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Diversity and vectorial capacity of mosquitoes in Kuruva Island, Wayanad District, Kerala, India

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Abstract

A survey on the occurrence of mosquito in Kuruva Island was made and their vectorial status was analyzed. This study was undertaken for six months from October 2010 to March 2011. Mosquito larvae were collected throughout the island and were later identified in the laboratory using systematic keys. A total of 18 mosquito species belonging to 5 genera, *Anopheles, Aedes, Culex, Mansonia and Armigeres* were identified. The habitat preference and vectorial capacity of these mosquito species were discussed.

Keywords: Mosquito, *Vector, Anopheles, Aedes, Culex, Mansonia, Armigeres*

1. Introduction

Kuruva Island / Kuruva dweep is a protected river delta on the Kabini River in Wayanad district, Kerala, India. Its dense and evergreen forest is rich in flora and fauna and hence is a major tourist attraction. Approximately 170916 tourists visited Kuruva Island in 2011- 2012. It is a restricted area and entry to this area is monitored by Vana Samrakshana Samiti a Department of Forest of Kerala. This island can be accessed by rafts and boats provided by Kerala Tourism Department. This island receives heavy rainfall hence it has a wide variety of habitat for the breeding of mosquitoes.

Mosquito profoundly play an important role as they are vectors of numerous diseases like Malaria, Filariasis, Japanese encephalitis (JE), Dengue fever, Chikungunya etc. These disease outbreaks occur due to both biological and environmental factors that encourage vector breeding [16].

Larval habitats of mosquitoes are diverse and they can thrive in habitat such as tree holes, bamboo stumps, plant pitcher etc. Perennial streams and wetlands provide mosquito habitat. Mosquito species of temperate regions oviposit in specific aquatic habitats that support characteristic plant communities [35].

There is a close association between the breeding behaviour of the mosquito vector and human alteration of natural habitat [44]. Selection of breeding sites by female mosquito is influenced by various factors. Natural and artificial container habitats are heterogeneous with environment, temporal and spatial fluctuations in temperature, water volume, nutrient condition and other factors [39]. Presence of mosquito larvae and their predators are influenced by habitat size [45]. Predators limit mosquito population and the intensity of predation and its significance vary greatly among habitat types [41].

Table 1 : Species Composition of Study Area

Sl. No	Genus	No of species
1	*Aedes*	9
2	*Anopheles*	4
3	*Culex*	3
4	*Armigeres*	1
5	*Mansonia*	1

As per WHO, in the year 2011 a total number of 68,000 clinical cases of JE (Pathogen: Japanese Encephalitis Virus) was recorded worldwide. Nearly 1.4 billion people in 73 countries are threatened by Lymphatic filariasis (Pathogen: *Wuchereria bancrofti*), over 120 million people currently infected and about 40 million disfigured and incapacitated by this disease. In the case of Malaria (Pathogen: *Plasmodium* sp.)I the year 2012, 207 million cases and an estimated 627,000 deaths were reported. About 2.5 billion people, i.e. 40% of the world populations are now at risk from Dengue (Pathogen: Dengue Virus). Chikungunya (Pathogen: Virus belonging to family Togaviridae) has been identified in nearly 40 countries in Asia, Africa, Europe and America.

An eco-friendly approach of vector control can be achieved by slight modification of the habitat. Studies of vector mosquitoes with special reference to their breeding habitat will help in better understanding and control of mosquito breeding.

2. Methodology

2.1 Study Area

Kuruva dweep (11°49′18″N 76°5′32″E) is a 950-acre (3.8 km^2) protected river delta on the Kabini River in the Wayanad district, Kerala, India. Its dense and evergreen forest is rich in flora and fauna. This uninhabited area is a major tourist attraction.

2.2 Sampling Method

Mosquito larvae were collected from randomly selected sites throughout the Kuruva Island for 6 months starting from October 2010 to March 2011. Larvae were collected from different habitats like tree holes, mud pools, rock pools, plastic containers etc. using dippers (12cm diameter and of 300 ml capacity), aquatic nets and glass pipette. These were then transferred to plastic vials for their transportation to the laboratory. All the sites were visited periodically. Collected larvae were categorized in the laboratory. The collected larvae were identified with a key of Barraud (1934) and Christophers (1933), catalogue of Stone and Knight (1959) and Rao (1981).

