International Journal of Mosquito Research

ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2015; 2(3): 10-13

Received: 08-06-2015
Accepted: 10-07-2015

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Mosquito Larval Diversity in Three Rural Areas of Kanyakumari District, Tamil Nadu

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Abstract
The present study gives an overview of data on the habitat biodiversity of mosquito larvae occurring in three different stations (Mylaudy, Nagercoil and Melpuram) of Kanyakumari District (Tamil Nadu), India, during June 2013 - May 2014. *Anopheles* sp., *Culex* sp. and *Aedes* sp. were *more* prevalent in Kanyakumari district. Population of *Anopheles* mosquito larvae was abundant in wet months (June to October) in all the three stations. The most prevalent genus in the district was *Anopheles*. *Aedes* was the second dominative genus. *Culex* sp. was abundant in all the three stations during the dry season from March to May 2014

Keywords: *Aedes, Anopheles,* diversity, mosquito larvae, vector-borne diseases

1. Introduction
In recent years, vector-borne diseases (VBD) have emerged as a serious public health problem in countries of the South-East Asia Region, including India. Mosquito borne diseases is a growing urban problem because of unplanned urbanization, industrialization and excessive population growth coupled with rural to urban migration [1]. Mosquito constitutes the most important single family of insects that affect the human and other animals [2].
Mosquitoes are found in all types of environments associated with lentic aquatic habitats for breeding such as sewage water, stagnant water, septic tanks etc. [3] and natural and artificial containers such as pools, gutters, coconut shells, tree holes, bamboo stumps, leaf axils, water tanks and so on [4, 5]. The breeding habitat is crucial for mosquito population dynamics, because it is the location where many important life cycle processes such as development of larva, emergence of adults, resting, swarming and mating of adults occur [6].
Diptera represents one of the largest orders of insects with more than 85,000 species including a large number of disease vectors [7]. Prominent among these are mosquitoes, which are placed under the sub-order Nematocera and family Culicidae. More than 3100 species of mosquitoes belonging to 34 genera have been recorded under three subfamilies, namely, Anopheline, Culicinae and Toxorhynchitinae [8]. The most important disease transmitting and nuisance causing mosquitoes belong to the genera *Anopheles, Culex, Aedes, Mansonia, Haemagogus, Sabithes* and *Psorophora*. Various species of *Anopheles, Culex, Aedes* and *Mansonia* are important as carriers of diseases. Malaria, Filariasis, Japanese Encephalitis (JE), Dengue fever and Dengue haemorrhagic fever (DHF) are the major mosquito borne diseases in India [9].
The problem of dengue has now been extended to newer areas including several rural areas. Of the 30 districts in Tamil Nadu, dengue cases have been reported from 29 districts between 1998 and 2005 which includes DSS/DHF outbreaks in Chennai [10] in 2001, Nagercoil and Tiruchirappalli in 2003 and DHF outbreaks in Krishnagiri and Dharmapuri districts [11] in 2001. In 2012, a total of 9,000 cases and 50 deaths were reported in Madurai, Tirunelveli and Kanyakumari districts [12]. Kanyakumari district is endemic for dengue and there has been no systematic study of vector and non-vector mosquito fauna carried out. Hence, an attempt has been made to survey the mosquito fauna in three selected sites of Kanyakumari district, Tamil Nadu, India.

2. Materials and Methods
Diversity studies of mosquito larvae have been carried out in 3 different stations in Kanyakumari District, selected based on climatic and geographic features, a permanent pond and around area in Melpalai, River Pazhayar in Suchindrum area, and a temporary rock pools in Mylaudy during June 2013 - May 2014.

2.1. Site Description

Kanyakumari district is the southernmost district of the state of Tamil Nadu, and the southernmost tip of Peninsular India. It is located between 77° 15' and 77° 36' of east of longitudes and 8° 03' and 8° 35' north of Latitudes. It covers an area of 1,685 sq. km, occupying 1.29% of the area of Tamil Nadu. Station 1, Melpalai is a small hamlet in MelpuramTaluk in Kanyakumari District of Tamil Nadu State, India. Melpuram is located at the latitude of 8° 32' and the longitude of 77°.2". Station 2, is located about 3 km from the river mouth (8° 9' 29.34" N and 77° 27' 41.81"' E). The river is broad and shallow in this region and there is no fast under currents. The river supplies water to the nearby wet lands, where cultivation is a yearlong activity. The river receives run off from paddy fields in this region and the waters are rich in fertilizers and pesticides. Station 3, Mylaudy is a region surrounded by two mountains. It is about ten miles from Kanyakumari to the north-west. It is located in the outskirts of the city (11.196° N, 77.626° E) between Suchindrum and Azhagapappapuram on the Nagercoil-Anjugramam route closely associated with a slum.

