Regular Article

Recent Research in Science and Technology 2016, 8(1): 1-5
http://scienceflora.org/journals/index.php/rrst/
doi: 10.19071/rrst.2016.v8.2942

Habitat characterization and diversity assessment of mosquitoes from selected coastal districts of Kerala, India

U. Sajith*, M. C. Rathy, C. C. Harilal

Division of Environmental Sciences, Department of Botany, University of Calicut, Malappuram, Kerala, India

Received: 04.01.2016
Accepted: 12.01.2016
Published: 20.01.2016

***Address for correspondence:**
U. Sajith,
Division of Environmental Science, Department of Botany, University of Calicut, Malappuram, Kerala, India - 679580.
E-mail: sajithbio@gmail.com

ABSTRACT

Vectors and host species in relation to environmental conditions are ensued in the effective transmission of many infectious diseases. Among the diverse array of vectors, mosquitoes stand at the top, spreading many devastating diseases to human beings such as malaria, dengue fever, chikungunya, and filariasis. Habitat heterogeneity and their physico-chemical attributes have a vital influence on the diversity and distribution of such vectors. A better understanding of the mosquito diversity in relation to environmental characteristics thus assumes utmost significance in disease surveillance and control. Ponnani and Chavakkad municipalities of Malappuram and Thrissur districts, respectively, are known to be endemic to many mosquito borne diseases. Repeated reports of such diseases, especially filariasis, in recent years suggest the necessity to assess the diversity of mosquito vectors and the habitats they preferred. Species composition, relative abundance and distribution status of mosquitoes were evaluated after sampling of larvae from heterogeneous habitats in pre- and post-monsoon seasons. Mosquito larvae collected were reared to adults in the laboratory. Species level identification of all the collected mosquitoes were carried out following: Christophers (1933) and Barraud (1934). Analysis of the water samples bearing larvae was also carried out for the assessment of physico-chemical characteristics. Larval density was higher in Chavakkad municipal area than Ponnani in both the seasons. The diversity of mosquito larvae during pre-monsoon season was higher (4 genera, 9 species) in Ponnani municipal area and lower (5 genera, 8 species) in Chavakkad. Similarly, diversity during post-monsoon season was higher (4 genera, 8 species) in Chavakkad municipal area and lower (4 genera, 7 species) in Ponnani. In both the seasons, *Culex* was the most predominant genus with higher species diversity followed by *Anopheles*. The results have evidenced the existence of diverse groups of mosquito species with respect to seasons, which can act as potential carriers of so many infectious diseases such as dengue, chikungunya, malaria and filariasis in these coastal environments.

KEY WORDS: *Culex*, diversity, mosquitoes, sewerage

INTRODUCTION

Public health remains under serious threat as long the oversize existence of vectors. Among the diverse array of vectors, mosquitoes stand at the top, spreading so many devastating diseases to human beings such as malaria, dengue fever, chikungunya, and filariasis. Effective transmission of such vector-borne diseases primarily depends on the complex interplay among vector mosquitoes and host species in relation to environmental conditions. Increasing vector population density, deteriorating infrastructure, inadequate access to health, water and sanitation services are some of the factors contributing to the risk of disease transmission (Macintyre *et al.*, 2002).

Mosquitoes have a worldwide distribution, and they breed in natural or manmade water bodies such as pools, rivers, lakes, tree holes, with a variety of oviposition sites (Rattanarithikul *et al.,* 2005). Larval distribution is greatly influenced by several factors such as types of water source, elevation, water movement, water temperature and associated vegetation (Rattanarithikul *et al.*, 2005). Oviposition, development of larva, adult emergence and many other processes take place in larval habitats, thus playing an important role in determining adult diversity, distribution and abundance (Overgaard *et al.*, 2002). The rate at which the diseases get transmitted among humans and also the resistance acquired by these insects makes them unique. Counteractive studies in finding out feasible

measures against these remarkably resistant insects are still persisting as a serious challenge.

To comprehend the epidemiology of different diseases, inventory on mosquito biodiversity is essential. Such systematic inquiries on the geographic distribution of insect vectors will help to evaluate the transmission risk of vector-borne diseases in a better way. Assessment of habitat characteristics of mosquitoes in an area help in the proper understanding of the growth conditions they preferring and also aid in the process of area wise eradication measures.

