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MOSQUITOES OF KUDAT: SPECIES COMPOSITION AND THEIR MEDICAL IMPORTANCE (DIPTERA: CULICIDAE)

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ABSTRACT

A survey of mosquito fauna was done to determine the mosquito population and species composition in Kudat. Outdoor human landing catches (HLC) were done from April to June 2015. A total of 4,350 mosquitoes, representing eight genera and 37 species were collected. These include *Aedes* (Stegomyia), *Aedimorphus*, *Anopheles*, *Armigeres*, *Culex*, *Mansonia*, *Phagomyia* and *Uranotaenia*. Medical important species are specially noted and discussed. *Armigeres* (52.7%) was the most abundant, followed by *Culex* (31.9%), *Aedes* (9.4%), and *Anopheles* (4.3%). *Armigeres kesseli* and *Ar. subabaltus* were the two most common species. *Armigeres annulipalpi* and *Phagomyia prominens* are new records of Sabah.

Keywords: Mosquito species composition, new records, medical importance, Kudat

ABSTRAK

Kaji selidik berkaitan dengan fauna nyamuk telah dijalankan untuk mengenalpasti populasi nyamuk serta komposisi spesis yang terdapat di Kudat. Kaedah tangkapan berumpan manusia ("human landing catch") teleh dipakai dari bulan Apil 2015 sehingga Jun 2015. Sejumlah 4,350 nyamuk terdiri daripada lapan genera dan 37 spesis teleh ditangkap. Antaranya ialah *Aedes* (Stegomyia), *Aedimorphus*, *Anopheles*, *Armigeres*, *Culex*, *Mansonia*, *Phagomyia* dan *Uranotaenia*. Spesis yang mempunyai kepentingan perubatan telah dibincang. Genus yang paling banyak termasuk *Armigeres* (52.7%), seterusnya *Culex* (31.9%), *Aedes* (9.4%), and *Anopheles* (4.3%). Spesis yang paling umum ialah *Armigeres kesseli* dan *Ar. subabaltus*. *Armigeres annulipalpi* and *Phagomyia prominens* ialah spesis rekod baru di Sabah.

Kata kunci: Spesies komposisi nyamuk, rekod baru, kepentingan perubatan, Kudat

INTRODUCTION

The importance of mosquitoes was highlighted when it was discovered as vector of filariasis in 1878 (Chernin, 1983), malaria in 1897 (Cox, 2010) and Japanese encephalitis in 1938 (Misra & Kalita, 2010). Mosquitoes are so important medically that it was considered as "the world deadliest animal".

As one of the twelve mega-biodiversity hotspots of the world, Malaysia is a tropical country with a high number of mosquito species (Foley *et al.*, 2007). This environment also promotes the establishment of several endemic mosquito-borne diseases, including dengue, malaria, chikungunya, filariasis and Japanese encephalitis.

Many researchers have focused their researches in intervention of disease vector and overlooked fundamental studies such as vector biodiversity (Ferguson *et al.*, 2010). They seek more obvious and immediate potential benefits, but information on the ecology and bionomics of mosquitoes is essential to sustaining long term success. In fact such knowledge is a prerequisite to eradication or elimination of disease carrying mosquitoes and hence the disease themselves (Ferguson *et al.*, 2010). Knowledge of species composition is vital to provide database of mosquito diversity, which are medically important, so that limited resources could be applied effectively in their control. Thus, this study was conducted to find out the mosquito species composition.

MATERIALS AND METHOD

The study site was selected in Kudat District (6.71-7.26N, 116.75-117.22E), where the highest malaria cases of *Plasmodium knowlesi* in Malaysia were reported in 2011 (William *et al.*, 2013). Only five villages: Paradason, Marabahai, Tuboh, Nangka, Nangaran were included, with a total population of 640.

Mosquitoes were collected with outdoor human landing catch (HLC) as only anthropophilic species transmit pathogen to human. A total of 24 nights HLC from 1800-2400 hour were carried out in two weeks intervals from April 2015 – June 2015. For each night there were three teams of two collectors per team, stationed in three different sites randomly. Landing mosquitoes were collected with 2x2.5cm transparent plastic vials.

Collected mosquitoes were preserved and identified with published keys (Rattanarithikul *et al.*, 2005; 2006a; 2006b). Literature search was carried out to identify all medical important species in collection.