2.2. Sample Collection

The field trip and collection of mosquito larvae were carried out during the period of 1 year from June 2013 to May 2014 from water bodies of three selected stations in Kanyakumari district by visiting every fortnight (15 days). Random samples from breeding places both natural (small lakes, streams, ponds, mud pools, rivers etc.) and artificial sites (irrigation channels, cement tanks, container type plastic, metal cans, earthen ware pots etc.) were taken. All the collected larvae were recorded. Mean and standard deviation of the collected mosquito larvae in three different stations were calculated. Later the larvae have been reared in the laboratory for adult emergence. The mosquito larvae were identified to genus level using the standard keys [13, 14]. Impacts of human activities and increasing environmental modifications in the breeding places of mosquitoes were identified by spot observations. Environmental temperature, rainfall and relative humidity were monitored during the study period.

3. Results

The results presented in tables 1, 2 and 3 indicate mosquitoes belonging to the genera *Anopheles*, *Culex* and *Aedes* were more prevalent in Kanyakumari district. Population of mosquitoes was abundant in wet months, from June to November as shown in figure 1, 2 and 3. *Anopheles* was the most dominative genus in all the three stations during the wet months. In station 1, population of *Anopheles* was 40.5 ± 1.70, 38.83 ± 2.60, 35 ± 3.41, 28 ± 3.16, 22.5±1.7, and 15.83± 1.86; station II, 37.5±1.71, 32.83±2.11, 28.5±2.81, 24.33± 2.47, 20.17± 1.32 and 14.67± 1.47 and in station III, 37 ± 1.29, 34.5 ± 1.71, 32.7 ± 1.59, 35.8±1.34, 27.2 ± 2.34, and 19.7±1.97. *Aedes* was the second dominative genus in all the three study stations. In station 1, population of *Aedes* was 5.5 ± 1.70, 7.67 ± 1.97, 4.8± 1.34, 5 ± 1.63, 7.17 ± 1.34 and 12.3 ±1.97 ; In station II, 8.83 ± 1.24, 7± 1.19, 8.5 ± 1.58, 9.83 ± 1.24, 12.5 ± 1.28 and 16.16 ± 1.58 and in station III, 7.5 ± 0.96, 6.83 ± 1.06, 8.5 ± 1.70, 5.67 ± 1.10 and 3.83 ± 1.34, and 17 ±1.29.

Table 1: Environmental factors during the study period in Kanyakumari District (June 2013 May 2014)

Months	Environmental factors			
	Temperature (ºC)	Humidity (%)	Light (Lux)	Rainfall (mm)
June	28.45	43	42700	9
July	27.55	79	61800	10
Aug	26.8	65	41600	2
Sep	26.1	81.8	57600	-
Oct	27.2	72	38900	Trace
Nov	26.5	70	41300	2
Dec	25.75	69	32000	-
Jan	26.85	73.09	38900	112.5
Feb	26	68	41200	-
Mar	27.85	41	59600	Trace
April	29.15	46	47600	4.3
May	28.95	47	40200	3

Table 2: Population of field collected mosquito larvae in station I during the study period

S. No	Name of the Genus	Number of larvae collected											
		June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Maxy
1	*Aedes*	5.5 ± 1.70	7.67 ± 1.97	4.8 ± 1.34	5 ± 1.63	7.17 ± 1.34	12.3 ± 1.97	17.5 ± 2.06	17.33± 1.59	16.6 7± 1.89	23 ± 1.29	22.5 ± 2.81	30.67 ± 1.97
2	*Anopheles*	40.5 ± 1.70	38.83 ± 2.60	35 ± 3.41	28 ± 3.16	22.5 ± 1.70	15.83 ± 1.86	13.5 ± 1.70	10 ± 1.52	8.33 ± 0.94	6.17 ± 1.34	6 ± 1.29	5.5 ± 0.47
3	*Culex*	15.67 ± 1.79	18.67 ± 1.97	16 ± 1.29	18.5 ± 1.71	12.17 ± 1.34	12.67 ± 1.11	9.33 ± 1.49	13.17± 1.34	14.83 ± 1.95	17.17 ± 1.67	22.67 ± 1.25	16.83 ± 1.08

Values are represented as mean ± S.D.