Chavakkad municipality of Thrissur district and Ponnani municipality of malappuram Districts are known to be endemic to many mosquito borne diseases. Repeated reports of such diseases, especially filariasis, in recent years suggest the necessity to assess the diversity of mosquito vectors and the disease environment confining to these areas. Habitat heterogeneity and their physico-chemical attributes have vital influence on the diversity and distribution of mosquito vectors. A better understanding of the mosquito diversity in relation to environmental characteristics thus assumes utmost significance in disease surveillance and control.

In this context, the present study has been outlined to evaluate the diversity and abundance of mosquito vectors associated with the Ponnani and Chavakkad municipal areas of Kerala, India, with respect to seasons. Assessment of habitat characteristics of mosquitoes was also carried out with the aim of contributing information toward the planning of area wise eradication strategies.

MATERIALS AND METHODS

Study Area

Chavakkad and Ponnani municipalities are sited along the coastal tract of Kerala, India, i.e., Thrissur and Malappuram districts, respectively (Plate 1). Sampling sites were enriched with major and minor water bodies which may have superior influence on the breeding and emergence of mosquito vectors.

Samples were collected from six random sites in each location.

Sampling and Identification of Mosquito Larvae

A sampling of mosquito larvae and pupae were carried out from heterogeneous water bodies in selected locations with the help of a dipper. The larval habitats

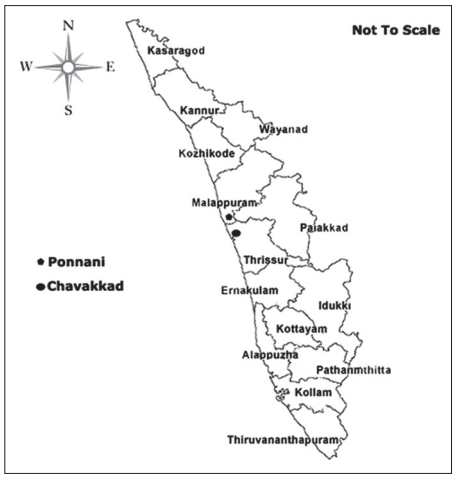

Plate 1: Sampling sites

subjected to collection include canals, pond, pits, and sewerages. The collected larvae/pupae were brought to the laboratory for rearing, followed by species level identification. For rearing, water samples containing larvae/pupae from each site were transferred to plastic jars. All the jars were covered with net of small mesh size to avoid escape of adult mosquitoes. A lid was maintained in the net for the collection of adult mosquitoes from the jars. No artificial food was given to the larvae as the water samples from the respective sites were enriched with nutrients. Emerging adult mosquitoes were collected with the help of a manual aspirator and killed with cotton swab of ethyl acetate.

Mosquito larvae collected and reared to adults during pre-monsoon and post-monsoon seasons were subjected to species level identification using taxonomic keys provided in "The fauna of British India, including Ceylon and Burma" by Christophers (1933) and Barraud (1934). The seasonal variation in mosquitoes was analyzed in terms of relative abundance and distribution (Rydzanicz and Lonc, 2003; Sengil *et al*., 2011). The mosquito species were also classified in the following relative abundance classes, i.e., satellite species (relative abundance <1%), sub-dominant species (relative abundance <5%) and dominant species (relative abundance >5%) following Trojan (2012). The following classes were used to represent the distribution status of different species as C1 (sporadic: 0-20%); C2 (infrequent: 20.1-40%); C3 (moderate: 40.1-60%); C4 (frequent: 60.1-80%; and C5 (constant: 80.1-100%), following Dziêczkowski (1972). Percentage densities of different genera in all the sampling sites during both the seasons were also analyzed and reported. Physico-chemical characteristics of the water samples bearing larvae were also subjected to analysis (APHA, 1998).

RESULTS AND DISCUSSION

Pre-monsoon Collection

Mosquito larvae collected from 12 sites representing 5 habitats in pre-monsoon season were reared to adults and subjected to species level identification. The result showed a higher larval density in the Chavakkad municipal area than Ponnani municipal area. The diversity of mosquito larvae during pre-monsoon season was higher (4 genera, 9 species) in Ponnani municipal area and lower (5 genera, 8 species) in Chavakkad. Relative abundance and distribution status of the total mosquito species collected in the pre-monsoon season were calculated (Table 1). In terms of relative abundance and distribution status *Culex quinquefasciatus*, *Culex sitiens,* and *Anopheles splendidus* were the most predominant species in the Ponnani municipal area of Malappuram district. *Aedes aegypti, Armigeres subalbatus,* and *C. quinquefasciatus* were the major species at Chavakkad municipal area of Thrissur district.

