4. Title: Ecology and Control of dengue vectors

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Introduction The studies described below were part of a collaborative investigation into the epidemiology of dengue hemorrhagic fever in Southeast Asia carried out together with the departments of Virology and Epidemiology. Reccurrence of epidemic dengue fever on the island of Koh Samui in the Gulf of Thailand provided the opportunity to study the ecology of the vector species in a relatively isolated situation. The companion studies on the epidemiologic and virologic aspects of dengue transmission on the island are reported under the SEATO Medical Research Study on Arboviruses.

Description A second epidemic of dengue hemorrhagic fever occurred in 1967 on the island of Ko Samui in the western part of the Gulf of Thailand (Fig. 1). Entomologic studies were initiated in August 1967 which were designed to determine the relative importance of the two vector species, Aedes aegypti and A. albopictus, in dengue transmission on the island. An entomology field station was established in the village of Baw Phut on the northern coast of the island. Weekly surveys of the A. aegypti and A. albopictus populations in the villages of Baw Phut and Mae Nam, on the northern coast, and in Ban Le and Ban Thong Thanot, on the southern coast, were carried out by means of collections of both larval and adult mosquitoes. House infestations were determined on the basis of the "one larva per container" technique in which a single 4th stage larva was collected from every infested water container on the premises of a total of 60 houses selected at random among the four villages. Outdoor breeding was monitored by checking the contents of water filled bamboo cups set out in a grid pattern through Baw Phut and Mae Nam. Collections of adult A. aegypti and A. albopictus were made from human bait between 0700–0900 and 1600 and 1800 hours in Baw Phut and Mae Nam and between 0700 to 1000 hours in Ban Le. Three teams of four men each made simultaneous biting collections at three sites— 1) inside a house, 2) 7–10 meters outside the house and 3) 100 meters from the house. Ovarian dissections were made on adults of both species in an attempt to determine physiologic ages. Weekly records of rainfall, temperature and relative humidity were maintained at the Baw Phut station. The identification of adult and larval Stegomyia mosquitoes collected during faunal surveys made on Koh Samui during 1966 and 1967 were completed during this period.

Results

Ecological observations on Ko Samui.

The surveys made during 1966 and 1967 indicated that both Aedes aegypti and A. albopictus were widely distributed on Ko Samui and on the other islands of the archipelago. In addition to these two species, seven other species belonging in the subgenus Stegomyia were identified in collections from Ko Samui A. albolineatus, A. annandalei, A. desmotes, A. gardnerii imitator, A. scutellaris(?), A. subalbopictus, and A. vittatus. Genitalia from 89 wild–caught A. albopictus males collected on Ko Samui during this period were examined and all were typical of that species. In addition to A. albopictus, and a few specimens, identified as A. subalbopictus, a third species of the scutellaris group, closely resembling A. scutellaris,

was collected in small numbers from Ko Samui and a smaller island in the archipelago. If this latter species proves to be A. scutellaris it increases to three (including A. aegypti and A. albopictus) the number of potential dengue vectors present in Thailand, for A. scutellaris is a proven vector of dengue virus on New Guinea. Aedes albopictus displayed the greatest range in the selection of oviposition sites of all of the Stegomyia species present on Ko Samui, and larvae of this species were collected from the edge of the sea to the summit of the mountains on the island (Table 2). Aedes aegypti breeding was confined largely to household containers, but some breeding occured in natural containers and in bamboo cups set out in Mae Nam and Baw Phut some of which were located more than 125 meters from the nearest dwelling (Figs 2 & 3). Furthermore, A. aegypti was apparently confined to the coastal plains and was not present above 50—100 meters elevation. Adults and larvae of both A. aegypti and A. albopictus were found on fishing, freight and passenger boats which put into Ang Thong, Ban Le, Mae Nam and Baw Phut.

