Ecology of Japanese Encephalitis Virus Vectors

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OBJECTIVE: To investigate the ecology of vectors of Japanese encephalitis virus (JEV) in Thailand, with particular emphasis on population dynamics and the development of control methods.

1) Chiangmai Valley Studies

BACKGOUND: The density of JEV vectors (*i.e., Culex fuscocephala, C. gelidus* and *C. tritaeniorhynchus*) in the Chiangmai Valley of Northern Thailand is closely related to the climatic conditions and agricultural practices in that area. As described in previous annual reports the population densities of the three vector species were consistently at their lowest levels during the cool, dry months from December–March each year. In Saraphi and Sanpatong districts where most of these entomologic studies were concentrated during 1973, the usual practice has been to plant a rainy season rice crop followed by tobacco, vegetables, peanuts and soybeans in the dry season; however, in August, September and October of 1973 a disastrous series of floods destroyed the rice crops in Saraphi district. Because of the loss of their 1973 crops, farmers in that district began planting a winter crop of hybrid rice in December 1973 and January and February 1974. This change in their usual agricultural practice produced large areas of flooded fields in the dry season, significantly increasing the numer of available vector breeding habitats during this time of year. Changes in vector population density and the frequency of human JEV infections were monitored during this period.

DESCRIPTION: Four battery–powered CDC light–traps were operated twice weekly in two rural sites in Saraphi and Sanpatong districts and eight traps were run once a week in Chiangmai City. In addition, three large Magoon traps baited with buffaloes were operated two nights per week in Saraphi district. Monthly indices of vector population densities were based on the number of females of each of the three species collected per trap per night in each study site. Pools of these species were prepared for JEV isolation attempts by the Department of Virology according to established procedures.

PROGRESS: As shown in Fig. 1, CDC light trap indices for both *C. fuscocephala* and *C. tritaeniorhynchus* in Saraphi during January 1974 were only slightly higher than in the same month of previous years; however, the density of both species was considerably higher during February 1974 than during the same period in previous years, with approximately a 20 fold increase for *C. fuscocephala* and a 4 fold increase for *C. tritaeniorhynchus*. *C. fuscocephala* populations were also considerably higher in February 1974 than they were during the peak of the rainy season (August) of 1973; however, *C. tritaeniorhynchus* densities were not as high as they were during August of the precedina year. Between February and March 1974 indices of both *C. fuscocephala* and *C. tritaeniorhynchus* showed a slight drop. Similar drops were noted during March 1970 and 1971, possible explanations of which are (1) increase in mosquito larvae predator populations, (2) lower humidity during this time of year which shortens life span of mosquitoes and (3) temporary drying of irrigated rice fields causing larval mortality. The *C. gelidus* indices for February 1974 were slightly lower than they were during this period in previous years.

The indices for JEV vector species collected in Saraphi from the buffalo baited Magoon traps are given in Fig. 2. With this collection method *C. fuscocephala* and *C. tritaeniorhynchus* were again significantly

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higher in January and February 1974 than they were during the same two months of 1973, while C. *gelidus* collections were smaller during 1974. Unlike the light trap collections, the numbers of mosquitoes of the three species collected in Magoon traps during the winter months of 1974 never reached the levels that were collected in July and August 1973.

The results of CDC light trap collections in Sanpatong during the winters of 1973 and 1974 and the rainy season of 1973 are shown in Fig. 3. No mosquito collections were made in this district during January 1974: however, the C. *fuscocephala* populations during February 1974 were approximately 10 times greater than the same month of 1973, and close to the same numbers as August 1973. C. *tritaeniorhynchus* populations were also at about the same levels in February 1974 as they were in August 1973; however, they were about 5 times greater than in Februay 1973.