Percentage densities of the four genera (*Culex, Anopheles, Armigeres,* and *Mansonia*) in all the sampling sites of Ponnani municipal area revealed that *Culex* was the predominant group (60.80%) followed by *Anopheles* (35.68%). The occurrence of both *Armigeres* (2.01%) and *Mansonia* (1.51%) was rare during the period of study. Similarly, data on percentage densities of the five genera *Culex, Armigeres, Anopheles, Aedes* and *Mansonia* in the Chavakkad municipal area were 44.69%, 22.12%, 17.26%, 14.60% and 1.33%, respectively.

Of the 12 sites representing 5 habitats selected for the study in the pre-monsoon season, 50% were sewerages followed by ponds (16.67%) and grassland water sources (16.67%). Depending on extend of pollution, the same type of habitat contain different genera of mosquitoes at different sites of the collection. Description, occurrence of mosquito genera and physico-chemical characteristics of different habitats of the two municipal areas in the pre-monsoon season was given in Table 2.

Post-monsoon Collection

Diversity studies on the mosquito larvae collected from 12 sites representing 3 habitats in post-monsoon season revealed that diversity of mosquito was maximum at Chavakkad municipal area (4 genera, 8 species) than Ponnani municipal area (4 genera, 7 species). Larval density was maximum in the Chavakkad municipal area than Ponnani. Relative abundance and distribution status of the total mosquito species collected in the post-monsoon season were calculated (Table 3). In terms of relative abundance and distribution status *C. quinquefasciatus*, *A. subalbatus,* and *A. splendidus* were the most predominant species in the Ponnani municipal area of Malappuram district. *A. aegypti, A. stephensi* and *C. quinquefasciatus* were the major species at Chavakkad municipal area.

In terms of percentage densities of different genera in the Ponnani municipal area, *Culex* was the most predominant genus (64.67%) followed by *Anopheles* (21.21%), whereas in the case of Chavakkad municipal area, *Culex* (63.49%) and *Aedes* (22.22%) were the major genera.

83.33% of the total sampling sites in the post-monsoon seasons were represented by sewerage. Description,

Table 1: Relative abundance and distribution status of mosquito species in the pre-monsoon season

Location	Mosquito species	Relative abundance (%)	Relative abundance status	Distribution (%)	Distribution status
Ponnani (Malappuram)	*A. splendidus*	16.58	Dominant	33.33	Infrequent
	A. stephensi	8.54	Dominant	33.33	Infrequent
	A. theobaldi	10.55	Dominant	16.67	Sporadic
	A. aureolineatus	2.01	Subdominant	33.33	Infrequent
	M. annulifera	1.51	Subdominant	16.67	Infrequent
	C. fuscocephala	3.52	Subdominant	16.67	Infrequent
	C. quinquefasciatus	16.58	Dominant	50	Moderate
	C. sitiens	25.53	Dominant	83.33	Constant
	C. vishnui	15.58	Dominant	66.67	Frequent
Chavakkad (Thrissur)	*A. aegypti*	14.60	Dominant	50	Moderate
	A. splendidus	7.08	Dominant	33.33	Infrequent
	A. stephensi	10.18	Dominant	16.67	Sporadic
	A. annulipalpis	3.10	Subdominant	16.67	Sporadic
	A. subalbatus	19.03	Dominant	50	Moderate
	M. uniformis	1.33	Subdominant	16.67	Sporadic
	C. quinquefasciatus	33.63	Dominant	83.33	Constant
	C. sitiens	11.06	Dominant	50	Moderate

A. splendidus: Anopheles splendidus, A. stephensi: Anopheles stephensi, A. theobaldi: Anopheles theobaldi, A. aureolineatus: Armigeres aureolineatus, M. annulifera: Mansonia annulifera, C. fuscocephala: Culex fuscocephala, C. quinquefasciatus: Culex quinquefasciatus, C. sitiens: Culex sitiens, C. vishnui: Culex vishnui, A. aegypti: Aedes aegypti, A. annulipalpis: Armigeres annulipalpis, A. subalbatus: Armigeres subalbatus, M. uniformis: Mansonia uniformis

Table 2: Description, occurrence of mosquito genera and physico-chemical characteristics of different habitats in the pre-monsoon season

