A REPORT OF *ANOPHELES* (DIPTERA : CULICIDAE) ATTRACTED TO COW BAIT IN A MALARIA ENDEMIC VILLAGE IN PENINSULAR MALAYSIA NEAR THE THAILAND BORDER

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Abstract. Twelve species of *Anopheles* were collected by using cow-baited net trap in a malarial endemic village in northern Peninsular Malaysia. *Anopheles maculatus* which is the main malaria vector with its densities were related to drought. *An. aconitus, An. kochi* and *An. philippinensis* were less susceptible to *P. falciparum* and *P. vivax* infection, and are not considered important in falciparum or vivax malaria transmission. Biting activities of *An. kochi* and *An. vagus* were primarily active after dusk and steadily declined after midmight. *An. maculatus* and *An. aconitus* showed biting activities throughout the night but *An. maculatus* showed two peaks of biting activity in the first half of the night.

INTRODUCTION

In Malaysia, it has been established that whenever the cover of jungle is cleared from hilly areas, *Anopheles maculatus* breeds prolifically in seepages and streams, and is responsible for the high malaria endemicity in the rubber and oil palm estates on the hill slopes. Other species of *Anopheles* have been regarded as merely temporary and relatively less important vectors of the disease. However, recently Rahman *et al* (1992) reported the presence of malarial oocysts from other species of *Anopheles*, namely *An. aconitus*, *An. kochi* and *An. philippinensis* from an endemic village located in an area, where the jungles had been extensively cleared in the early 1980s for the construction of the East-West Highway linking the western and eastern coastal parts of West Malaysia; at the same time much of the cleared lands had been planted with rubber, oil palm and fruit trees.

The only form of vector control program carried out in the village by government health workers is in the form of residual house spraying with 25% EC DDT at the rate of 2g/m^2. But the spraying is primarily targetted at *An. maculatus*, but not at other possible vectors. In view of the above, information on new vectors and their behavior as base-line data needs to be collected. This paper reports on some entomological base-line data on *An. maculatus*, *An. aconitus*, *An. kochi* and *An. philippinensis* in an effort to prepare a framework for a vector control program involving not just *An. maculatus* but also these other *Anopheles* species as well.

MATERIALS AND METHODS

Study area: Observations were conducted in a small endemic village, known as Kampong Bongor, located at about 13.5 km from the Thailand border (long 101° 11'E, lat 5° 30.5'N). The 150 houses in the village were in or near rubber plantations, fruit plantations and secondary forests. The study area was previously described by Rahman *et al* (1992), elsewhere.

Daily rainfall readings were recorded at Kuala Kenderong Meteorological Station, Department of Irrigation and Drainage, Malaysia, situated about 0.5 km away from the study area.

Mosquito collections: *Anopheles* mosquitos were collected for 1 night each month from January until December 1991, using cow-baited net trap method (Service, 1976). Captures were made for 10 minute periods at the end of the hour from 1900 to 0700 hour by a two-man team at ground level, 2 m outside an inhabited dwelling. However, the sunset time was set at 1900 hours to allow for seasonal variation in daylight length according to Local Mean Time. Mosquitos were identified the following morning.

RESULTS

Biting cycles

Biting activity patterns of the four predominant *Anopheles* in the village are shown in Fig 1. Biting