2) Insecticide susceptibility of JEV vectors

BACKGROUND: Insecticide susceptibility tests run during 1970[1] indicated that adult C. *fuscocephala*, C. *gelidus* and C. *tritaeniorhynchus* were resistant to 4% DDT, the concentration employed for residual spraying of dwellings by the National Malaria Eradication Project in Thailand. The susceptibility of larval stages of these three species to DDT was not determined at that time, but both larvae and adults were found to be susceptible to malathion. The above results are puzzling because DDT is not widely used for agricultural purposes in the Chiangmai Valley, and houses in the area have not been sprayed with this chemical for malaria control for more than 10 years. Thus, there is no apparent DDT pressure on these mosquito populations to account of their state of resistance to this insecticide. On the other hand, organophosphates, including malathion, are commonly used in the Chiangmai Valley to control pests on crops such as tobacco, but insecticides are not used to control pests of rice.

DESCRIPTION: To confirm the findings of the 1970 susceptibility tests adults and larvae of C. *fuscocephala* and C. *tritaeniorhynchus* were retested. In addition, *Culex tritaeniorhynchus* were collected from near pig farms at Amphur Bang Nam Prieo, Changwat Chachoengsao, near the eastern edge of the central plain and about 60 kilometers from Bangkok. This area is under cultivation during most of the year with both dry season and rainy season crops. Most of the rice planted in this area is one of the several new hybrid varieties, such as RD-1, which require use of fertilizers and insecticides. In contrast, in the Chiangmai Valley, the majority of the farmers still plant traditional varieties of rice (80 per cent of which is glutinous rice) which do not require fertilization or protection from insect pests. Over half of the farmers in Bang Nam Prieo use granular BHC with fertilizer application applied at planting time, and more than three-fourths of them employ organophosphates such as parathion, azodrin or endrin against pests on the maturing rice plants. A majority of the farmers in the area report fish are killed following organophosphate applications. Because of the marked differences in rice cultivation as practiced in these two areas of Thailand, the susceptibility of JEV vectors from Chiangmai Valley and Chachoengsao were compared.

PROGRESS: As in the 1970 tests, adults of C. *fuscocephala* and C. *tritaeniorhynchus* from Saraphi district of Chiangmai were found to be resistant to DDT. The larvae of both species, however, were susceptible to this insecticide (Table 1). Only C. *tritaeniorhynchus* from Chachoengsao were tested during this period. While larvae were susceptible to both DDT and BHC, adults exhibited partial resistance to DDT (Table 2). Further tests of C. *tritaeniorhynchus*, C. *gelidus* and C. *fuscocephala* from Chachoengsao against DDT, BHC and organosphosphate insecticides are planned,

REFERENCES:

1. Annual Report SEATO Medical Research Laboratory, Bangkok Thailand, 1970-71.

Table 1. Toxicity of DDT and Malathion to *Culex fuscocephala* and *C. tritaeniorhynchus* from Saraphi District, Chiangmai Province 1973–74.

Species	Stage	Insecticide	LC_{50}*	LC_{90}*	Interpretation
C. tritaeniorhynchus	Adult	DDT	2.72% at 1 hr	> 4.0% at 1 hr	Resistant
C. tritaeniorhynchus	Larval	DDT	0.0058 ppm at 24 hr	0.012 ppm at 24 hr	Susceptible
C. fuscocephala	Adult	DDT	3.3% at 1 hr	> 4.0% at 1 hr	Resistant
C. fuscocephala	Larval	DDT	0.0039 ppm at 24 hr	0.0075 ppm at 24 hr	Susceptible
C. fuscocephala	Larval	Malathion	0.034 ppm at 24 hr	0.063 ppm at 24 hr	Susceptible

* LC_{50} and LC_{90}: Concentrations of an insecticide required to kill 50% and 90% respectively, of the exposed population in a specified period of time.

Table 2. Toxicity of DDT and BHC to *Culex tritaeniorhynchus* from Bang Nam Prieo District, Chachoengsao Province 1973–74.