Station no	Description	Occurrence of mosquito genera	pH	Temperature (°C)	Turbidity (NTU)	Total acidity (mg/L)	Total alkalinity (mg/L)	DO (mg/L)	Total hardness (mg/L)	Chloride (mg/L)	Total solids (mg/L)
P1	Canal	*Culex, Anopheles*	8.18	29.5	11	80	340	2.58	1880	105.08	4200
P2	Sewerage	*Culex, Armigeres*	7.48	29	13.2	140	370	0.48	138	336.54	14,100
P3	Grassland	*Culex, Anopheles, Mansonia*	7.97	28.5	3.2	130	270	1.45	1160	136.32	15,500
P4	Sewerage	*Culex, Armigeres*	7.41	29	16.1	160	250	0.322	164	215.84	16,200
P5	Pond	*Culex, Anopheles*	6.97	29.5	0.8	200	150	1.94	70	63.9	6000
P6	Pond	*Culex, Anopheles*	6.87	29	1	280	180	2.25	56	97.98	8700
C1	Sewerage	*Culex, Armigeres, Aedes*	6.89	26.8	13.4	200	125	0	110	255.6	5800
C2	Sewerage	*Culex, Aedes*	6.13	27.4	27.8	375	200	1.63	90	205.9	10,700
C3	Grassland	*Culex, Anopheles, Mansonia*	7.64	27.2	2.6	125	300	1.43	70	56.8	500
C4	Sewerage	*Culex, Armigeres*	6.11	27.1	19.4	325	150	0	170	149.1	5600
C5	Sewerage	*Culex, Anopheles*	6.93	28.2	23.1	225	150	2.45	280	184.6	6800
C6	Coconut shell	*Armigeres, Aedes*	7.04	27.7	1.8	150	175	4.08	40	78.1	100

Table 3: Relative abundance and distribution status of mosquito species in the post-monsoon season

Location	Mosquito species	Relative abundance (%)	Relative abundance status	Distribution (%)	Distribution status
Ponnani (Malappuram)	*A. aegypti*	2.17	Subdominant	16.67	Sporadic
	A. splendidus	13.59	Dominant	33.33	Infrequent
	A. stephensi	7.61	Dominant	33.33	Infrequent
	A. subalbatus	11.96	Dominant	33.33	Infrequent
	C. quinquefasciatus	52.17	Dominant	83.33	Constant
	C. sitiens	11.41	Dominant	33.33	Infrequent
	C. vishnui	1.09	Subdominant	16.67	Sporadic
Chavakkad (Thrissur)	*A. aegypti*	22.22	Dominant	66.67	Frequent
	A. stephensi	12.17	Dominant	33.33	Infrequent
	A. subalbatus	2.12	Subdominant	16.67	Sporadic
	C. fuscanus	7.41	Dominant	33.33	Infrequent
	C. gelidus	3.17	Subdominant	16.67	Sporadic
	C. quinquefasciatus	40.74	Dominant	83.33	Constant
	C. sitiens	1.06	Subdominant	16.67	Sporadic
	C. vishnui	11.11	Dominant	33.33	Infrequent

A. splendidus: Anopheles splendidus, A. stephensi: Anopheles stephensi, C. quinquefasciatus: Culex quinquefasciatus, C. sitiens: Culex sitiens, C. vishnui: Culex vishnui, A. aegypti: Aedes aegypti, A. subalbatus: Armigeres subalbatus, C. fuscanus: Culex fuscanus

Table 4: Description, occurrence of mosquito genera and physico-chemical characteristics of different habitats in the post-monsoon season

Station no	Description	Occurrence of mosquito genera	pH	Temperature (°C)	Turbidity (NTU)	Total acidity (mg/L)	Total alkalinity (mg/L)	DO (mg/L)	Total hardness (mg/L)	Chloride (mg/L)	Total solids (mg/L)
P1	Sewerage	*Culex, Anopheles*	7.76	27.5	19.4	150	600	1.22	270	624.8	700
P2	Grassland	*Culex, Anopheles*	7.22	27.5	3.8	150	400	4.9	244	184.6	300
P3	Sewerage	*Culex, Aedes*	6.84	28.2	11.5	275	200	2.45	52	440.2	800
P4	Sewerage	*Culex*	6.62	27.5	11.9	325	150	0.41	68	397.6	700
P5	Sewerage	*Culex, Armigeres*	7.59	28.1	6.6	100	550	0	36	1050.8	5600
P6	Sewerage	*Culex, Armigeres*	7.03	28.5	13.2	100	300	0.41	124	596.4	500
C1	Sewerage	*Culex, Anopheles*	6.33	27.2	17.6	350	150	0	300	681.6	4500
C2	Sewerage	*Culex, Aedes*	7.22	27.5	11.2	225	500	0.41	470	454.4	5500
C3	Sewerage	*Culex*	7.81	27	8.1	100	850	1.22	360	291.1	7700
C4	Sewerage	*Culex, Aedes*	7.19	28.8	10.4	200	450	0.41	830	560.9	2700
C5	Sewerage	*Culex, Anopheles, Aedes*	6.76	28.5	14	275	200	0	280	489.9	1300
C6	Coconut shell	*Armigeres, Aedes*	6.49	27.5	5.9	475	200	3.67	160	36.92	300