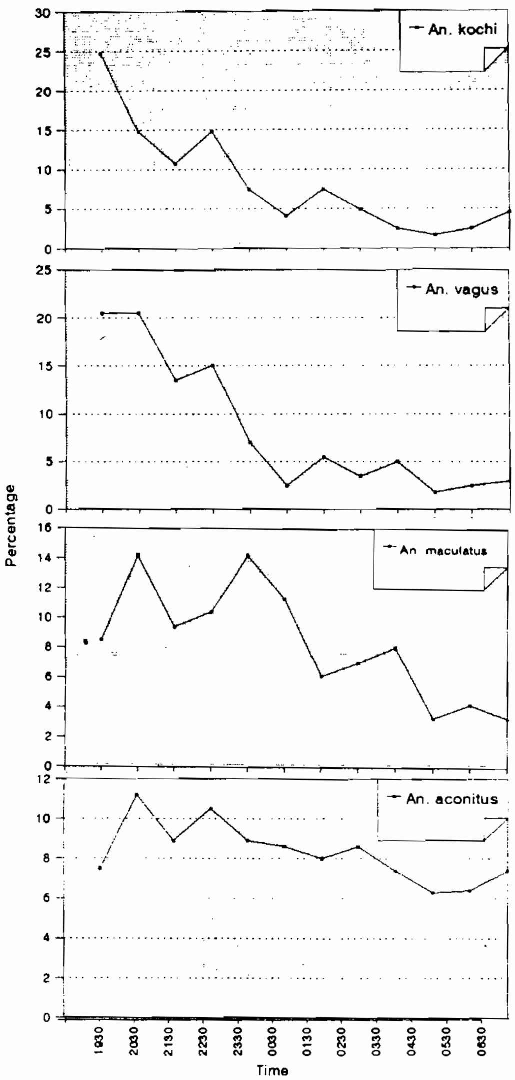

Fig 1–Biting activity of *Anopheles* mosquitos collected biting cow at the study village.

cycles of *An. kochi* and *An. vagus* were almost similar. Their peak biting activities occurred after dusk. Their biting activities declined steadily near midnight. Smaller peaks were observed after the major peak. Schultz (1992) showed a similar feeding pattern of *An. kochi* collected in a carabao-baited trap in Philippines.

An. maculatus and *An. aconitus* showed biting activities throughout the night (Fig 1). *An. maculatus* showed two peaks of biting activity in the first half of the night. The biting activity declined in the second half of the night. The biting pattern of *An. maculatus* in this study was similar to that collected on carabao-baited trap in Philippines by Schultz (1992). However, the biting activity of *An. maculatus* on man was different. The biting was observed throughout the night with a major peak around midnight (Loong *et al*, 1988; Moorhouse and Wharton, 1965). The biting activity of *An. aconitus* continued throughout the night with two small peaks between 1800-2300 hour. In Indonesia, *An. aconitus* is one of the main vectors of malaria in Java and it is zoophilic. The man biting activity occurs between 1800-2400 hour (Kirnowardoyo, 1985).

The mosquitos collected comprised 12 species, with *An. maculatus* being the most dominant, whilst *An. indefinitus* and *An. campestris* were the two least dominant ones (Table 1). Only 4 species were found to be positive for malarial oocysts: *An. maculatus, An. aconitus, An. kochi* and *An. philippinensis*; other species were discounted from further discussion.

An. maculatus was always present (Fig 2), with an average number of 55.4 bites/night, a maximum of 147 in February and a minimum of 5 in September (Table 2). High densities of the species were recorded from January until May (96.8 bites/night) when total monthly rainfalls were low. Low densities were recorded from June until December (mean 13.4 bites/

Table 1

Anopheles mosquitos caught biting cattle on 24 man-nights in the village.

Species		No.	% of total
An. maculatus		578	55.4
An. aconitus		266	25.5
An. kochi		136	13.1
An. vagus		97	9.3
An. jamesii		96	9.2
An. barbirostris		83	8.0
An. philippensis		63	6.0
An. tesselatus		36	3.5
An. sinensis		23	2.2
An. ramsayi		14	1.3
An. indefinitus		1	0.2
An. campestris		1	0.2
Total	12	1,394	

Table 2

Monthly mosquito biting rate due to *An. maculatus, An. aconitus, An. kochi* and *An. philippensis* in the study village.

Month	*An. maculatus*	*An. aconitus*	*An. kochi*	*An. philippensis*
Jan	84	21	0	3
Feb	147	33	11	8
Mar	134	45	2	3
Apr	66	45	17	11
May	53	55	57	5
June	10	12	13	9
Jul	8	10	9	3
Aug	12	8	5	4
Sep	5	2	0	2
Oct	15	11	7	5
Nov	16	12	10	8
Dec	28	12	5	2
Mean	55.4	25.5	13.0	6.0
Total	578	266	136	63

night) which corresponded to the wet season (Fig 2). The annual biting rate of *An. maculatus* was estimated to be 578/night.

