

Comparative Susceptibility of *Anopheles maculatus*  
and *Anopheles balabacensis* to *Plasmodium vivax*

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OBJECTIVE : To compare the efficiency of various potential vectors of *P. vivax*. To evaluate the susceptibility of "secondary vectors".

BACKGROUND : While investigating the possible reappearance of malaria in the Chiang Mai Valley in collaboration with the National Malaria Eradication Project from 1976 to 1977, it became apparent that potential vectors other than *Anopheles minimus* and *Anopheles balabacensis* were breeding in the study area. Because the role that these possible secondary vectors may play in human malaria transmission in Thailand is still unknown, a study to compare the susceptibility of various anopheline species to *P. falciparum* and *P. vivax* was established. Established colonies of *Anopheles balabacensis* (Khao Mai Khaeo strain) and *Anopheles maculatus* (Kuala Lumpur strain) existed at AFRIMS; thus, the susceptibility of these two species was examined first. *Anopheles balabacensis* is a major vector of malaria in the forested foothills of Thailand and *An. maculatus* is a primary vector in cleared or partially-cleared foothills in Peninsular Malaysia.

MATERIALS AND METHODS : The study was initiated in Phrabuddhabat and continued at the Kanchanaburi Provincial Hospital. Patients were admitted to the male medical ward from the hospital out-patient department or from clinics of the National Malaria Eradication Project, in Phrabuddhabat, Pak Chong and Kanchanaburi.

Sixty laboratory-reared *Anopheles balabacensis* and 60 *Anopheles maculatus* were simultaneously fed on patients prior to therapy. Ten engorged mosquitoes of both species were then withheld for determination of longevity. Mosquitoes were also fed each day on uninfected volunteers as simultaneous controls. The mosquitoes were reared and maintained either at the AFRIMS Phrabuddhabat insectary or at the insectary in Bangkok to be transported to the study site in Kanchanaburi. Both species were four to five days old on the day of feeding and were dissected seven and fourteen days post-feeding. Midguts and salivary glands were examined for oocysts and sporozoites respectively, with oocyst and sporozoite indices being determined at the time of dissection.

RESULTS : Dissection results may be summarized in two ways : individual mosquito data, and data from mosquito lots (each lot comprises 50 individuals).

Table 1 shows individual mosquito data. The percentage engorging when exposed to an infected patient was higher in the *balabacensis* than in the *maculatus* group. Also the numbers of mosquitoes surviving to dissection was higher in the *balabacensis* group. The positivity rate was likewise higher in *balabacensis*.

Table 2 presents mosquito lot data. Again lots of *balabacensis* were more likely to be infected than *maculatus*, and the positivity rate was higher among *balabacensis* lots.

When positive lots were compared in terms of oocyst numbers/gut, oocyst diameters, and sporozoite densities (Table 3), *vivax* oocysts were found to be greater in number and of larger mean diameter in *balabacensis* than in *maculatus*. Sporozoites were found in glands in greater numbers in *balabacensis* than in *maculatus*.

Generally, laboratory-reared *An. balabacensis* appear to be more efficient vectors than laboratory-reared *An. maculatus*, in terms of engorgement, survival, positivity, and numbers of oocysts and sporozoites developing in the mosquito.

When suitable colonies of other potential vectors were established at the Laboratory, it is planned that they will be tested in a similar fashion.

Table 1. Feeding and dissection results from mosquitoes fed on untreated *P. vivax* patients

	<i>Anopheles balabacensis</i>	<i>Anopheles maculatus</i>
Total number of mosquitoes fed (% engorged)	5283 (80)	4145 (63)
Total number dissected	3403	1935
Percent survival	82	74
Total number dissected (oocysts) (% positive)	743 (27)	591 (19)
Total number dissected (sporozoites) (% positive)	2660 (22)	1326 (16)

Table 2. Dissection results from mosquito lots fed on untreated *P. vivax* patients

	<i>Anopheles balabacensis</i>	<i>Anopheles maculatus</i>
Number of mosquito feeds	109	109
Number of feeds positive (oocysts)	40	33
Number of feeds positive (sporozoites)	44	33
Total number of feeds positive (% positive)	49 (45)	39 (36)

Table 3. Results of dissection of 14 lots of *Anopheles balabacensis* and *Anopheles maculatus* positive for *Plasmodium vivax*

	<i>Anopheles balabacensis</i>	<i>Anopheles maculatus</i>
Mean # of oocysts/gut (range)	30.5 (2-110)	19.2 (2-86)
Mean diameter of oocysts (range)	43.9 (30-60 $\mu$ )	41.8 (24-58 $\mu$ )
Mean sporozoite level (range)	+3.1 (+2 - +4)	+2.6 (0 - +4)