Ecology of Malaria in Northern Thailand

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OBJECTIVE : To investigate the reappearance of malaria in the Chiangmai Valley and other areas of Northern Thailand.

BACKGROUND : The Chiangmai Valley was site of the first malaria eradication program (1949-1950) in Thailand, and the valley floor has been considered free of all but imported malaria cases for the past twenty-five years. Malaria has persisted, however, in the mountains and foothills surrounding Chiangmai Valley, and during the past three years the Malaria Eradication Project has reported the occurrence of apparently indigenous cases of malaria among residents of the valley floor. Entomological surveys carried out by our lab in Chiangmai province between 1962 and 1970 recorded the presence of *Anopheles minimus*, the principal vector of malaria in Chiangmai Valley in past years, in Doi Saket, Mae Rim, Muang, Sankampaeng and Saraphi Districts, all located on the floor or at the edge of the valley. Other potential vectors such as *Anopheles balabacensis* and *Anopheles maculatus* have been found in these areas. It is apparent that, despite many years of eradication efforts in and around the Chiangmai Valley, populations of malaria vectors are still present at its periphery and may be extending their ranges onto the valley floor once again.

METHODS : From August 1976 a surveillance of anopheline populations was carried out in Doi Saket, Hang Dong, and Mae Rim Districts on a monthly basis until September 1977. Three rural villages in each district were surveyed, with one of the villages being located in the foothills, one on the valley floor, and the other situated in between. Human population in the nine villages is 3,580.

Battery powered CDC light traps together with a CO_2 attractant (dry ice) were used to monitor adult anophelines. In each area on a particular night, twelve traps were placed outside of houses and six were placed inside. In one month each of the nine villages was visited three times, with traps being set in the evening and being picked up in the morning. Light trap collections were sorted according to mosquito species and all suspected vectors were dissected and examined for malaria parasites. Recently engorged females were preserved for precipitin tests. Some indoor and outdoor human bait collections were made periodically with the adults being processed the same way as those caught in light traps.

Larval collections were made at all the villages to detect anopheline breeding sites. Surveys were conducted each month to measure fluctuation of anopheline populations.

RESULTS : During the past year the National Malaria Eradication Project reported a total of six cases of malaria in all three study villages in Amphor Doi Saket, one case in the Amphor Mae Rim foothill village, and three cases in the Amphor Hang Dong village near the foothills. They applied DDT to houses in only four of the nine study villages, the others having had no control since 1963.

A total of 7,052 *Anopheles* mosquitoes were collected in CDC light traps (with CO_2) in the three Chiangmai districts (Table 1). As expected, anopheline populations were highest during the warm wet months. Collections in December and January were reduced greatly due primarily to colder temperatures in those months. *Anopheles kochi, nivipes,* and *vagus* were caught in the greatest numbers throughout the year.

Table 2 lists the six species considered by the Malaria Project people in Thailand to be possible potential malaria vectors, and the total number of each collected.

Anopheles aconitus, maculatus, and *minimus* collections by month are shown in Figure 1. *Anopheles aconitus* was caught most frequently, particularly in October and December. Collections of *Anopheles minimus* were very low from October to May. Figure 2 shows that *Anopheles campestris* was caught primarily in October and February. The other two species were captured in any numbers only in August, 1976.

All six potential vector species were dissected and the ovaries examined. Individuals found to be parous were further dissected and examined for malaria parasites. Of eleven hundred females dissected, 49 per cent were found to be parous. None of these had oocysts on their guts or sporozoites in their salivary glands.

Of the 292 *Anopheles minimus* caught in light traps, one third were in traps which had been placed inside houses. Some of these had recently taken a bloodmeal. This species was found most frequently in Amphor Mae Rim, especially during 1977 (Figure 3). Larvae of this species were collected in all three districts and were found in two out of the three villages located on the valley floor. Adults were found in every village but one.

Bloodmeal analysis of engorged females is not yet complete but all other aspects of this study are.