The study was approved by the Medical Research & Ethic Committee of Ministry of Health Malaysia (NMRR-12-786-13048). All mosquito collectors signed informed consent forms and were provided with antimalarial prophylaxis.

RESULT

A total of 4,270 mosquitoes belonging to 36 species of 8 genera were collected (Table 1). The most abundant species was *Armigeres kesseli* (43.91%), followed by *Culex sitiens* (14.36%), *Aedes albopictus* (8.99%), *Ar. subabaltus* (7.56%), *Cx. vishnui* (3.19%), *Aedimorphus vexans* (2.69%), *Anopheles balabacensis* (2.58%), and *An. donaldi* (1.05%). The remaining species contributed less than 1%. Another 12.11% of mosquitoes belonging mostly to *Cx. vishnui* group were unidentifiable due to poor state of their morphological characteristics.

Among 36 species collected, 18 disease vectors were identified (Table 2). Human malaria is carried by anophelines: *An. balabacensis*, *An. donaldi*, and *An. maculatus*. Dengue, Chikungunya and Japenese encephalitis are carried by *Ae. aegypti* and *Ae. albopictus*. Japanese encephalititc is also transmitted by *Aedeomorphus vexans, Ar. subabaltus, Cx. bitaeniorhyncus, Cx. fuscocephala, Cx. quinquefasciatus, Cx. gelidus, Cx. sitiens, Cx. tritaeniorhynus, Cx. vishnui, Cx. pseudovishnui, and Cx. whitmorei.* The primary vectors of filariasis are *Mansonia uniformis* and *Man. indiana* while secondary vectors are *Cx. quinquefasciatus, An. balabacensis, An. donaldi, Ar. subabaltus,* and *Coquillettidia crassipes*.

DISCUSSION

Armigeres subabaltus and *Ar. kesseli* were found to be dominant most likely due to the abundance of breeding sites. Many *Armigeres* larvae were found breeding in many coconut shells during site investigation. The coconut shell can also be mutual breeding sites for *Armigeres jugraensis, Ar. malayi* and *Ar. moultoni* (Toma *et al.*, 2012). Besides, the improper management of sewage system, such as the uncovered septic tank provides ideal breeding sites to *Armigeres* spp (Rajavel, 1992). This putrefied water found in sewage and agricultural plantation could be helped the breeding of *Culex sitiens,* as it was also found in southern Thailand (Prummongkol *et al.*, 2012).

Larvae of *Aedes albopictus* were abundant in water drums and containers. Some third instar larvae were also found breeding in a tree holes of forested area. These explains the plasticity of *Ae. albopictus* in breeding site selection (Gratz, 2004).

Another finding is the host seeking behaviour of *Ae. albopictus,* a diurnal species (Sullivan *et al.*, 1971), however, our result suggested that *Ae. albopictus* is also active at night when host approaches (Dieng *et al.*, 2015). We also collected three adults of *Ae. aegypti*. These two species are very competent in arboviruses transmission (Gratz, 2004) and are the most important dengue vectors in Malaysia. Thus their presence could be a risk factor to local people.

Anopheles balabacensis is primary human malaria vector in northern Borneo (Reid, 1968). It is the predominant anopheline in Kudat where the other species are represented in a small percentage (Wong *et al.*, 2015). *An. donaldi* and *An. maculatus* are the malaria vector in Sandakan (Goh *et al.*, 2013) and Peninsula Malaysia (Reid, 1968). *Armigeres subabaltus* has been recorded positive with *Brugia pahangi* filarial worms in Peninsula Malaysia (Muslim *et al.*, 2013), but there is no evidence to show that it is a disease vector in Borneo island. The vectorial potential of *Armigeres* mosquitoes should be determined in future study.

Finally, *Armigeres annulipalpi* and *Phagomyia prominens* were recorded for the first time in Sabah. These two species are distributed in Oriental area (VectorMap, 2014) such as China, India, Vietnam, Cambodia, Nepal, Thailand and Indonesia. The vector status of these two species in Sabah is currently unknown.

