ANNUAL PROGRESS REPORT

SEATO Medic Study No. 47	Mosquito Fauna of Thailand
Project No. 3A 025601 A 811	Military Medical Research Program S.E. Asia
Task 01:	Military Medical Research Program S.E. Asia
Subtask 01:	Military Medical Research Program SEASIA (Thailand)
Reporting Installation	US Army-SEATO Medical Research Laboratory APO 146, San Francisco, California
	Division of Medical Research Laboratories
	Department of Medical Entomology
Period Covered by Report:	1 April 1963 to 31 March 1964
Principal Investigator:	Major John E. Scanlon, MSC
Assistant Investigators:	Mr. Sahem Esah Mrs. Rampa Rattanarithikul Mr. Manop Rattanarithikul
Reports Control Symbol:	MEDDH-288
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ABSTRACT

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This study is designed to obtain information on the taxonomy and distribution of the mosquitoes of Thailand. Mosquitoes were collected in many parts of Thailand in connection with various disease studies, or specifically for the purposes of this study. Many thousands of specimens were added to the collections during the year, including many associated sets of larval and pupal skins and adults. Additional illustrations were prepared for a projected handbook to the Anopheles of Thailand, and for a larger monographic work on the entire mosquito fauna of the country. Reference specimens were supplied to other cooperating institutions, and arrangements were made to extend the scope of the project

to include a greater part of Southeast Asia. In addition to the taxonomic study, observations were made on the biting habits, breeding habits and other aspects of the biologies of mosquitoes in Thailand, with emphasis on the species found in forested areas.

BODY OF REPORT

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Objective: To identify, catalog and redescribe all of the mosquitoes of Thailand. Most of the specimens studied are collected in connection with disease studies. Information is also assembled on the distribution, breeding habits, feeding habits, and other aspects of the biologies of the various species. The eventual goal of the study is the production of a monograph on the mosquitoes of the area, together with keys, handbooks, and other identification aids for the use of workers in public health and associated fields.

Description: Mosquitoes are collected from many parts of Thailand in connection with various studies on arthropod-borne viruses and malaria.

Additional collections of a specialized nature are made to obtain associated larvae, pupae and adults for illustration and for other detailed studies. All of the material collected is assigned a collection number for use in cards and record books which are kept as permanent records of the distribution and biology of the species concerned. New species are described for inclusion in the final monograph. As specimens of sufficiently good quality are accumulated they are sent to the 406th Medical Laboratory in Japan for illustration by a team of biological illustrators.

Progress: This program was greatly expanded during the year and steps were taken to change the concept of operation somewhat. Collections were obtained from a great many parts of the country, and much greater emphasis was placed on reared series and sibling series than in the previous year. Several additional technicians achieved facility in the identification of some of the complex species groups. The various activities in the study lend themselves better to separate discussion, as outlined below:

General Remarks and Curatorial Report

During the year 4,695 adults were pinned and added to the collection. Slides were prepared from 8,130 larvae and 366 male and female genitalia. The slide preparation particularly was at a much higher level than last year, and many of these were matched series of larval and pupal skins, and the genitalia of the associated adults. Collections of specimens for reference purposes were supplied to the 20th Medical Co. (Prev. Med.) and the 406th Medical Laboratory, Japan. The latter were in addition to those specimens supplied to that organization for illustration. Additional space was added for storage of specimens. The emphasis of the program was somewhat changed during the year, due to the recognition of a large number of species in the Thailand mosquito fauna which had previously been known only from other parts of Asia. These, added to the number already known to have their type localities outside the country, indicated the necessity for expanding the geographical limits of the study to other parts of SE Asia. Preliminary arrangements were made to obtain material from adjacent areas of Asia, with the cooperation of the R & D Command, Office of the Surgeon General. The final form for these arrangements was still under discussion at the time of this report, but some preliminary arrangements were made. These will be discussed below for each country concerned. Dr. John Belkin, University of California visited the laboratory in August and accompanied the principal investigator to Japan, where discussions were held on the form of illustration which should be used in the SE Asia study and Dr. Belkin's similar project on the mosquitoes of middle America. Several preliminary sketches were submitted by the artists, and these are still under study.

