis are found to breed in irrigated paddy fields, mud pools, fallow fields, rainwater pools etc. *Mansonioides* are found breeding in pond water areas in association with pistia and other water plants. The species of *Aedes* which includes mostly the potential dengue and chikungunya vectors viz. *Aedes aegypti* and *Aedes albopictus* are found to breed in waste tyre dumps, coconut shell, leaf axils, and manmade artificial containers which can store rain water.

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**Table 1:** List of species of mosquito fauna in Alappuzha district, Kerala state

Sr. No.	Species Name	Type of habitats for larvae collections							
		GP	CT	PF	TH	RP	BP	LA	AC
1	<i>Aedes (Aedimorphus) vexans</i> (Meigen,1830)	+	-	-	-	-	-	-	A
2	<i>Ae. (Stegomyia) aegypti</i> (Linnaeus,1762)	-	+	-	+	-	+	+	A
3	<i>Ae. (Stg.) albopictus</i> (Skuse,1894)	-	+	-	+	+	+	+	A
4	<i>Ae. (Fredwardsius) vittatus</i> (Bigot,1861)	-	+	-	-	+	+	+	A
5	<i>Anopheles (Anopheles) barbirostris</i> (Van der Wulp,1984)	+	-	+	-	-	-	-	A
6	<i>An. (An.) nigerrimus</i> (Giles,1900)	-	-	+	-	-	-	-	A
7	<i>An. (An.) peditaeniatus</i> (Leicester,1908)	+	-	+	-	-	-	-	A
8	<i>An. (An.) sinensis</i> (Wiedemann,)	+	-	-	-	-	-	-	A
9	<i>An. (Cel.) culicifacies</i> (Giles,1901)	+	-	+	-	-	-	-	A
10	<i>An. (Cel.) fluviatilis</i> (James,1902)	+	-	-	-	-	-	-	A
11	<i>An.(Cel.) jamesii</i> (Theobald, 1901)	+	-	-	-	-	-	-	A
12	<i>An. (Cel.) pallidus</i> (Theobald ,1901)	+	-	-	-	-	-	-	A
13	<i>An. (Cel.) subpictus</i> (Grassi,1899)	-	-	+	-	-	-	-	A
14	<i>An. (Cel.) vagus</i> (Doenitz,1902)	+	-	+	-	-	-	-	A
15	<i>Armigeres (Armigeres) subalbatus</i> (Coquillett,1898)	+	+	+	-	-	+	+	A
16	<i>Coquillettidia (Coquillettidia) crassipes</i> (Van der Wulp,1892)	-	-	-	-	-	-	-	A
17	<i>Culex (Culex) bitaeniorhynchus</i> (Giles,1901)	-	-	+	-	-	-	-	A
18	<i>Cx. (Lutzia) fuscans</i> (Wiedemann,1820)	+	-	+	-	-	-	-	A
19	<i>Cx. (Cx.) fuscocephala</i> (Theobald,1907)	+	-	+	-	-	-	-	A
20	<i>Cx.(Cx.) gelidus</i> (Theobald,1901)	+	-	+	+	-	+	-	A
21	<i>Cx.(Cx.) infula</i> (Theobald,1901)	+	-	+	-	-	-	-	A
22	<i>Cx.(Cx.) pseudovishnui</i> (Colless,1957)	-	-	+	-	-	-	-	A
23	<i>Cx.(Cx.) quinquefasciatus</i> (Say,1823)	+	-	-	-	-	+	-	A
24	<i>Cx.(Cx.) sinensis</i> (Theobald,1903)	+	-	+	-	-	-	-	A
25	<i>Cx.(Cx.) sitiens</i> (Wiedemann,1828)	+	-	-	-	-	-	-	A
26	<i>Cx.(Cx.) tritaeniorhynchus</i> (Giles,1901)	+	+	-	-	-	-	-	A
27	<i>Cx.(Cx.) vishnui</i> (Theobald,1901)	+	-	+	-	-	-	-	A
28	<i>Cx. (Eumelanomyia) brevipalpis</i> (Giles,1902)	+	-	-	-	-	-	-	A
29	<i>Cx. (Lophoceraomyia) minutissimus</i> (Theobald,1901)	+	-	-	-	-	-	-	A
30	<i>Ficalbia (Ficalbia) minima</i> (Theobald,1901)	+	-	-	-	-	-	-	A
31	<i>Fi. (Mimomyia) hybrid a</i> (Leicester,1908)	+	-	-	-	-	-	-	A
32	<i>Fi. (Mim.) chamberlaini</i> (Ludlow,1904)	+	-	-	-	+	-	-	A
33	<i>Fi. (Etorleptomyia) luzonensis</i> (Ludlow,1905)	-	-	-	-	-	-	-	A
34	<i>Heizmannia (Heizmannia) indica</i> (Theobald,1905)	-	-	-	+	+	-	+	A
35	<i>Mansonia (Mansonioides) annulifera</i> (Theobald,1901)	-	-	-	-	-	-	-	A
36	<i>Ma. (Man.) indiana</i> (Edwards,1903)	-	-	-	-	-	-	-	A
37	<i>Ma. (Man.) uniformis</i> (Theobald,1901)	-	-	-	-	-	-	-	A
38	<i>Mimomyia (Mimomyia) chamberlaini</i> (Ludlow,1904)	+	-	-	-	-	-	-	-
39	<i>Tripteroides (Rachionotomyia) affinis</i> (Edwards,1913)	-	-	-	-	-	-	+	-
40	<i>Uranotaenia (Pseudoficalbia) bimaculata</i> (Leicester,1908)	+	-	-	-	-	-	-	-
41	<i>Ur. (Ur.) annandalei</i> (Barraud,1926)	+	-	-	-	-	-	-	A
42	<i>Ur. (Ur.) christophersi</i> (Barraud,1926)	+	-	-	-	-	-	-	A
43	<i>Ur. (Ur.) atra</i> (Theobald,1905)	+	-	-	-	-	-	-	A
44	<i>Ur. (Ur.) maculipleura</i> (Leicester,1908)	+	-	-	-	-	-	-	A

