MOSQUITO FAUNA OF THE BENGKOKA PENINSULA, SABAH, MALAYSIA

W.H. CHEONG, K.P. LOONG, S. MAHADEVAN, J.W. MAK* and S.K.P. KAN**

Division of Medical Entomology, *Division of Filariasis and Malaria, Institute for Medical Research, Kuala Lumpur, Malaysia, **Medical Department, Kota Kinabalu, Sabah, Malaysia.

INTRODUCTION

A biomedical field study of the Collaborative Programme of the Institute for Medical Research, Sabah State Health Services, and the World Health Organization on research and training in tropical diseases was initiated in the Bengkoka Peninsula, northeast Sabah State in April 1981. The primary objective of the study was to determine the epidemiological characteristics of malaria, filariasis and malnutrition in rural communities of this remote area.

The entomology component of the programme was concerned with the study of the mosquito fauna, in particular the vectors of malaria and filariasis. Its major objectives were to (a) collect and identify the major mosquito fauna at the study sites, especially the vectors of malaria and filariasis, (b) define the principal factors which underly the maintenance of transmission of malaria and filariasis by their vectors, (c) describe the dynamics of transmission and vector bionomics with a view to evaluate control programmes and formulate vector control strategies.

In this paper the results of the first reconnaissance survey of six kampungs (villages) and some detail study in one of them conducted in 1981 are reported.

Study Area:

The area in which the six villages, named from west to east as Rosob, Rokom, Kebatasan, Sinukab, Kanibongan and Pantai, are situated lies along the base of the Bengkoka Peninsula (Fig. 1). Collections were made in two villages, Kampung Pias and Kampung Morontomon instead of Kampung Kanibongan. It consists of low hills centrally situated with low-lying coastal aprons. The central hill portions are covered by primary and secondary forests with alternating areas of scrub and open grass. The coastal area is variously swampy or sandy.

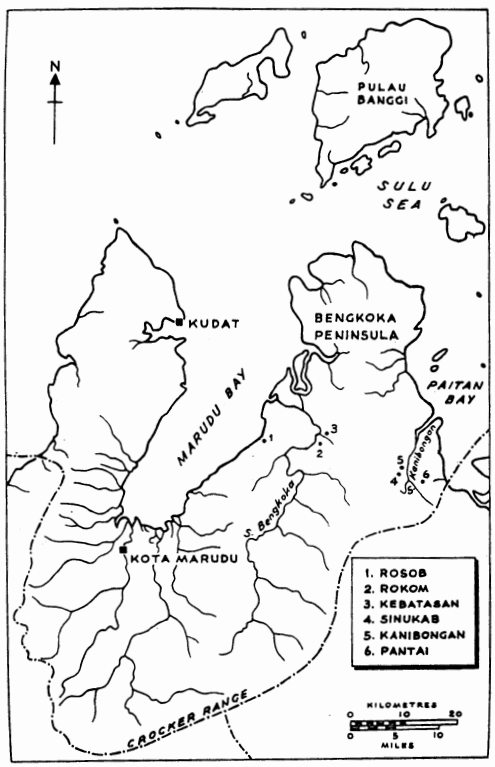

Fig. 1—The Kudat Residency showing the Bengkoka Peninsula and the villages surveyed.

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The area is sparsely populated and relatively underserved. Ethnically, the people are mainly Rungus and Bajau, two of the native communities of Sabah. Their subsistence is by shifting agriculture and, along the coast, by fishing and coconut harvesting.

The climate is tropical-equatorial. The mean daily temperature changes very little throughout the year and in the lowlands is about 27°C. The annual rainfall in Bengkoka Peninsula is about 300-350 cm with heavy rainfall during the north-east monsoon period of December to February.

MATERIALS AND METHODS

A single night was devoted to field studies in each village during the reconnaissance survey. Two methods were used to trap adult mosquitoes in each village.