Arrangements Outside Thailand

Vietnam: The principal investigator visited Saigon in connection with an investigation of hemorrhagic fever in Vietnam and discussed the mosquito collection program with Capt. V. Loy, Entomologist, 20th Medical Co. (Prev. Med.) and Dr. Do Van Quy, Chief, Department of Entomology and Parasitology, Pasteur Institute. Both subsequently visited this Department and examined the mosquito collection. Arrangements were made to effect a continual exchange of material and both organizations were supplied with a collection of Thai mosquito species.

Malaya: Preliminary arrangements were made with the Director of the United States Army Medical Research Unit, Kuala Lumpur, to have Capt. J. Gentry, Entomologist, assist in the collection of mosquito specimens in Malaysia as part of the routine work of the organization.

India: Type specimens were examined in the collections of the Zoological Survey of India (Indian Museum) Calcutta, and the National Malaria Eradication Project, New Delhi. Notes on all of the type specimens still extant in these collections were made for inclusion in discussions of the status of the various species in the final monograph. Several types were found to be missing, presumably having been lost in the partition of India and Pakistan.

Japan: Various stages of forty one species of Anopheles were sent to Japan for illustration during the year, and a number of plates were completed, examined and returned to the artists. Preliminary drawings were made of Aedes and Culex species as a basis for discussion of the final form of the proposed monograph.

Taxonomic Progress

Many species were added to the Thailand collection in the Department during the year. Many of these are new records for Thailand, and many require confirmation by examination of type material.

Toxorhynchites: These very large and striking mosquitoes are not important as disease vectors, since the adults do not take blood. However, they have been used in Hawaii and elsewhere as mosquito control agents, since the large larvae are predators and cannibals. In 1959, Dr. E. B. Thurman described three new species of Toxorhynchites from a limited area near Chiengmai, each based on a single male specimen. Our collections in the same area have produced the same species, along with the appropriate females. However, at least eight additional species are present, as well as five forms of the common "species" Toxorhynchites splendens.

Some of the complex relationships revealed can probably only be solved by sibling rearing, which is extremely difficult with this group. The first eggs from a female of this genus were obtained late in the report period, after two years of effort.

Anopheles: A key to the Anopheles adults and larvae was constructed by Dr. Do Van Quy during his stay in the Department. All of the species of Anopheles thought to be present in Thailand are included. The key is being tested by Department personnel at present, and after modification copies of it will be available on request by interested workers. As noted above, progress was made in illustrating the adults, larvae and pupae of Thai Anopheles during the year, several data led studies were also made. Sibling rearings and examination of a large number of specimens indicated that the several morphological forms of Anopheles subpictus in Thailand probably do not deserve taxonomic recognition. Using two alternate forms of four selected taxonomic characters, one may construct eight hypothetical 'varieties' of Anopheles subpictus. All eight of these forms (six of which had received names in various parts of Asia) were found in limited area of Thailand, and most of them have now appeared in progeny from sibling rearings which are still in progress. The completed study will be reported in detail at a later date. Sibling rearings of Anopheles barbirostris and its dark-winged form Anopheles campestris also lead to the conclusion that these forms may not be taxonomically distinct at the special level. Several forms of Anopheles jamesi were also found in the malaria study area in Cholburi. The most extreme of these, with an extra dark band on the palp, might be considered a separate species, if the complete series of specimens had not been examined. The same was found to be true of the "pseudowillmori" form of A. maculatus. A list of the species of Anopheles reported to occur in Thailand is presented in table 1. As will be noted, some of these records are quite doubtful. After the list was prepared an additional species of Anopheles, hitherto known only from the Madras, India was found in Khao Yai National Park. This species is still under investigation; as is another, apparently new and related species from South Thailand. Both of these are tree-hole breeding species.

Biological and Distribution Studies

In coordination with the various taxonomic and disease studies, data on the behavior and biology of the various mosquito species are assembled for future use. Some separate biological investigations are also conducted. Two of these are summarized below from material being prepared for publication.

Table 1. A working checklist of the Anopheles of Thailand[1].