Species	Stage	Insecticide	LC_{50}*	LC_{90}*	Interpretation
C. tritaeniorhynchus	Adult	DDT	1.60% at 1 hr	2.22% at 1 hr	Intermediate Resistance
C. tritaeniorhynchus	Larval	DDT	0.0013 ppm at 24 hr	0.0047 ppm at 24 hr	Susceptible
C. tritaeniorhynchus	Larval	BHC	0.0124 ppm at 24 hr	0.0327 ppm at 24 hr	Susceptible

* LC_{50} ond LC_{90}: Concentrations of an insecticide required to kill 50% and 90%, respectively, of the exposed population in a specified period of time.

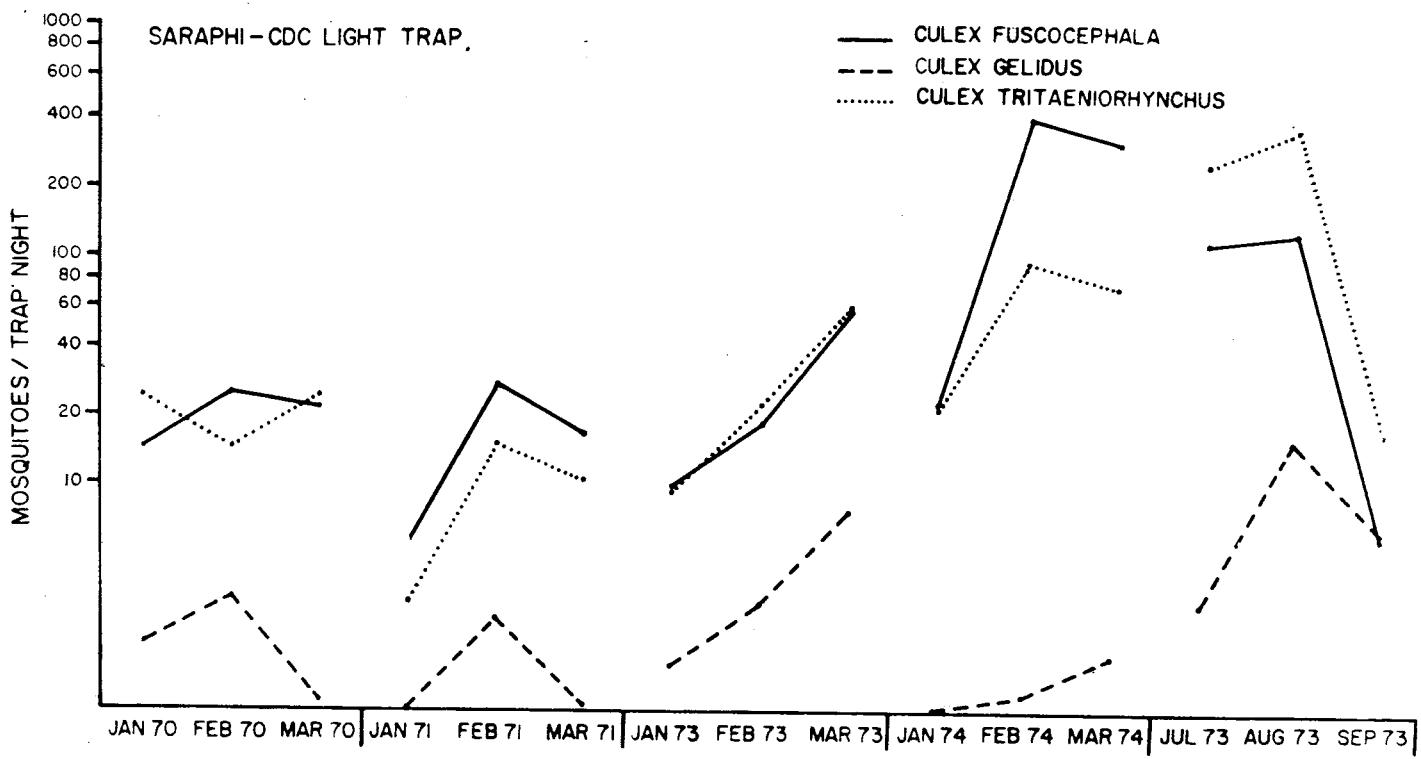

Figure I. Number of Mosquitoes Collected per CDC Trap Night during Dry Seasons of 1970 – 74 and 1973 Rainy Season – Saraphi District, Chiangmai