Human bait net trap (HBT), originally tested in Malaysia by Gater (1935) and subsequently by Colless (1959) and Reid (1961) was used with two collectors sleeping under small nets within the large net from 1800 to 0600 hours. The men woke up at two hourly intervals to collect all mosquitoes attracted to and resting on the outer net. The density of mosquitoes taken by this method is expressed as the number per trap night.

Human bare leg catch (BLC) was used by two or more collectors seated at a catch site trapped mosquitoes landing on their bare legs and body. A single mosquito taken in a glass vial 50 × 19 mm with a wad of moist tissue at the base and plugged with cotton wool. This method facilitated identification of the catch alive. The catch commenced with the first mosquito bite at dusk and continued for two hours, this period representing the peak activity of *Mansonia*. The density is expressed as the number taken per man hour.

Mosquitoes were identified on the morning following each catch and dissected for malarial parasites and filariae in anophelines and for filariae in culicines. The ovaries of mosquitoes were also examined for parity by the method of tracheolar coiling (Detinova, 1962).

During the follow-up visit to Pantai in October 1981 four human bait net catches (HBT) and six bare leg catches (BLC) were made on eight nights in and around four houses with some inmates positive for microfilariae.

RESULTS

The results of the baseline survey carried out in April 1981 in the 7 villages are shown in Table 1. There had been little rainfall in several weeks prior to the visit and the mosquito catches were small in most villages except in Kebatasan. Despite these unfavourable conditions 31 species of mosquitoes of six genera were identified (*Anopheles* 6; *Mansonia* 3; *Coquillettidia* 2; *Aedes* 5; *Culex* 12 and *Armigeres* 3) totalling to a collection of 666. Of the total catch 55.1% was *Mansonia*, mainly *Ma. bonneae*. Three *Anopheles collessi* were collected, 2 in Rosob and 1 in Kebatasan. There is no previous record of this species being found in mainland Sabah. It has been reported so far in parts of Peninsular Malaysia and in the Labuan island and is a proven vector of *Plasmodium traguli* in the mouse-deer.

In Rosob, of the nine *An. balabacensis*, one (11.1%) was found to be heavily infected with sporozoites. Thus malaria transmission was active despite a parasite rate of 6.3% among the human population. Two out of 86 (2.3%) *Ma. bonneae* were infected with *Brugia* in Kebatasan where the microfilaria rate for *B. malayi* was 24.4%.

The vector species had high parous rates. In Rosob *An. balabacensis* had a parous rate

Table 1

Mosquito collections from seven villages in the Bengkoka Peninsula, Kudat, Sabah.

Species	Kampung Rosob			Kampung Rokom Darat			Kampung Kebatasan Darat			Kampung Sinukab			Kampung Pias			Kampung Morontomon			Kampung Pantai			Total All Localities		
	A*	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Anopheles																								
(Anopheles)																								
collessi	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
donaldi	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
(Cellia)																								
balabacensis	8	1	0.889	-	-	-	1	1	-	-	-	-	-	-	-	-	2	-	7	5	0.167	16	9	0.480
maculatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
tessellatus	-	-	-	1	-	-	-	3	-	-	-	-	-	-	-	-	5	-	-	-	-	1	8	-
Mansonia bonneae	-	1	1.00	11	-	0.727	28	62	0.826	4	5	0.444	-	110	0.518	-	48	0.667	7	5	0.833	50	231	0.661
Ma. dives	-	1	1.00	4	-	1.00	5	11	0.750	-	1	-	-	8	0.750	-	8	0.625	-	-	-	9	29	0.763
Ma. uniformis	4	-	1.00	-	-	-	25	13	0.711	-	-	-	-	-	-	-	-	-	-	-	-	29	13	0.738
Coquillettidia																								
crassipes	-	1	-	-	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-
nigrosignata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-
Aedes																								
(Aedes)																								
butleri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	1	-	-	1	-	-
(Aedimorphus)																								
vexans	4	-	1.00	-	-	-	60	2	0.500	-	-	-	-	1	-	-	-	-	-	-	-	74	3	0.531
(Cancraedes)																								
indonesiae	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	-	-	8	1	-
(Finlaya)																								
pseudo/subniveus	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
(Stegomyia)																								
albopictus	3	-	-	-	-	-	-	-	-	1	-	-	-	11	-	-	37	-	8	-	-	12	48	-

*A = Human bait net trap; B = Bare leg catch; C = with parous proportions.