Subgenus (Anopheles)

aitkenii aitkenii James, 1903
aitkenii bengalensis Puri, 1930
albotaeniatus (Theobald, 1903)
annandalei interruptus Puri, 1929
argyropus (Swellengrebel, 1914)
baezai Gater, 1933
barbirostris Van der Wulp, 1884
barbumbrosus Strickland & Choudhurry, 1927
brevipalpis Roper, 1924
bulkleyi Causey, 1937
campestris Reid, 1962
crawfordi Reid, 1953
gigas formosus Ludlow 1909[1].
gigas sumatrana Swellengrebel and Rodenwaldt, 1932 1.
hodgkini, Reid, 1952
indiensis Theobald, 1901
insulaeflorum (Swellengrebel & Swellengregel, 1919)
lesteri paraliae Sandosham, 1959
letifer Sandosham, 1944
montanus Stanton and Hacker, 1917
nigerrimus Giles, 1900
palmatus (Rodenwaldt, 1926)
peditaeniatus (Leicester, 1908)
pursati Laveran, 1902
separatus (Leicester, 1908)
sinensis Wiedemann, 1828
umbrosus (Theobald, 1903)

Subgenus (Cellia)

aconitus Dönitz, 1902
annularis Van der Wulp, 1884
balabacensis balabacensis Baisas, 1936
balabacensis introlatus Colless, 1957
culifacies Giles 1901
filipinae Manalang, 1930
fluviatilis James, 1902
jamesii Theobald, 1901
jeyporiensis jeyporiensis James 1902*
jeyporiensis candidiensis Koidzumi, 1924
karwari (James, 1903)
kochi Dönitz, 1901
ludlowae (Theobald, 1903)*
maculatus maculatus (Theobald, 1901)
maculatus willmori (James, 1903)*
majidi Young and Majid, 1928
minimus Theobald, 1901
pallidus Theobald, 1901
pampanai Büttiker and Beales, 1959
philippinensis Ludlow, 1902
ramsayi Covell, 1927
riparis macarthuri Colless, 1956
splendidus Koizumi, 1920
stephensi Liston, 1901
subpictus subpictus Grassi, 1897**
subpictus indefinitus (Ludlow, 1904)
subpictus malayensis Hacker, 1921
sundaicus (Rodenwaldt, 1925)
tessellatus Theobald, 1901
vagus Dönitz, 1902
varuna Iyengar, 1924

1. Based on published records, the files of the National Malaria Eradication Project, Thailand, and collections of the SEATO Medical Research Laboratory.

2. Doubtful record, additional collecting necessary

Man-biting Mosquitoes on Doi Pui, Chiengmai

During a two year period many human biting collections were made on Doi Pui a 6,000 foot peak just west of Chiengmai. A lower peak on the mountain, Doi Sutep (4,000 feet) is the site of a famous monastary. Doi Sutep is the type locality for a large number of zoological species, largely because of its ease of access from the city. A road has extended to Doi Sutep for a number of years, and this was recently extended to the summit of Doi Pui. The mountain is also interesting because of the range of vegetation which can be seen on its slopes. These are presented in diagrammatic form in figure 1. The valley floor at Chiengmai lies at an latitude of 1,000 feet above sea level. The area was originally covered with deciduous forests, including teak (Tectona grandis), but almost all of the valley floor has now been cleared for agriculture. On the lower slopes of the mountain there are remnants of Dipterocarp savannah forest, but the soils are so poor that growth is generally poor. Pentacme siamensis and Shorea obtusa are the predominant trees. On the lower slopes of the mountain proper, broad-leaved decidupus trees predominate, and there is a decided leaf fall in the dry months of February to May. At that time fires burn almost continuously on the mountain. From around the 2,500 feet level tall trees, largely dipterocarps and large oaks being to predominate, especially in the shaded steep-sided valleys which cut the slopes. In these patches of tall trees, the canopy is almost complete, and while the ground dries somewhat in the dry season, it does not reach the sere condition of the lower slopes. In many pockets on the slopes from 2,500 to 4,000 feet there are large stands of very large, tall trees (Quercus, Castanopsis and Dipterocarpus), which form a completely closed canopy through which very little light penetrates to the forest floor. The upper levels of the mountain consist largely of open forest, including a number of small oaks, with a few pines on the upper slopes.