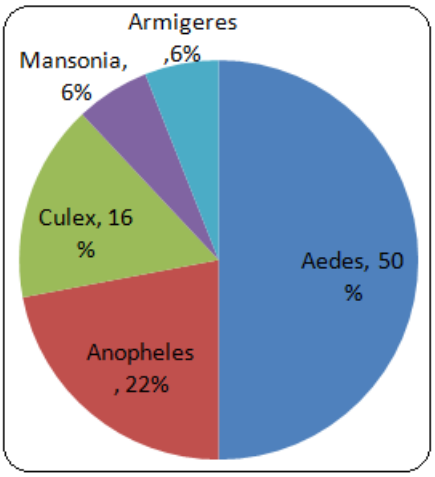

Fig 1: Species Composition of Study Area

3. Result and Discussion

A total of 18 mosquito species belonging to 5 genera was collected and identified. Of these collected mosquitoes *Aedes* was the predominant genera with 9 species followed by *Anopheles* with 4 sp., *Culex* with 3 sp., *Armigeres* and *Mansonia* were the least collected genus with only one species representing each.

According to White [46] mosquitoes are grouped on their preference to breeding habitats, which emphasized the ability of different species to select their breeding habitat. They are capable of occupying a wide variety of habitats, fresh water, brackish water, or any water (clear, turbid or polluted) except in marine habitats with high salt concentration [33]. Majority of the mosquitoes collected in this study prefer fresh water for their breeding. *Aedes* mosquitoes, also known as floodwater mosquitoes, lay eggs on damp soils or in dry tree holes and containers rather than on standing water. Boorman [6] observed the appearance of pupae of *Aedes vittatus* in rock-pools four days after rain. Larval population of *Aedes aegypti* and *Aedes albopictus* has been recorded in rock pools, streams, canals, containers and tree holes [20] which is in agreement with the present study as these where the predominant breeding habitats of the study area.

Most *Anopheles* species are known to change their ecological range and behavior by adapting to new climatic, ecological and human induced changes [24]. Anophilines breed in clear to slightly turbid water [5, 36]. Kuruva island is a protected area with minimal chemical contamination and according to Jaal [15] *Anopheles* prefers water that is not contaminated by waste products or chemicals for breeding. *Anopheles vagus* is found to be present in habitats prone to spring tide [17] and is also found to breed in association with *An.philippinensis* in rice fields with algal growth, streams, ditches, tanks, Nullahs etc [22]. Pemola Devi and Jauhari [29], in their study, observed larvae of *Anopheles subpictus* in all aquatic habitats and their high density was found in pools, muddy rain pools and in almost any temporary collection of water.

Maximum immature associations, recorded in the habitats such as steams, rock holes and seepage pools suggest high survival rate, ovipositional preference and favorable phyto-chemical characteristics. Prolonged water logging with fast changing ecological conditions and extensive surface area of habitats offer favourable breeding conditions to a number of mosquito species including disease vectors [28].

Table 2: List of Collected Mosquito Species with their Vectorial Capacity

SL. No.	GENERA	SPECIES	VECTORIAL STATUS
1	*Aedes*	*aegypti*	West Nile virus, Dengue, Yellow fever, Chikungunya
		albopictus	WNV, Dengue
		chrysolinneatus	
		niveus	Filariasis, Dengue
		pseudotoeniatus	
		scatophagoides	
		vexanus	Rift Valley Fever Virus, WNV
		vittatus	Chikungunya
		walbus	
2	*Anopheles*	*peditaeniatus*	JE
		pallidus	
		subpictus	Malaria,JE
		vagus	Malaria
3	*Armigeres*	*subalbatus*	*Wuchereria bancrofti , Dirofilaria immitis and Burgia pahangi*
4	*Culex*	*bitaeniorhynchus*	JE, lymphatic filariasis, *bancrofti* filariasis, Murray Valley encephalitis, Batai virus
		fuscans	
		vishnui	JE
5	*Mansonia*	*annulifera*	*Brugia malayi*

Mansonia prefer habitats with well- developed beds of submerged, floating- leaf or emergent aquatic macrophytes. Unlike other mosquitoes, the larvae and pupae of *Mansonia* must attach their breathing tubes to the underwater roots, stems or leaves of floating aquatic plants if they are to survive [31]. *Mansonia annulifera* prefer ponds infested with *Pistia stratiotes* [14]. *Armigeres subalbatus* is commonly found close to human dwellings especially in sub- urban areas with poor sanitation [30].