Table 1 (cont'd)

Species	Kampung Rosob			Kampung Rokom Darat			Kampung Kebatasan Darat			Kampung Sinukab			Kampung Pias			Kampung Morontomon			Kampung Pantai			Total All Localities		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Armigeres (Armigeres)																								
malayi	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-
subalbatus	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	2	-	2	3	-
Culex (Culex)																								
annulus	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	3	-	-	-	-	3	3	-
bitaeniorhynchus	1	-	-	16	-	0.563	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	17	1	0.588
fuscocephalus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
gelidus	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
pseudovishnui	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
quinquefasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-
sitiens	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
tritaeniorhynchus	60	-	0.683	4	-	1.00	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	64	1	0.703
whitmorei	1	-	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
(Culiciomyia) nigropunctatus	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
(Lophoceromyia) cinctellus	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
(Lutzia) sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

Table 2

Mosquito collections, their densities and filarial infections at Kampung Pantai.

Species	Human Bait Net Trap (8 nights)		Human Bare Leg Catch (12 nights)		Parous Proportions	No. infected (%)
	No.	Catch per night	No.	Density per man-hour		
Anopheles						
(Anopheles)						
barbirostris	1	0.12	12	0.12	0.555	-
baezai	3	0.37	5	0.05	0.286	-
donaldi	1	0.12	4	0.04	1.00	-
separatus	-	-	1	0.01	-	-
(Cellia)						
balabacensis	6	0.75	46	0.46	0.725	-
kochi	3	0.37	5	0.05	1.00	-
maculatus	1	0.12	9	0.09	0.700	-
philippinensis	1	0.12	-	-	-	-
sundaicus	1	0.12	1	0.01	-	-
tessellatus	13	1.62	23	0.23	0.700	-
vagus	1	0.12	-	-	-	-
Mansonia						
bonneae	18	2.25	164	1.64	0.945	2 (1.09)
dives	-	-	9	0.09	0.880	-
uniformis	2	0.25	6	0.06	1.0	-
Coquillettidia crassipes	-	-	1	0.01	-	-
Aedes (Aedes) butleri	109	13.62	183	1.83	0.215	-
(Aedimorphus)						
vexans	212	26.5	365	3.65	0.376	-
(Banksinella)						
lineatopennis	3	0.37	1	0.01	-	-
(Cancraedes)						
indonesiae cf.	7	0.87	19	0.19	-	-
(Finlaya) poecilius	1	0.12	-	-	-	-
(Mucidus) aurantius	-	-	8	0.08	-	-
(Stegomyia) albopictus	14	1.75	63	0.63	0.450	-
Armigeres (Armigeres)						
durhami	-	-	1	0.01	-	-
subalbatus	3	0.37	16	0.16	0.75	-
sp.	-	-	2	0.02	-	-

Table 2 (cont'd)