The results of weekly surveys of the A. aegypti and A. albopictus populations made between August 1967 and March 1968 by three methods are summarized in Figures 2—6. Mean temperatures (C°), total rainfall and mean saturation deficit measured at Ban Baw Phut during this period are summarized in Fig. 7. The results of the adult collections in Baw Phut and Mae Nam, summarized in Figs. 4 and 5, suggest that densities of the adult populations of both A. aegypti and A. albopictus were related to rainfall and saturation deficit. During September when the weather was at the driest point (Fig. 7), there was a marked decline in number of adults of both species, but following the outset of the monsoon rains in October there was a sharp rise in the numbers of adults collected. The decline in numbers of A. albopictus adults collected after December was apparently related to the cessation of rains (Fig. 5), while the fall off in A. aegypti adult collections was probably related to the fact that the number of domestic water containers in use on Ko Samui as well as the percentage of containers infested dropped off sharply after December (Fig. 8). During the monsoon season every container available is pressed into use for storage of rain water which is preferred by the islanders to well water for drinking and cooking purposes.

The results of dissections of adult A. aegypti and A. albopictus made on Ko Samui during this period are summarized in Tables 3 and 4. The high proportion of gravid females in these collections indicates that gonotrophic discordance (the need for multiple blood meals during the course of a single gonotrophic cycle) is a phenomenon common to both species. The frequency of such feeding behavior has an obvious bearing on the potential vector efficiency of these two species.

Aedes aegypti control on Koh Samui

A field trial for the control of Aedes aegypti, conducted by personnel of the SEATO Medical Research Laboratory, Walter Reed Army Institute of Research, and U.S. Department of Agriculture, in the village of Baw Phut on Koh Samui was begun on 16 October 1967. Two principal control methods were utilized:

1) The organophosphate, malathion, was dispersed in a fog as a space treatment for the destruction of adult mosquitoes. A hand—carried pulse—jet fogger (Swing Fog) was employed which dispersed 2% malathion diluted in diesel oil at a rate of 5.5 gallons per hour. Fogging was carried out daily between 0700 and 1100 hours for one week and then every other day for an additional period of three weeks. Fogging was accomplished by drifting the fog through the village at 100—200 yard intervals. The area of Baw Phut was estimated to be 20—25 acres. The amount of malathion fuel oil solution used varied from 3—4 gallons for each coverage of the village.

2) The second method of control consisted of the application of the organophosphate, Abate, to household water containers in the village. The applications were made with dilutions of the insecticide concentrate in water delivered by means of hand operated orchid sprayers. Initially, it was decided to treat the water containers with insecticide in amounts giving final concentrations of 0.5 ppm. After water containers in 15 houses had been treated one child exposed to treated water was reported ill. Treatment

was discontinued for several days although no causal relationship between the illness and water treatment was established. The remainder of the containers in the village were treated with a dosage of 0.25 ppm. A total of 725 water containers were treated in the village of which 363 contained mosquito larvae. There were 142 houses in the village with an average of 5 water containers per house.

Weekly surveys of the village for mosquito breeding were made to observe the effects of combined fogging and water treatments. No breeding was observed for a period of 2 weeks in containers treated with 0.25—0.5 ppm of Abate. Two weeks following treatment A. aegypti larvae were found in treated jars. A bioassay of 14 water samples from the village indicate that only 44% of the samples contained sufficient Abate to kill mosquito larvae. As a result, on 7 and 8 November the village water containers were retreated with a dosage of 1.0 ppm. No A. aegypti larvae were found in Baw Phut for 5 weeks following the final treatment. On the sixth week larvae were found in 3 of 119 containers, but during the following two weeks all containers examined were again negative. On the ninth week larvae were found in 2 of 97 containers. On the 11th week the entire village was surveyed and mosquito larvae (predominantly A. aegypti) were found in 56 out of 108 houses checked. Throughout the period of this experiment the A. aegypti house indices remained above 40 percent in the neighboring village of Mae Nam (Fig. 6). Following treatment of the domestic water containers in Baw Phut there was a concurrent cessation of oviposition by A. aegypti in the bamboo cups set out in that village, although the A. albopictus breeding was apparently unaffected (Fig. 2). This observation indicates that oviposition in the bamboo cups was by emigrants from the domestic (household) populations rather than by feral A. aegypti.

Following the initiation of malathion fogging in Baw Phut there was a dramatic reduction in the numbers of adult A. aegypti collected, and for four weeks no adults of that species were collected in the village (Fig. 4). It is difficult to determine what effect the fogging had upon the A. albopictus population in Baw Phut, for adults of that species continued to be present throughout the period of the fogging applications (Fig. 5). It should be noted, however, that the peak in the numbers of A. albopictus adults collected in Mae Nam occurred in November, while the peak for Baw Phut was not reached until December, after the fogging operations had been discontinued.