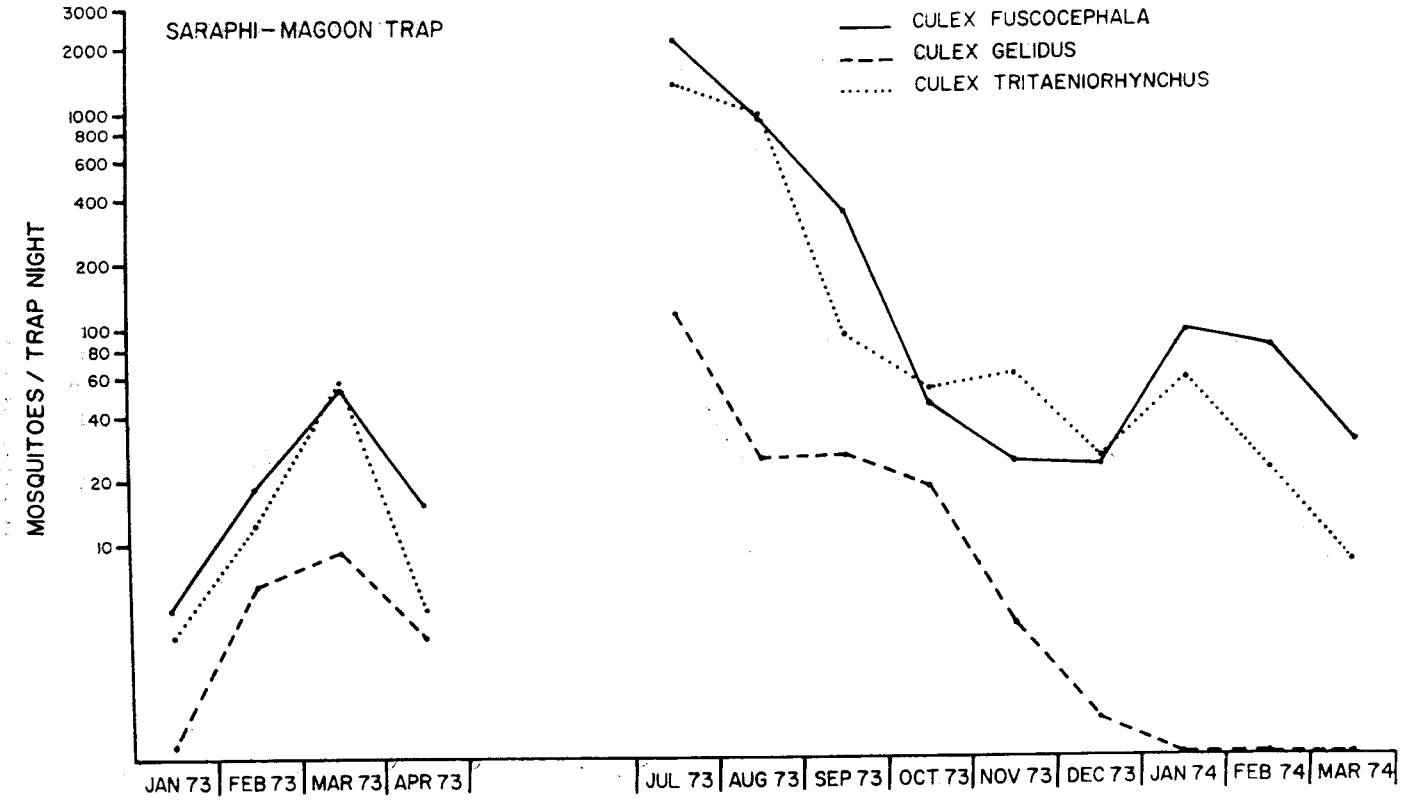

FIGURE 2. NUMBER OF MOSQUITOES COLLECTED PER NIGHT IN MAGOON TRAPS DURING 1973 – 1974 – SARAPHI DISTRICT, CHIANGMAI