occurrence of mosquito genera and physico-chemical characteristics of different habitats in the post-monsoon season is given in Table 4.

Assessment of mosquito vector diversity in a place where disease transmission is likely to occur is integral for implementing surveillance programs and control measures. The two municipal areas selected for this study, i.e., Chavakkad and Ponnani of Thrissur and Malappuram districts, respectively, are known to be endemic to many mosquito borne diseases. The primary objective of this study was to establish general seasonal distribution and

population patterns across these municipal areas of Kerala. On an overall assessment, it was noticed that various mosquito species of different genera were present within in these municipal areas, implicating the possible appalling diseases that they transmit. Mosquito species recorded from the municipal areas are potential carriers of diseases like filariasis, chikungunya, dengue fever and malaria. The study thus highlights the necessity for exigent management measures in the municipal areas against these remarkably resistant vectors so that the adverse effect of the dreadful diseases they spread can be minimized to a possible extent.

CONCLUSION

Assessment of mosquito fauna of the two coastal districts of Kerala with reference to their habitat characteristics was carried out seasonally. In the pre-monsoon season, mosquito diversity was a higher in the Ponnani municipal area of Malappuram district, whereas higher species diversity in the post-monsoon season was reported from the Chavakkad municipal area of Thrissur district. In both the seasons, *Culex* was the most predominant genus in terms of diversity and distribution. 50% of the total breeding habitats in the pre-monsoon season and 83.33% in the post-monsoon season were represented by sewerage. The study reveals the existence of a diverse group of mosquitoes and discusses their possible health implications in these areas with recommendations of urgent management measures against many devastating diseases.

REFERENCES

APHA. Standard Methods for the Examinations of Water and Wastewater. 20th ed. Washington, D.C: American Public Health Association. American Water Works Association, Water Environment Federation Publication; 1998.

Barraud PJ. The Fauna of British India Including Ceylon and Burma. Diptera. Vol. V. London: Taylor and Francis; 1934.

Christophers SR. The Fauna of British India Including Ceylon and Burma. Diptera Family Culicidae, Tribe Anophelini. Vol. IV. London: Taylor and Francis; 1933.

Dzieczkowski, A. Quantitative Research snails beech south-western Polish. Study of ecological and fauna. Prace Biological, PTPN, 1972;35:243-332.

Macintyre K, Keating J, Sosler S, Kibe L, Mbogo CM, Githeko AK, *et al*. Examining the determinants of mosquito avoidance practices in two Kenyan cities. Malar J 2002;1:14.

Overgaard HJ, Tsuda Y, Suwonkerd W, Takagi M. Characteristics of *Anophelesminimus* (Diptera: Culicidae) larval habitats in northern Thailand. Environ Entomol 2002;31:134-41.

Rattanarithikul R, Harbach RE, Harrison BA, Panthusiri P, Jones JW, Coleman RE. Illustrated keys to the mosquitoes of Thailand. II. Genera *Culex* and *Lutzia*. Southeast Asian J Trop Med Public Health 2005;36: 1-97.

Rydzanicz K, Lonc E. Species composition and seasonal dynamics of mosquito larvae in the Wroclaw, Poland area. J Vector Ecol 2003;28:255-66.

Sengil AZ, Akkaya H, Gonenc M, Gonenc D, Ozkan D. Species composition and monthly distribution of mosquito (Culicidae) larvae in the Istanbul metropolitan area, Turkey. Int J Biol Med Res 2011;2:415-24.

Trojan P. Analiza struktury fauny (The analysis of the fauna's structure). Memorab Zool 2012;47:1-120.