Table 3: Population of field collected mosquito larvae in station II during the study period

S. No	Name of the Genus	Number of larvae collected											
		June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1	*Aedes*	8.83 ± 1.24	7 ± 1.19	8.5 ± 1.58	9.83 ± 1.04	12.5 ± 1.28	16.16 ± 1.58	19.17± 1.90	21.1 7 ± 1.97	24.33 ± 2.32	24.5 ± 2.42	28 ± 2.50	26.67± 2.58
2	*Anopheles*	37.5 ± 1.71	32.8 3 ± 2.1 1	28.5 ± 2.81	24.33 ± 2.47	20.17 ± 1.32	14.67 ± 1.47	13.8 3 ± 1.35	9.83 ± 0.87	7.67 ± 1.02	8.5 ± 2.81	6.33 ± 1.97	9.67 ± 1.59
3	*Culex*	12 ± 1.29	9.17 ± 0.91	14.5 ± 1.42	16.67 ± 1.58	17.5 ± 1.70	13.83 ± 1.34	16.33± 1.49	15.5 ± 1.3 8	19.3 ± 1.49	23 ± 2.03	25.83± 2.61	30.83 ± 3.23

Values are represented as mean ± S.D.

Table 4: Population of field collected mosquito larvae in station III during the study period

S. No	Name of the Genus	Number of larvae collected											
		June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May
1	*Aedes*	7.5 ± 0.96	6.83 ± 1.06	8.5 ± 1.70	5.67 ± 1.10	3.83 ± 1.34	17 ± 1.29	21 ± 1.63	23.2 ± 2.12	25.8 ± 2.47	28.5 ± 2.87	13 ± 1.01	9.67 ± 1.11
2	*Anopheles*	37 ± 1.29	34.5 ± 1.71	32.7 ± 1.59	35.8 ± 1.34	27.2 ± 2.34	19.7± 1.97	16 ± 1.41	9.67 ± 1.10	12.5 ± 0.95	6.17 ± 1.06	7.33 ± 1.24	12.5 ± 1.71
3	*Culex*	15 ± 1.29	17.5 ± 1.63	18.5 ± 1.71	13.3 ± 1.49	15.3± 1.97	18 ± 1.29	23.8 ± 1.34	25.5 ± 2.24	23.5 ± 1.71	22.2± 1.34	13 ± 1.15	9.17 ± 1.06

Values are represented as mean ± S.D.

Population of *Culex* in station I was 15.67 ± 1.79, 18.67 ± 1.97, 16 ± 1.29, 18.5 ± 1.71, 12.17 ±1.34 and 12.67 ±1.11; station II, 12 ± 1.29, 9.17 ±0.91, 14.5 ± 1.42, 16.67 ± 1.58, 17.5 ± 1.70 and 13.83 ± 1.34 and in station III, 15 ± 1.29, 17 ± 1.63, 18.5 ± 1.71, 13.33 ± 1.49, 15.33 ± 1.97 and 18 ± 1.29 respectively leading to malaria cases.

From December to May, dry months, *Aedes* population in station I was 17.5 ± 2.06, 17.33 ± 1.59, 16.7 ± 1.89, 23 ± 1.29, 22.5 ±2.81 and 30.67 ± 3.5; station II was 19.17 ± 1.90. 21.17 ± 1.97, 24.33 ± 2.32, 24.5 ± 2.42, 28 ± 2.5 and 26.67 ± 2.58 and in station III, it was 21 ± 1.63, 23.2 ± 2.12, 25.83 ± 2.47, and 28.5 ± 2.87, 13 ± 1.01 and 9.67 ±1.11.