Human biting collections were made in the evening at the edge of the city of Chiengmai, and in day and evening hours in the forest at various elevations. All of the catches consisted of bare-leg collections, with the collectors taking the females which came to bite them in chloroform tubes. A few collections were made in plain glass tubes to obtain females for egg laying. Collectors worked for on-half hour, giving all of the females collected one lot number. The quantitative data from these collections are being tabulated for publication, but a qualitative analysis of the collection data is presented in table 2. The town collections were made in the compound of the SEATO Medical Research Laboratory approximately one kilometer from the base of the mountain. Cow biting collections were made at the same site, and light trap collections are also available for later analysis.

FIGURE . A SCHEMATIC DIAGRAM OF VEGETATION ON DOI SUTHEP MOUNTAIN, CHIENGMAI.

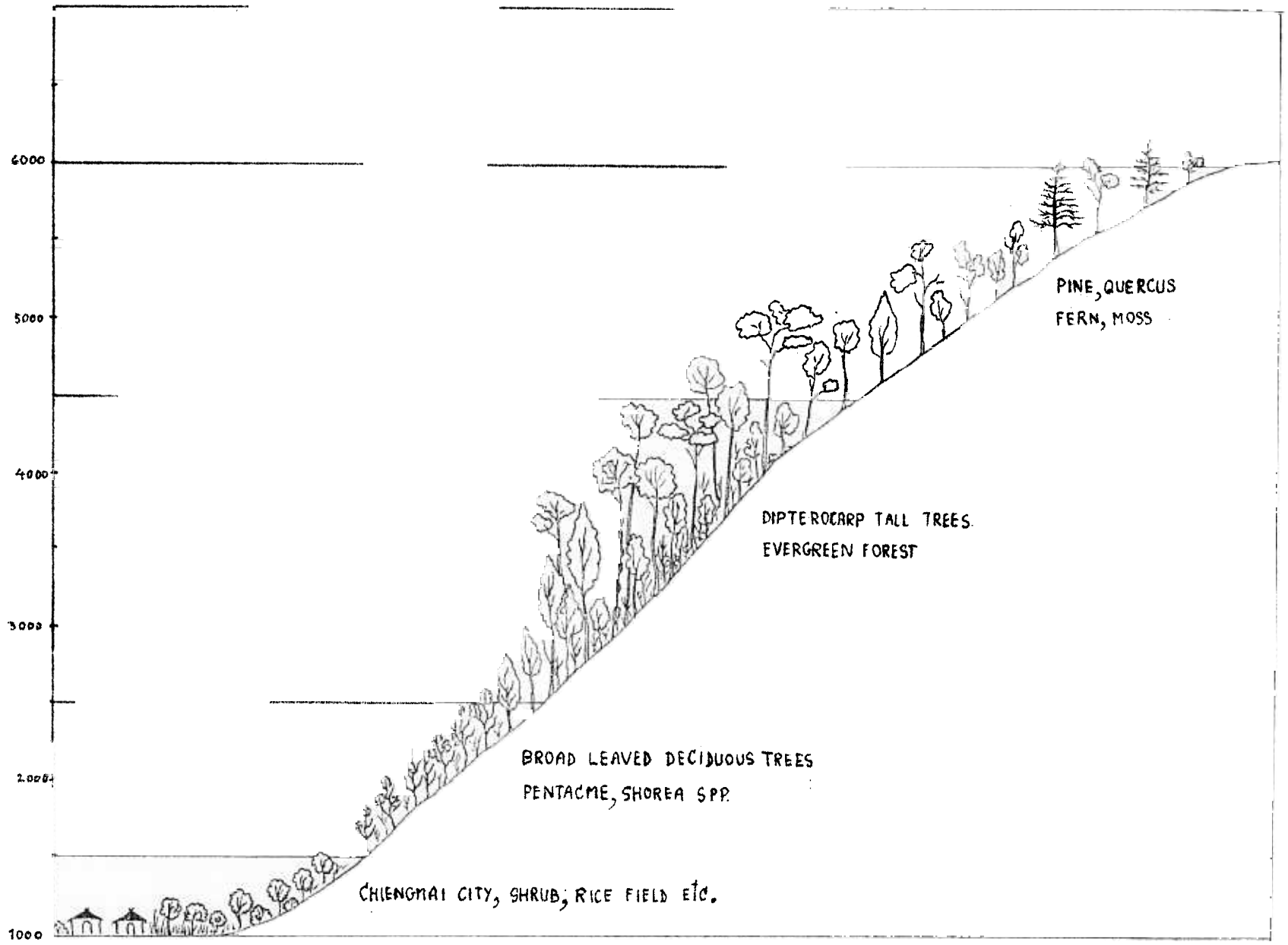

Table 2. Man-biting mosquitoes, Doi Pui, Chiengmai.

SPECIES	Number of collections	Town 1000 feet: 80	1500-2500 feet: 57	2500-4500 feet: 141	4500 feet to summit: 37
Anopheles (anopheles)	aitkeni	0	0	+	0
	annandalei	0	0	0	+
	argyropus	+	0	0	0
	barbirostris	0	+	+	0
	barbumbrosus	0	0	*	0
	nigerrimus	+	0	0	0
	peditaeniatus	+	0	0	0
	sinensis	+	0	0	0
Anopheles (cellia)	aconitus	+	0	0	0
	balabacensis	0	+	+	0
	jeyporiensis can.	+	0	0	0
	karwari	0	0	+	0
	kochi	+	+	0	0
	maculatus	+	+	+	+
	philippinensis	+	0	0	0
	splendidus	+	0	0	0