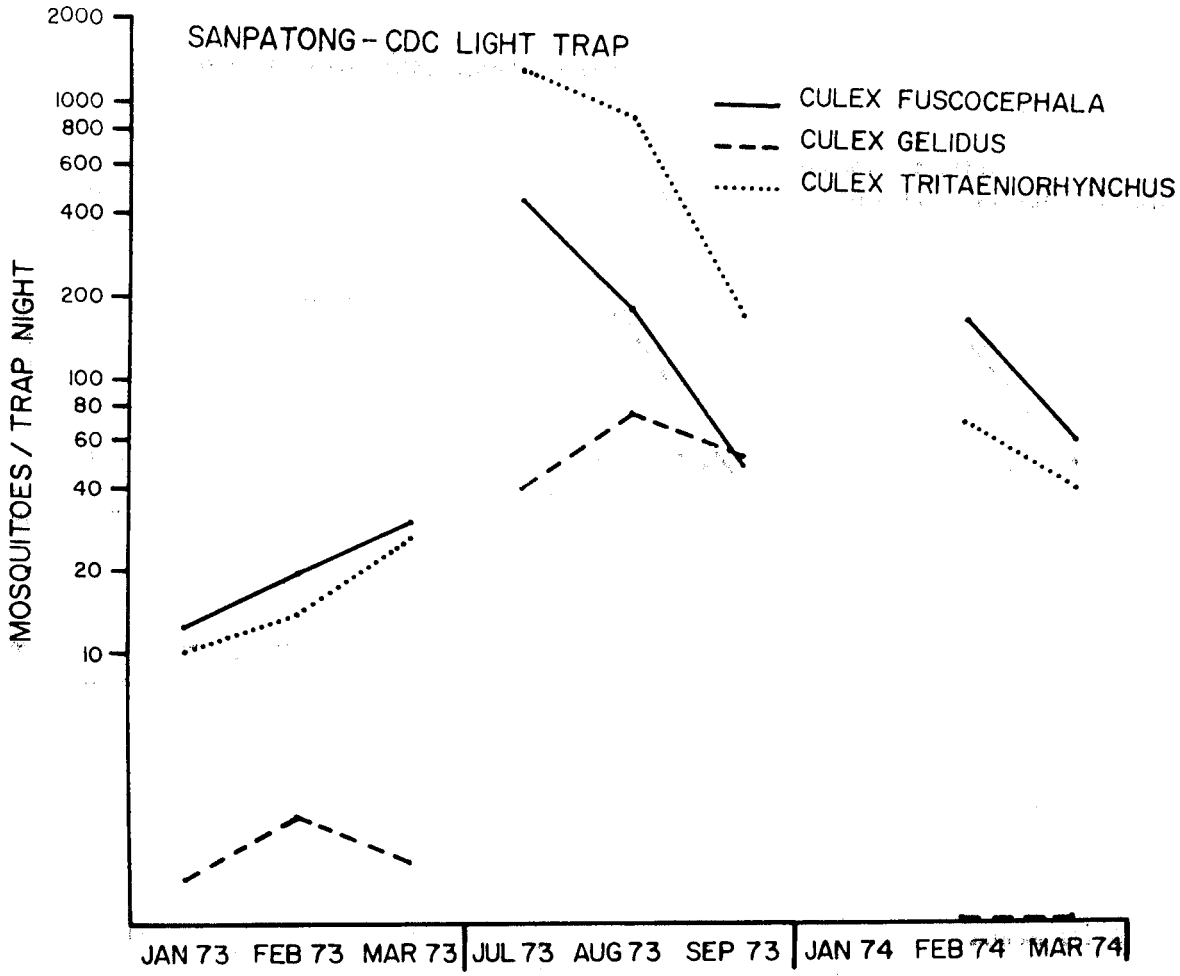

FIGURE 3. NUMBER OF MOSQUITOES COLLECTED PER CDC TRAP NIGHT DURING 1973 AND 1974 – SANPATONG, CHIANGMAI