SPECIES COMPOSITION OF ADULT *ANOPHELES* POPULATIONS AND THEIR BREEDING HABITATS IN HULU PERAK DISTRICT, PENINSULAR MALAYSIA

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Abstract. Using the cow-baited trap (CBT) method, 1,845 *Anopheles* mosquitos, comprising 14 species, were caught in malaria-endemic area of Hulu Perak district, Peninsular Malaysia. The two dominant species were *An. barbirostris* (18.59%) and *An. aconitus* (18.86%). *Anopheles maculatus*, the main malaria vector, constituted 9.11% of the total number of mosquitos sampled. Three hundred and seventy-seven *Anopheles* larvae, comprising 8 species, were sampled using the North Carolina Biological Station dipper. *Anopheles barbirostris* larvae amounted to 64.69% of the total number of larvae; *An. aconitus* accounted for 10.65% of larvae. Seven habitats were identified as breeding places of *Anopheles*. Most species were found to breed in paddies, fishponds, and rivers. Other less popular habitats were temporary pools, mountain streams, and spring wells.

INTRODUCTION

Peninsular Malaysia, an equatorial region with relatively high temperatures and humidity, is well suited to the breeding of various species of mosquitos; 434 species of mosquitos representing 20 genera, have been reported, of which 75 are *Anopheles* that comprise 2 subgenera, *ie Anopheles* and *Cellia* (Abu Hassan and Che Salmah, 1990). Only 9 of these 75 species of *Anopheles* are vectors of malaria (Harinasuta *et al*, 1962; Tham, 1989), with *An. maculatus* being the main vector (Sandosham and Thomas, 1962; Rahman *et al*, 1995).

The control of *Anopheles* mosquitos in Malaysia has not been entirely successful because of insufficient knowledge of ecology and breeding habitats. This paper reports on the species composition and breeding habitats of *Anopheles* in Hulu Perak district, an area endemic for malaria.

MATERIALS AND METHODS

In Malaysia, catching mosquitos during the daytime gives unsatisfactory results, especially for *Anopheles*, which rest outdoors during the day (Wharton, 1950, 1951; Abu Hassan, 1994). In the present study, mosquitos were caught at night using the modified cow-baited trap (CBT) described by Reid (1968). The trap comprised a net (2.4x2.4x1.6 m), a 1.2 m zip door on one side; the net was hung 0.3 m from the ground to allow the entry of mosquitos into the trap from below; the cow was tied inside the trap; a plastic sheet was hung above the trap to protect it from rainwater. At the end of every hour, two collectors entered the trap to collect the mosquitos that were resting on the walls: mosquitos were collected for 15 minutes during each 12 hours, beginning at sunset and ending at sunrise.

Larvae were sampled using the North Carolina Biological Station dipper, which is made of plastic, has a capacity of 450 ml, and has an aluminium handle, which can be shortened or lengthened as desired. Samples were poured into enamel trays and larvae were sorted using the techniques of Jaal (1990) and O'Malley (1995). First and second instars were reared to third instars before they were indentified; the species of larvae were identified using the keys of Reid (1968) and Stojanovich and Scoot (1966).

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RESULTS

A total of *Anopheles* mosquitos were sampled. Fourteen species, from two subgenera (*Anopheles* and *Cellia*) were identified: *An. barbirostris, An. sinensis, An. peditaeniatus, An. separatus, An. nigerrimus, An. crowfordii* (from the subgenus *Anopheles*) and *An. aconitus, An. kochi, An. maculatus, An. philippinensis. An. vagus, An. tessellatus, An. ramsayi, An. jamesii* (from the subgenus *Cellia*) (Table 1).

The two dominant species were *An. aconitus* (18.86%) and *An. barbirostris* (18.59%). Other less important species were *An. sinensis* (14.15%), *An. kochi* (13.22%), *An. maculatus* (9.11%), *An. philippinensis* (9.11%). *Anopheles vagus* and *An. tessellatus* constituted not more than 6% of the total population, while the sum of *An. ramsayi* and *An. jamesii* amounted to less than 1% of the total population of *Anopheles* mosquitos.

A total of *Anopheles* lavae, from 8 species, were sampled; *An. barbirostris* larvae were the most common (64.90%). *An. aconitus* larvae constituted 10.65% of the total larval population, while *An. kochi* larvae were fewer (8.48%). Other species are shown in Table 2.

Seven types of habitats were identified as the breeding places of *Anopheles* (Table 3). *An. barbirostris* were more widely distributed among the various habitats than the other species: *An.*

Table 1
Composition of *Anopheles* adults sampled using the CBT method during 1993 at Hulu Perak district, Peninsular Malaysia.