	subpictus	+	0	0	0
	tessellatus	+	0	0	0
	vagus	+	+	+	0
Mansonia (Coguilletidia)	crassipes	+	0	+	0
Mansonia (Mansonioides)	annulifera	+	0	0	0
	dives	+	0	0	0
	indiana	+	0	0	0
	uniformis	+	0	0	0
Heizmannia	aureochaeta	0	+	+	0
	covelli	+	+	0	0
	communis (of.)	0	+	0	0
	mattinglyi	0	+	+	+
	metallica	0	+	0	0
	reidi	0	0	+	+
	sp.	0	+	0	0
Aedes (Mucidus)	ferinus	+	0	0	0
Aedes (Finlaya)	alboniveus	0	+	0	0
	albolateralis	+	+	+	+
	assamensis	0	+	0	0
	aureostraitus	0	+	+	0
	chrysolineatus	0	0	+	+

Table 2 (Continuation)

SPECIES	Number of collections	Town 1000 feet: 80	1500-2500 feet: 57	2500-4500 feet: 141	4500 feet to summit: 37
	elsiae	0	+	0	+
	feegradei	0	+	0	0
	formosensis	0	+	+	+
	harveyi	0	+	+	+
	khazani	0	0	0	+
	macfarlanei	0	+	+	0
	niveus (s.l.)	+	+	+	+
	pallirostris	0	0	+	0
	pseudotaeniatus	0	0	+	0
	saxicola	0	0	+	+
	shortii	0	0	0	+
Aedes (Stegomyia)	aegypti	+	0	0	0
	albopictus	+	+	+	+
	annandalei	0	+	0	0
	mediopunctatus	0	+	0	0
	subalbopictus	+	+	0	0
	vittatus	+	+	0	0
	w. albus	+	+	+	+
Aedes (Aedimorphus)	mediolineatus	+	0	0	0
	taeniorhynchoides	+	0	+	0
	vexans	+	+	+	0
Aedes (Neomelaniconion)	lineatopennis	+	0	+	0
Aedes (Diceramyia)	iyengari	+	0	0	0
Aedes (Aedes)	andamensis	+	0	0	0
Armigeres (Armigeres)	aureolineatus	0	+	0	0
	durhami	0	0	+	0
	malayi	0	+	0	0
	subalbatus	+	+	+	+
	theobaldi	+	+	+	0
Armigeres (Leicesteria)	annulitaris	0	+	+	0
	dentatus	0	+	0	0
	dolichocephalus	0	+	0	0
	longipalpis	0	0	+	0
	magnus	0	+	0	0
	omissus	+	+	+	+
Armigeres(Leicesteriomyia)	flavus	0	+	+	+
Culex (Culiciomyia)	pallidothorax	0	0	+	0