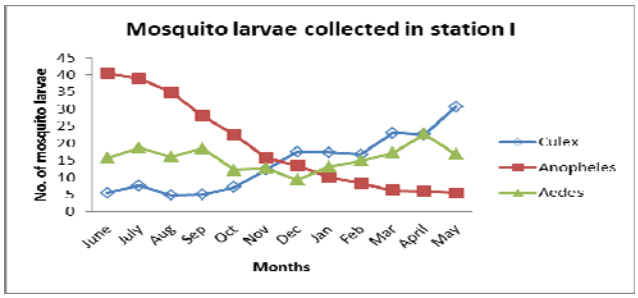

Fig 1: Monthly variation in the diversity of mosquito larvae in station 1

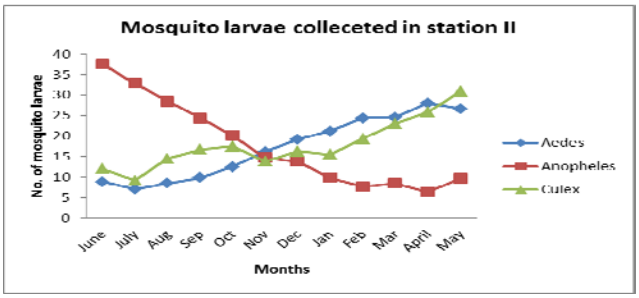

Fig 2: Monthly variation in the diversity of mosquito larvae in station 2

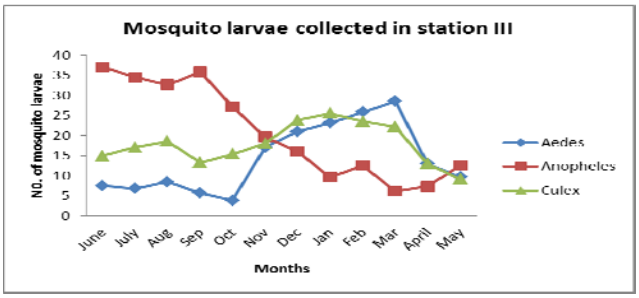

Fig 3: Monthly variation in the diversity of mosquito larvae in station 3

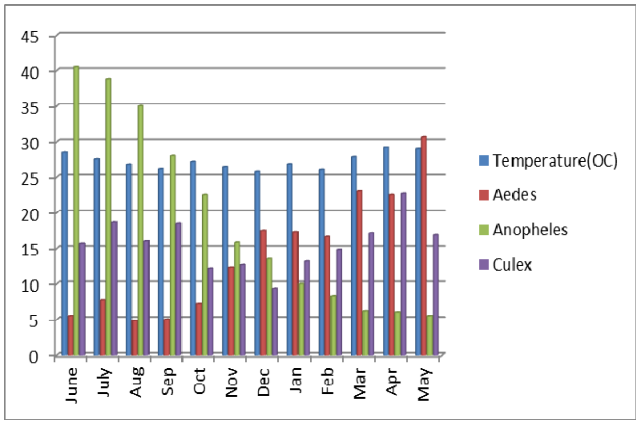

Fig 4: Relationship between mosquito larval population and Temperature in station I

Population of *Culex* mosquitoes in station I was 9.33 ± 1.49, 13.17 ± 1.34, 14.83 ± 1.95, 17.17 ± 1.67, 22.67 ± 2.25 and 16.83 ± 1.52; In station II, it was 16.33 ± 1.49, 15.5 ± 1.38, 19.3± 1.49, 23 ± 2.03, 25.83 ± 2.61 and 30.83 ± 3.23 and in station III, it was 23.83 ± 1.34, 25.5 ± 2.24, 23.5 ± 2.12, 22.2 ± 1.34, 13 ± 1.15 and 9.17 ± 1.06 whereas *Anopheles* population in station I was, 13.5 ± 1.70, 10 ± 1.52, 8.33 ± 0.94, 6.17 ± 1.34, 6 ± 0.58 and 5.5 ± 0.47. In station II, it was 13.83 ± 1.35, 9.83 ± 0.87, 7.67 ± 1.02, 8.5 ± 2.81, 6.33 ± 1.97 and 9.67 ± 1.59 and in station III, it was 16 ± 1.41, 9.67 ± 1.10, 12.5 ± 0.95, 6.17 ± 1.06, 7.33 ± 1.24 and 12.5 ± 1.71 and occupies the third position. The most prevalent genus in the district was *Anopheles*.

4. Discussion

Aedes aegypti is the principle dengue vector of urban areas [12]. The larvae of *Cx. quinquefasciatus* were collected more in number and they usually breed in stagnant and polluted water with high organic contents which placed *Cx. quinquefasciatus* as a non-forest species and anthropophilic nature [15, 16, 12]. 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. Besides, water chemistry of aquatic habitats may also play a critical role in determining the survival rate of mosquitoes. The ability of gravid mosquito females to distinguish among potential oviposition sites that will or will not support the growth, development and survival of their offspring are critical to the maintenance of the mosquito population [17]. The rapid spread of *Aedes* sp. in Tiruchirappalli district was due to the storage of water in cement tanks and plastic container. From this investigation, it is clear that there are many chances of mild dengue viral infection spreading in the sampling location.

The source reduction is an effective way for the community to manage the populations of many kinds of mosquitoes [18]. For the eradication of mosquito breeding containers or breeding sites in and around living, working areas should be taken into consideration, since the presence of water in containers is probably the most important factor in determining the breeding of mosquitoes, especially *Aedes* sp. and *Culex* sp. As a result, a mosquito control programme should be established at Tiruchirappalli district. Such a programme would reduce the risk to both animals and humans, and hence prevent the development of disease motivations in surrounding locations. From the survey it is evident that in Kanyakumari District, good numbers of lentic aquatic habitats were found to be hosting mosquito immatures, though difference in the physical and biological features of these habitats were prominent. Among the three genera, *Culex* stood first as the most abundant species in indoor and outdoor collections in the present study during the dry season from November 2013 to May 2014 and this finding was in line with the finding of Thenmozhi *et al*. [19]. In addition to these factors like temperature, humidity and rainfall other related climatic attributes may also be responsible for the observed species variation, which needs to be confirmed through further studies.

5. Acknowledgement

We greatly appreciate the financial support provided by the University Grants Commission New Delhi, Government of India in the form of Research Fellowship (Project F. No. 42-552/2013 (SR). Laboratory facilities provided by Department of Zoology, Scott Christian College, Nagercoil is also thankfully put on record.

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