An. aconitus was also always present (Fig 2) with an average of 22.2 bites/night. Like *An. maculatus*, high densities of this species were also recorded during the dry season (mean 39.8 bites/night) and low densities during the rainy season (mean 9.6 bites/night). The annual biting rate of *An. aconitus* was estimated to be 266 bites/night. *An. aconitus* was reported carrying *P. vivax* and served as a minor vector of malaria in Sri Lanka (Ramasamy *et al*, 1992).

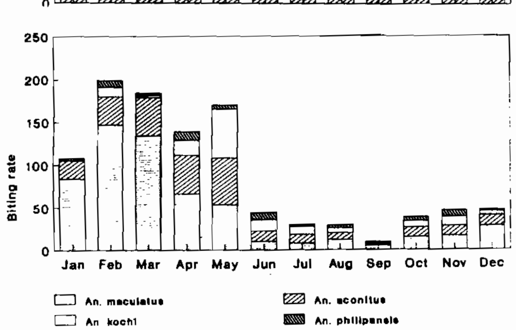

Fig 2–Monthly mean biting rates of *Anopheles* mosquitos at the study village.

An. kochi and *An. philippinensis* were less important; their annual biting rates were low at 136 and 63 respectively. *An. kochi* was totally absent in January and September, whilst although *An. philippinensis* was always present, its density is generally low.

Thus, the inhabitants of this village were bitten by malarial vectors throughout the year, and could receive a total of 1,394 bites per year from *An. maculatus, An. aconitus, An. kochi* and *An. philippensis.*

DISCUSSION

This study confirms the importance of *An. maculatus* as the principal malaria vector in the northern part of West Malaysia near the Malaysia-Thailand border. *An. aconitus, An. kochi* and *An.*

philipinensis were less susceptible to *P. falciparum* and *P. vivax* infection, and are not considered important in *falciparum* or *vivax* malaria transmission. Although these three species developed oocysts of *P. falciparum* and *P. vivax*, generally they have lower oocyst infection rates and produced fewer oocysts than in *An. maculatus*. Also, oocysts in these species were generally one-third or less than the size of those in *An. maculatus* which may be related to the abnormal development of the oocysts.

It is interesting to note that although *An. maculatus* is zoophilic and exophagic (Abu Hassan, 1994), they were still caught biting man indoors in the study village (Rahman and Abu Hassan, unpublished observations) and elsewhere in the country too (Chooi, 1985). This preference of *An. maculatus* for being zoophilic may be linked to the source and availability of blood-meals. MacFayden (1963) reported that large numbers of animals are known to be associated with forest ecosystems because of the protection and food supply it affords. The rich vertebrate fauna of the forests in the study village are a constant supply of ready bloodmeals for mosquitos. Thick vegetations of the study village provide resting places for adult *An. maculatus* mosquitos and possibly explains its preference for being exophagic.

Nevertheless, people of this village can receive a total of 578 bites annually due to *An. maculatus* acting as the principal vector. Seasonal peaks of the biting rate were observed in the dry season, such that 84% were collected in the dry season (January to May) and only 16% in the wet season (June to December). Rahman *et al* (1993, 1994) reported that *An. aconitus* and *An. maculatus* were in high numbers during the dry season in the nearby area. Such a high level of biting justifies the planning of a proper vector control program. Obviously, the spraying of DDT alone has not been effective in controlling the mosquito population of the study village. This study underlines the need for entomological evaluation of every malariological situation in relation to the concept of stratification in malariology (WHO, 1986).

The animal-baited trap has several disadvantages in comparison to man-biting collection when studying mosquito biting activity. First, it limits the number of collections during the night; for every 10 minutes, 2 men go in to collect the mosquitos in the trap. Fewer collections result in a less accurate detection of biting activity patterns. Secondly, mosquitos only rest on the trap walls during hours of darkness, so collections can only be carried out from sunset to sunrise. Some biting peaks as seen in man biting activity may be missed in the animal-baited trap. Thirdly, data collected from cow-baited trap could not be accurately used to extrapolate to human malaria transmission. However, the advantage of animal-baited trap is that, species rarely collected from man-baits are often collected in sufficient numbers from animal-bait, therefore, providing at least a general indication of its biting activity and seasonal abundance. A knowledge on biting rhythm of the mosquito is critical in determining the periods of potential disease transmission as well as in scheduling the sampling of the biting female mosquito population.

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