Table 1. *Anopheles* spp. Collected in CDC Light Traps (with CO_2) - Chiangmai, August 1976 - August 1977

District	A	S	O	N	D	J	F	M	A	M	J	J	A	Total
Amphor Doi Saket	367	414	149	116	15	26	57	79	79	96	101	415	131	2,045
Amphor Mae Rim	175	372	665	125	145	27	143	130	176	295	560	556	242	3,611
Amphor Hang Dong	314	143	86	61	10	21	139	116	11	90	27	318	60	1,396
Total	856	929	900	302	170	74	339	325	266	481	688	1289	433	7,052

Table 2. Potential Malaria Vectors Collected in CDC Light Traps (with CO_2) Chiangmai Valley, August 1976 - August 1977.

Species	Total Number
Anopheles aconitus	722
Anopheles campestris	125
Anopheles culicifacies	58
Anopheles jeyporiensis	58
Anopheles maculatus	258
Anopheles minimus	292

Fig. I CDC Light Trap (with CO_2) Collections — Chiang Mai.

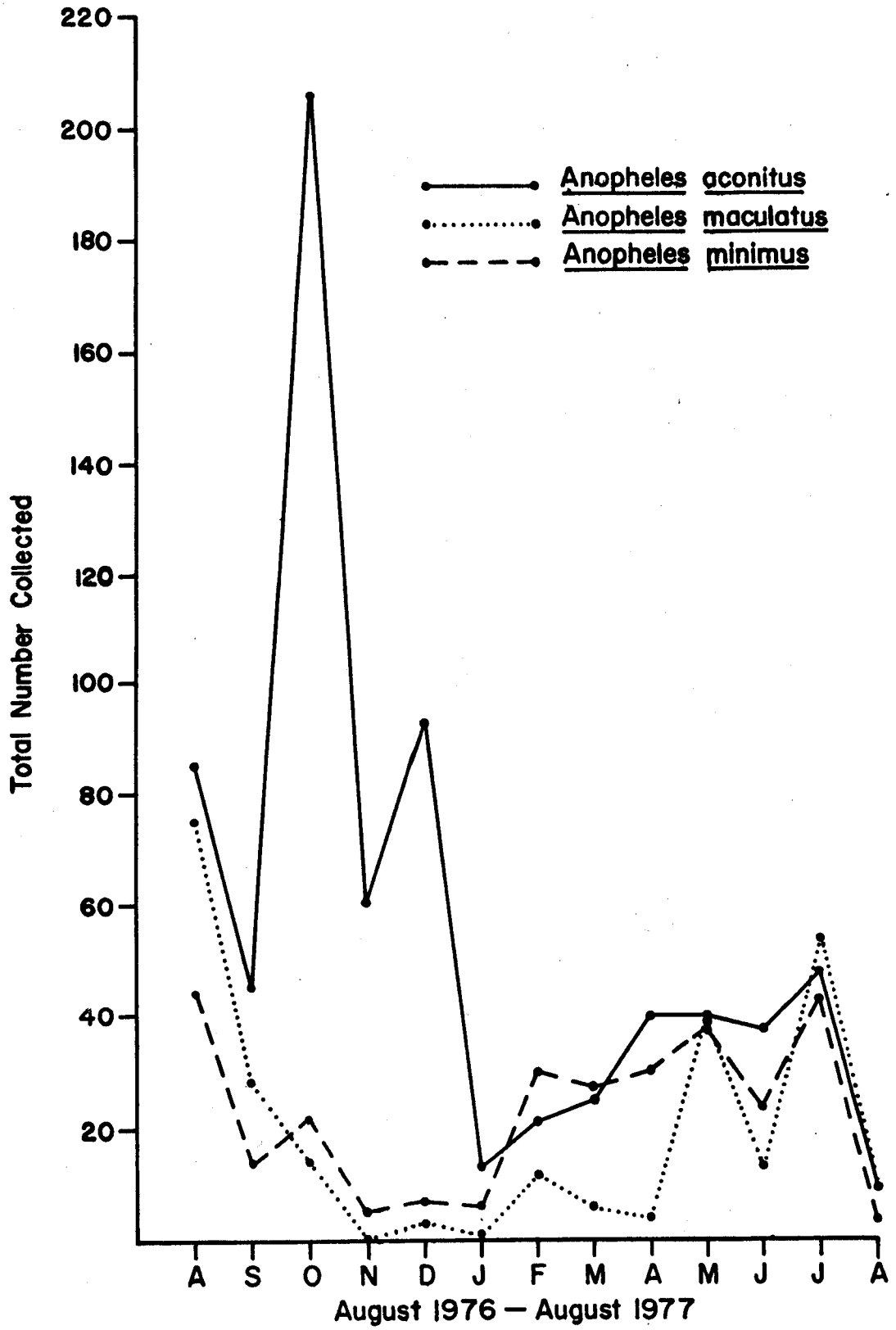

Fig. 2 CDC Light Trap (with CO_2) Collections– Chiang Mai.