Table 2 (Continuation)

SPECIES	Number of collections	Town 1000 feet 80	1500-2500 feet 57	2500-4500 feet 141	4500 feet to summit 37
Culex (Culex)	annulus	+	+	+	0
	barraudi	0	0	+	0
	fuscocephalus	+	+	+	0
	gelidus	+	0	+	0
	pseudovishnui	+	+	+	+
	quinquefasciatus	+	+	+	0
	sinensis	+	+	+	0
	tritaeniorhychus	+	0	+	0
	whitmorei	+	0	+	0
Udaya	argyrurus	0	0	+	0
SPECIES TOTAL		44	43	44	19

The total number of species for the first three levels (Table 2) was almost the same, while the number dropped of sharply for the upper levels of the mountain. The number of collections at each level was not equal, since collectors were engaged in other studies which brought them to certain sites more frequently than others. However, the man hours at each level was sufficient to sample the population.

Relatively few species were found at all levels. These included: Anopheles maculatus, Aedes albolateralis, Ae. albopictus, Ae. w-albus, Armigeres subalbatus, Ar. omissus and Culex pseudovishnui. Of these, Ae. albopictus is almost certainly a vector of dengue virus and Anopheles maculatus is know to transmit malaria in parts of SE Asia, although not widely in Thailand.

It should also be noted that the species and genera represented in this human biting collections are a relatively small portion of the total mosquito fauna of the area. The biting habits of many of the forest species remains unknown.

Anopheles: Most of the Anopheles species were taken on the lower slope and town area. These are predominantly surface water or rice field breeders (A. argyropus, nigerrimus, peditaeniatus, sinensis, aconitus, jeyporiensis candidiensis, kochi, philippinensis, subpictus and tessellatus) Anopheles vagus penetrated much further into the forest then had been expected, but it is a common species and capable of breeding in a variety of places. Anopheles annandalei is a tree-hole breeding species, generally found only in heavy forest. Anopheles barbirostris, aitkeni and barbumbros breed generally in pools and seepages along streams in the forest. Barbirostris is also found in open areas, and it was somewhat surprising to find it missing from the town collections. A. balabacensis is a potent malaria vector in some parts of Thailand. It is generally found under forest cover in the foothills, breeding in small pools along streams and in seepages,

Mansonia: The finding of M. crassipes at the 2,500-4,500 foot level in heavy forest was somewhat surprising, since this species, along with the other Mansonis species listed, breeds in ground pools covered with floating vegetation. These species are important pests, and transmit filariae in lowland areas, but they generally do not enter hill forest.

Heizmannia: The members of this genus are almost entirely restricted to the forest environment. They breed in tree holes and bamboo stumps, but the breeding places of many of the species remains unknown. Since they feed readily in the canopy it is possible that breeding occurs mostly in tree holes high in the forest. In many ways these species resemble the Neotropical Sabethini, both in morphology an biology. Their role in disease transmission is unknown, but their habits would additional attention.

Aedes: The single Mucidus species feeds chiefly on domestic mammals, but sometimes feeds on man. It is not a forest species. The Finlaya species, however, are chiefly forest inhabiting, as can be seen in the table. The occurrance of niveus and albolateralis, closely related species, in the town area is interesting. It is probable that a number of species are covered by these two names, as the taxonomy of the group is difficult and incomplete, and the females are especially difficult to determine. All of the other species were taken in the forest. Considerable information has been accumulated on the habits of these very common forest mosquitoes, and this will be published in detail. Some members of the genus are very important human biters in the jungle, and they deserve considerable attention as potential virus vectors. The Stegomyia species, on the other hand, include the known vectors of dengue virus, aegypti and albopictus. The distribution of these species has been discussed in the report of Study No.42. All of the species reported from the forest are tree-hole, rock pool and bamboo breeders. They were occasionally taken in large numbers and may be important virus vectors within the forest. They were more restricted to the middle slopes than the Finalya species. Aedes vexans is a common forest species over much of the world, although it is also found in rather open areas. The other two Aedimorphus species are more typical of the open or scrub type of terrain than the forest. The same is true of Ae. lineatopennis and the finding of this species at 2,500-4,500 feet was surprising. Ae. iyengeri is a forest fringe species, but its habits are quite poorly known.