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Table 1 Species composition of mosquitoes

Species	Apr	May	Jun	%
Aedimorphus vexans (Meigen)	-	-	115	2.69
Anopheles balabacensis Baisas	51	19	40	2.58
Anopheles donaldi Reid	18	10	17	1.05
Anopheles maculatus Theobald	11	-	-	0.26
Anopheles umbrosus gp.	8	1	-	0.21
Armigeres annulipalpis (Theobald)	1	-	1	0.05
Armigeres jugaensis (Leicester)	-	15	6	0.49
Armigeres kesseli Ramanlingam	645	565	665	43.91
Armigeres kuchingensis Edwards	-	2	-	0.05
Armigeres malayi (Theobald)	-	2	-	0.05
Armigeres moultoni Edwards	1	-	-	0.02
Armigeres subabaltus (Coquillett)	99	94	130	7.56
Coquillettidia crassipes (van der Wulp)	-	1	-	0.02
Culex alis Theobald	5	-	-	0.12
Culex bitaeniorhychus Giles	-	-	3	0.07
Culex gelidus Theobald	1	5	13	0.44
Culex pseudovishnui Colless	-	4	6	0.23
Culex quinquefasciatus Say	7	5	7	0.44
Culex sitiens Wiedemann	18	445	150	14.36
Total	865	1168	1153	

Species	Apr	May	Jun	%
Culex tritaeniarhycus Giles	5	3	8	0.37
Culex vishnui Theobald	9	37	90	3.19
Culex whitei Barraud	-	1	-	0.01
Culex whitmorei (Giles)	-	1	-	0.01
Cx. sp1	121	112	284	12.11
Mansonia indiana Edwards	-	1	-	0.01
Mansonia uniformis (Theobald)	1	1	8	0.23
Mansonia sp1	-	1	-	0.05
Paraaedes sp1	-	1	-	0.05
Phagomyia prominens (Barraud)	-	-	1	0.05
Aedes aegypti (Linnaeus)	-	-	3	0.07
Aedes albopictus (Skuse)	5	217	162	8.99
Aedes malayensis (Colless)	-	1	-	0.05
Aedes pseudalbopicta Borel	2	2	2	0.14
Aedes patriciae (Mattingly)	-	2	-	0.05
Aedes w-albus Theobald	-	-	1	0.01
Aedes sp1	-	1	-	0.01
Uranotaenia lateralis Ludlow	-	1	-	0.01
Total	143	382	559	
Grand total			4,270/100%	

Table 2 Medical important mosquito species

Species	Medical important	References
Aedeomorphus vexans	Japanese Encephalitis	Sucharit *et al.*, 1989
Aedes aegyti Aedes albopictus	Chikungunya	Noridah *et al.*, 2007; Pulmanausahakul *et al.*, 2011
	Dengue	Singh & Paul, 1969; Gratz, 2004; Lee & Rohani, 2005
	JE	Misra & Kalita, 2010; Vythilingam *et al.*, 1995
Anopheles balabacensis	Malaria	Reid, 1968; Hii *et al.*, 1985; Wong *et al.*, 2015
	Filariasis	Hii *et al.*, 1985
Anopheles donaldi	Malaria	Vythilingam *et al.*, 2005
	Filariasis	Reid, 1968; Vythilingam *et al.*, 1996
Anopheles maculatus	Malaria	Reid, 1968
Armigeres subabaltus	Filariasis	Aliota *et al.*, 2011; Muslim *et al.*, 2013
	JE	Rosen, 1986; Misra & Kalita, 2010
Coquillettidia crassipes	Filariasis	Chiang *et al.*, 1984
Culex.bitaeniorhycus	JE	Sucharit *et al.*, 1989; Vythilingam *et al.*, 1995
Culex gelidus	JE	Macdonald *et al.*, 1967; Vythilingam *et al.*, 1997
Culex pseudovishnui	JE	Sucharit *et al.*, 1989
Culex quinquefasciatus	JE	Rosen, 1986; Vythilingam *et al.*, 1997; Misra & Kalita, 2010
	Filariasis	Vythilingam *et al.*, 2005
Culex sitiens	JE	Vythilingam *et al.*, 1995; Vythilingam *et al.*, 2002
Culex tritaeniorhycus	JE	Macdonald *et al.*, 1967; Vythilingam *et al.*, 1995; 1997
Culex vishnui	JE	Sucharit *et al.*, 1989; Vythilingam *et al.*, 1995
Culex whitmorei	JE	Peiris *et al.*, 1993
Mansonia indiana	Filariasis	Wharton, 1962; Chiang, 1993
Mansonia uniformis	Filariasis	Wharton, 1962; Chiang *et al.*, 1984; Chiang, 1993

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