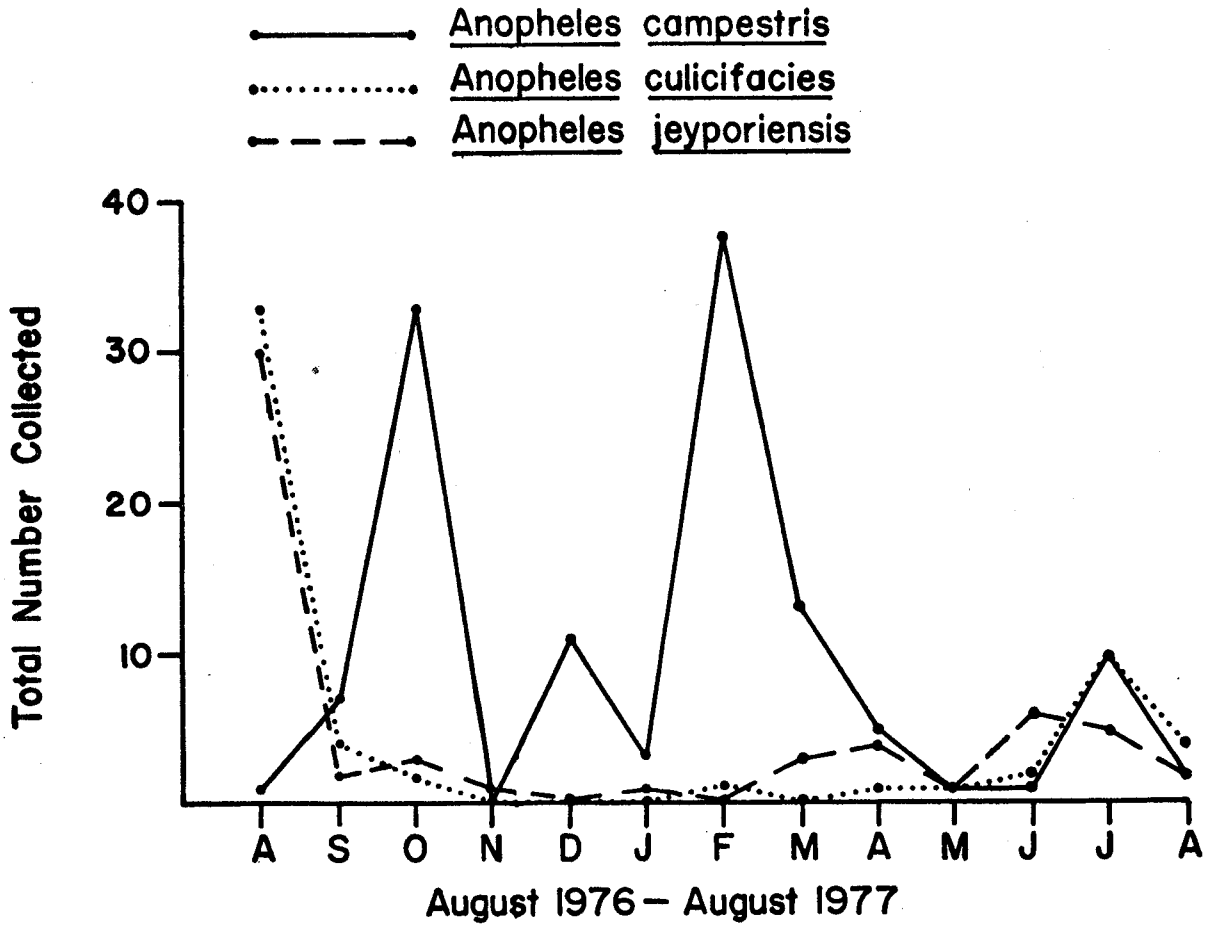
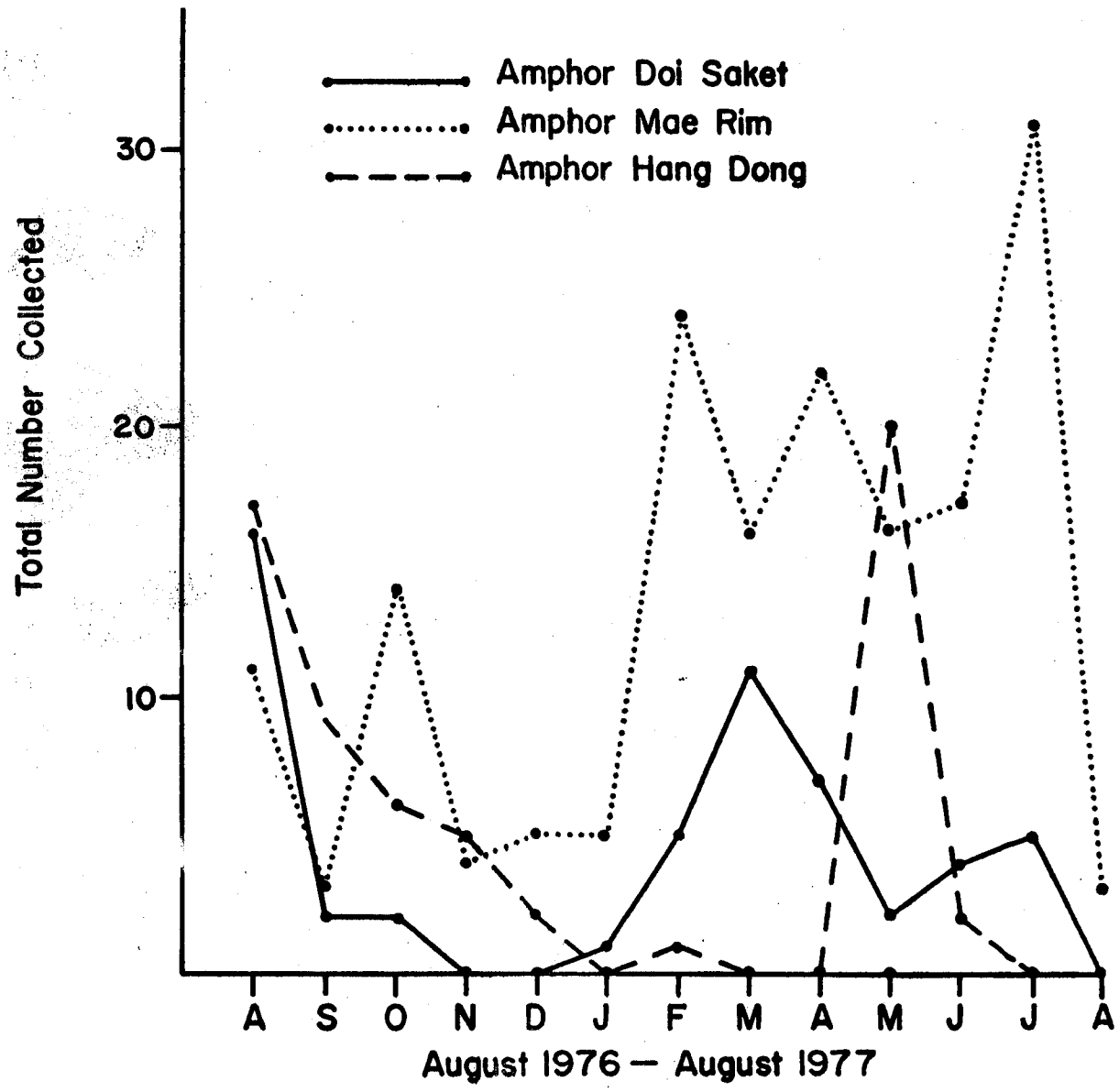
Fig. 3 CDC Light Trap (with CO_2) Collections of *Anopheles minimus*– Chiang Mai.