Culex mosquitoes prefer highly polluted habitat like drains [7] and larvae of this genus are found in habitats like artificial containers, flood pools, rock pools, irrigation ditches and stream margines. *Culex bitaeniorhynchus* are abundant in stream margins [34]. Apiwaphnasorn [3] in 2006 reported that *Culex bitaeniorhynchus and Culex vishnui* mainly prefer rural areas as their breeding habitat. *Culex* sp. were the most abundant and found over, all habitats most frequently in fragmented forest, rice field, rural and suburban habitats [42]. These observations are in agreement with the present study.

Table 3: Disease Vectors Composition of Study Area

Sl. No	Diseases	No Of Vectors
1	JE	4
2	Filariasis	4
3	Malaria	3
4	Dengue	3
5	Chikungunya	2
6	West Nile virus	2
7	Other	5

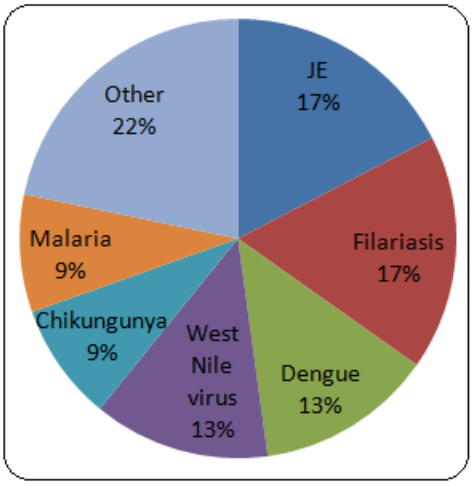

Fig 2: Disease Vector Composition of Study Area

Among the collected 4 species of *Anopheles*, 3 were incriminated vectors and these included *An. peditaeniatus*, *An. vagus* and *An.subpictus.* Mourya *et. al.* [23] in 1989 isolated JE virus from *An.pediataeniatus. An. subpictus* which is considered as the secondary vector of Malaria [27, 21] is also appeare to play a role in JE virus transmission [13, 12]. Amerasihae *et. al*. [2] reported *An. vagus* as a malarial vector as it can transmit *Plasmodium falciparum*. Sompoon *et. al*., [38], in Northwestern Thailand, found a fresh water strain susceptible to both *P. falciparum* and *P. vivax*.

According to Anderson and Rico-Hesse [1], Dengue viruses are maintained in a human- mosquito- human cycle with *Aedes aegypti.* WHO 2013 documented *Ae. aegypti* as the primary vector of Dengue and Chikungunya and *Ae. albopictus* as the secondary vector of Dengue which also transmit Chikungunya and WNV in Asia, Africa and Europe. *Ae.vexanus* play a significant role in WNV transmission [43] and *Ae. niveus* is a proven jungle vector of Dengue and *Bancroftian filariasis* [9].

Cx.bitaeniorhynchus is a vector of Lymphatic Filariasis, Murray valley encephalitis and Batai virus [48]. *Culex vishnui* is considered as one of the chief vectors of JE and *Culex bitaeniorynchus* is also found to be responsible for the transmission of JE virus in different parts of India [29]. Sabesan *et. al.,* [37] in 1991 listed *Mansonia annulifera* as a more potent vector of *Brugia malayi* and in Travancore, India by Iyengar [14]. Ar. Subalbatus is an incriminated vector of JE [19], *Wuchereria bancrofti* in India [11], *Dirofilaria immitis* in peninsular Malaysia [8] and zoonotic *Burgia pahangi* infection [25].

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5. Conclusion
This preliminary study revealed the presence of *Aedes aegypti*, *Aedes albinopictus* and *Culex bitaeniorhynchus* which are considered as the major vectors of Dengue, Chikungunya and JE respectively in Kuruva Island. The presence of these vector mosquitoes is a serious issue as Kuruva Island is visited by people from all over the world.

Among the total collected mosquitoes *Aedes* mosquitoes (50%) was the predominant which support earlier findings that Aedes mosquitoes prefer clear water for their breeding. The presence of mosquito species that are not commonly found in forest ecosystem may be due to the change in habitat by tourism. Majority of these collected species were incriminated vectors of JE and Filariasis which is a major concern as Kuruva Island is visited by large number of tourist every year. This study thus provides information about the diversity and vectorial status of the mosquitoes of Kuruva Island and will aid in prevention and control of mosquito borne diseases in this area.

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