Species	Number caught	Percentage
Anopheles (Anopheles)		
An. barbirostris	343	18.59
An. sinensis	261	14.15
An. peditaeniatus	49	2.66
An. separatus	35	1.89
An. nigerrimus	8	0.43
An. crowfordii	3	0.16
Anopheles (Cellia)		
An. aconitus	348	18.86
An. kochi	244	13.22
An. maculatus	168	9.11
An. philippinensis	168	9.11
An. vagus	105	5.69
An. tessellatus	103	5.58
An. ramsayi	99	0.49
An. jamesii	1	0.05

Table 2
Showing composition of *Anopheles* larvae sampled in the study area.

Anopheles species	Percentage
An. barbirostris	64.90
An. aconitus	10.65
An. kochi	8.48
An. maculatus	7.30
An. sinensis	4.19
An. vagus	2.32
An. tessellatus	1.12
An. peditaeniatus	1.04

Table 3
Anopheles larval habitats in Hulu Perak district, Peninsular Malaysia.

Habitat	Species	Number sampled
Paddies	*An. barbirostris*	130
	An. sinensis	14
	An. kochi	9
	An. peditaeniatus	7
Fish-ponds	*An. barbirostris*	126
	An. kochi	14
	An. aconitus	6
	An. vagus	4
Temporary pools	*An. vagus*	6
	An. sinensis	8
Mountain streams	*An. maculatus*	17
	An. kochi	12
Spring wells	*An. barbirostris*	15
Rivers	*An. barbirostris*	22
	An. maculatus	18
	An. kochi	8
	An. tessellatus	8

barirostris larvae were found in paddies, fish-ponds, spring wells and rivers; the two habitats in which it was not found were temporary pools and mountain streams. Other species were more selective: *An. kochi* could be found breeding in paddies, fish-ponds, mountain streams and rivers; *An. maculatus* bred near mountain streams and rivers; *An. sinensis* were found in paddies and temporary pools; *An. peditaeniatus* bred only in paddies; *An. tesselatus* bred near rivers.

DISCUSSION

Anopheles larvae were found in various habitats. Clean pools, either permanent or temporary, that are not contaminated by waste products or chemicals, are suitable for the breeding of *Anopheles* (Jaal, 1990). Environmental factors such as temperature (Goma, 1966), light (Russel and Roa, 1942), and rainfall (Wahab, 1995) are believed to affect the selection of breeding habitats.

During the sampling period, the paddies were being prepared for the planting stage. The soil was repeatedly tilled, and treated with fertilizers and insecticides; the paddy ecosystem was disturbed and unsettled, which may have affected the presence of *Anopheles* larvae, as shown by Llagas de Las (1986).

According to McCrae (1984), female *An. gambiae* mosquitos prefer dark to clear waters for oviposition; this may be true for *An. barbirostris, An. sinensis, An. peditaeniatus,* and *An. kochi* because the water in the paddies was darker than that of the other habitats in the study area.

Anopheles barbirostris lavae were predominant throughout the sampling period. Most of these larvae were sampled from paddies, fish-ponds, and numerous neglected pools. In Thailand, the species is also found in abundance in paddies and in swamps and canals (Rattanarithikul *et al,* 1994). The breeding places for *An. aconitus* in the present study were of the type reported from elsewhere in the country by Hodkin (1956).

Anopheles kochi and *An. vagus* prefer the same breeding habitats (Hodkin, 1956; Jaal, 1990), and it was not surprising to find both species breeding in temporary pools. Jaal (1990) found the two species breeding in temporary pools made by the hoofprints of animals such as cattle and buffalos in the neighboring State of Kedah; in Thailand, Rattanarithikul *et al* (1994) found that the breeding of *An. vagus,* but not the breeding of *An. kochi,* was confined to temporary pools. Rattanarithikul *et al* (1994) and other workers (Sandosham and Thomas, 1982; Roa, 1984) showed that *An. kochi* are more common in the foothills.

Anopheles tessellatus and *An. kochi* were found in common habitats. They were found breeding near open waters exposed to sunlight, although elsewhere, the two species have been reported to breed only in places covered by vegetation (Reid, 1968; Sandosham and Thomas, 1982). *An. sinensis* was found to breed in paddies, as similarly reported by Jaal (1990) in Kedah, and Rattanarithikul *et al* (1994) in Thailand. *An. maculatus,* the main vector for malaria, was found to breed in flowing waters exposed to sunlight, as shown by Rahman *et al* (1992).

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