Species	Human Bait Net Trap (8 nights)		Human Bare Leg Catch (12 nights)		Parous Proportions	No. infected (%)
	No.	Catch per night	No.	Density per man-hour		
Culex (Culex) annulus	59	7.37	49	0.49	0.579	-
bitaeniorhynchus	-	-	2	0.02	-	-
gelidus	18	2.25	43	0.43	-	-
pseudosinensis	12	1.5	9	0.09	-	-
pseudovishnui	160	20.0	141	1.41	0.385	-
quinquefasciatus	13	1.62	7	0.07	0.421	-
sinensis	3	0.37	4	0.04	-	-
tritaeniorhynchus	95	11.87	59	0.59	0.550	-
(Culiciomyia) spathifurca	1	0.12	-	-	-	-
(Lophoceromyia) cinctellus	1	0.12	-	-	-	-
Uranotaenia sp.	1	0.12	-	-	-	-

of 0.889 with a mean daily survivorship, for two and three day gonotrophic cycles, of 0.952. *Ma. bonneae* in Kebatasan had a parous rate of 0.826 with a mean daily survivorship, for a four-day gonotrophic cycle of 0.953. Likewise the other species of *Mansonia* too showed high parous rates. Thus the conditions, with high vector survivorship, were ideal for the transmission of both malaria and brugian filariasis in the region.

The results of the follow-up study at Pantai, in October 1981 are presented in Table 2. A total of 37 species of mosquitoes of 7 genera were found in Pantai by the two methods of collection. These included *Anopheles* 11, *Aedes* 8, *Armigeres* 3, *Culex* 10, *Mansonia* 3, *Coquillettidia* 1 and *Uranotaenia* 1. The total catch was 2020. Parous rates among the *Anopheles* and *Mansonia* vectors remained high despite the higher densities encountered during the visit. A total of 119 *Anopheles* were dissected including 51 *An. balabacensis*, 10 *An. maculatus* and 2 *An. sundaicus* and no infection was found. Two out of 182 *Ma. bonneae* (1.09%) were found infected with early stage *B. malayi*.

DISCUSSION

The area of Sabah selected for the present study is considered to be underserved and to be malarious with filariasis and nutritional problems. Malaria is perhaps the most important current public health problem in Sabah with over 51,000 cases reported in 1981. Little was known on the vectors of malaria in Sabah prior to 1939. It was through the efforts of McArthur (1947, 1951, 1954) that the importance of *An. leucosphyrus (= balabacensis)* was first noted with a 3% infection rate. This would certainly have been *An. balabacensis* as *An. leucosphyrus* was not found beyond the Baram river, Division 4 of Sarawak (Reid, 1968). *An. balabacensis* has been recently reported by Ramalingam (1974) from Beaufort and Sandakan in Sabah. We now have further evidence of involvement of *An. balabacensis* in transmission with the

infection in Rosob and another in Kampung Sinagang, Tenom district, where one *An. balabacensis* out of 48 (2.1%) was found to be heavily infected with sporozoites.

The finding of *An. collessi* adds one more to the list of new records for Sabah since Ramalingam (1974) reported finding *An. interruptus* Puri, 1929; *An. leucosphyrus* Dontiz, 1901; *An. litoralis* King, 1932; in other parts of Sabah.

Evidence of endemic filariasis in Sabah has been documented by Barclay (1965, 1969) and by Hii (1978). They showed that both *Brugia malayi* and *Wuchereria bancrofti* were present and that microfilaria rates were usually higher for subperiodic *B. malayi* than for *W. bancrofti*. Our studies provide evidence of transmission of *Brugia*, probably *B. malayi*, by *Ma. bonneae*. The presence in Sabah of other vectors of subperiodic *B. malayi* of Peninsular Malaysia, namely *Ma. dives* and *Ma. uniformis* suggest that they could also be involved in transmission.

SUMMARY

A total of 37 species of mosquitoes from seven genera were collected in six villages in the Bengkoka Peninsula, Sabah State, during two visits in 1981 in connection with studies on malaria and filariasis. Fifty-five per cent of the total mosquitoes collected were *Mansonia*. *An. collessi* constituted a new record of the species from Sabah. *An. balabacensis* was found to be naturally infected with sporozoites. *Ma. bonneae* was found to be naturally infected with *Brugia*, probably *B. malayi*. Parous rates of *An. balabacensis* and *Ma. bonneae* were very high with consequent high probability of survival ideally suiting transmission of malaria and filariasis.

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