+ = Present, - = Absent

GP- Ground pools, CT – cement tank, PF - Paddy field, TH – Tree hole, RP – Rocky pool, BP – Broken pots, LA – Leaf axils, AC – Adult cached

**Table 2:** List of species of mosquito fauna in Kottayam district, Kerala state

S. No	Species name	Types of habitats for larvae collections							
		GP	CT	PF	TH	RP	BP	LA	AC
1	<i>Aedes (Finlaya) chrysolineatus</i> (Theobald,1907)	-	+	-	-	+	+	-	-
2	<i>Ae. (Finlaya) greenii</i> (Theobald,1903)	-	+	-	-	+	+	-	-
3	<i>Ae. (Fredwardsius) vittatus</i> (Bigot,1861)	-	+	-	+	+	+	-	<b>A</b>
4	<i>Ae. (Stg.) aegypti</i> (Linnaeus,1762)	-	+	-	+	-	+	-	-
5	<i>Ae. (Stg.) albopictus</i> (Skuse,1894)	-	+	+	-	+	+	+	-
6	<i>Ae. (Stg.) w-albus</i> (Theobald,1905)	-	-	-	-	+	-	-	<b>A</b>
7	<i>Anopheles (cellia) dirus</i> (peyton & Harrison,1979)	+	-	-	-	-	-	-	-
8	<i>Armigeres (Armigeres) aureolineatus</i> (Leicester,1908)	-	+	-	-	-	+	+	-
9	<i>Ar. (Arm.) subalbatus</i> (Coquillett,1898)	+	+	+	-	-	+	+	<b>A</b>
10	<i>Culex (Eumelanomyia) malayi</i> (Leicester,1908)	+	-	-	-	+	-	-	-
11	<i>Cx. (Lutzia) fuscianus</i> (Wiedemann,1820)	+	-	-	-	-	-	-	-
12	<i>Cx. (Culex) mimuloides</i> (Barraud,1924)	-	+	-	-	+	-	-	-
13	<i>Cx. (Cx.) quinquefasciatus</i> (Say,1823)	+	-	-	-	-	-	-	<b>A</b>
14	<i>Cx. (Lophoceraomyia) minutissimus</i> (Theobald,1907)	+	-	-	-	-	-	-	-
15	<i>Cx. (Lop.) uniformis</i> (Theobald,1905)	+	-	-	-	-	-	-	-
16	<i>Cx. (Culiciomyia) pallidothorax</i> (Theobald,1905)	+	-	-	-	-	-	-	-
17	<i>Heizmannia (Heizmannia) indica</i> (Theobald,1910)	-	+	-	+	+	-	-	-
18	<i>He. (Heizmannia) greenii</i> (Theobald,1905)	-	+	-	+	+	-	-	-
19	<i>Tx. (Toxorhynchites) splendens</i> (Wiedemann,1819)	-	+	-	-	-	-	-	-
20	<i>Tripteroides (Rachionotomyia) affinis</i> (Edwards,1913)	+	-	-	-	-	-	-	-
21	<i>Uranotaenia (Uranotaenia) maculipleura</i> (Leicester,1908)	-	-	-	-	-	-	-	<b>A</b>

+ = Present, - = Absent

GP- Ground pools, CT – cement tank, PF - Paddy field, TH – Tree hole, RP – Rocky pool, BP – Broken pots, LA – Leaf axils, AC – Adult only cached

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