Armigeres: In the subgenus Armigeres, one species, subalbatus, has an extremely wide distribution. It breeds in artificial containers, tree holes and bamboo sections, and is a persistant biter of man wherever encountered. There is a possibility that several species are still masquerading under this name, despite recent intensive work on the group. The other members of the subgenus are primarily forest dwellers. Members of the other two subgenera are bamboo breeders, and all of them will attack man in some numbers during the day in the forest shade. Armigeres flavus may be particularly abundant in forest areas in or near bamboo thickets.

Culex: Almost all of the Culex (Culex) species are abundant to extremely abundant in urban areas, barraudi being the only exception among the species included in table 2. The considerable concentration of Culex species at the 2500-4500 foot level in the forest, however, is unexpected. C. annulus and pseudovishnui were particularly abundant in the deep forest, often the most abundant night biting species. Several of these species are proven or suspected vectors of Japanese encephailitis virus and other viral agents. The distribution of these viruses in the forest environment is unknown, but birds are believed to be involved in their dissemination, and it is interesting to note that annulus and pseudovishnui were captured feeding in the forest canopy.

Udaya: The species captured is tentatively identified as argyrurus, appears to differ slightly from that species. Members of the genus appear to be restricted to forest environments, where they are occasionally feed on man.

As noted above, the quantitative aspects of these collections, identification of some of the species are still in preparation for publication.

The use of artificial containers in mosquito surveys in monsoon and evergreen forest.

A number of workers have reported using bamboo sections, rubber tapping cups and other devices in surveys for mosquitoes in tropical areas of Asia and Africa. However, most of these reports have been from areas where mosquito breeding was continuous through the year. On Doi Pui, described in the previous section, the forests, even where listed as evergreen, dry out to a considerable extent during the year. So much so, that larvae of treehole breeding species become very difficult to find from roughly December to June. During that period most treeholes and bamboo sections become extremely dry and many of the open slopes of the mountain are burned over by brush fires. A number of bamboo sections and clay bowls were set out at various levels on the mountain, filled with stream water and examined weekly to determine which species of mosquitoes might breed in them when breeding in nature was at its lowest point. Bamboo sections were approximately 2" by 9", cut from Thrysostachys siamensis, and they were placed on the ground at the foot of trees, or approximately five feet above ground level. The clay bowls were of local manufacture, fired, and about 6" in diameter. A few bamboo sections were suspended from 20-85 feet in the canopy. There was little bamboo growing in any of the areas surveyed, and all of them were areas of rather dense tree growth. Three of the four areas surveyed were in the deciduous tree range at 2500, 3000 and 3,500 feet altude. The latter was in a deep ravine with sheltered bottom. The fourth site was in a cirque, enclosed by granite walls and rather well watered, even in the hot dry season. The ground was swampy and a small amount of surface water remained through the year. Elephants had made a number of footprints in the area, providing additional larval sites.

The collection records have been tabulated separately for these two different sorts of area- the very dry and the fairly moist. Twenty species were found in the bamboo pots in the dry area (table 3), while only six species were found in rock pools and a stream bed nearby. In this dry situation the bamboo pots seemed to offer to promise as a survey tool in determining the breeding potential of Aedes albopictus, the Armigeres species, and the various Tripteroides species. The latter genus, however is unimportant, for/can be seen in the proceding study that no Tripteroides fed on man during several hundred man-hours of biting

Table 3. Mosquito larvae in artificial and natural breeding sites, Doi Pui, Chiengmai, March - June 1963. (Deciducus forest at 2500, 3000 and 3500 foot levels)

Species	Artificial		Natural	
	Larvae Bamboo-Ground	Larvae Bamboo-5 [1]	Larvae	Habitat
Aedes albopictus	89	89	-	-
Aedes elsiae	-	-	3	Rock pool
Aedes niveus		1	-	-
Aedes saxicola	-	-	3	Rock pool
Aedes subalbopictus	2	-	-	-
Aedes w-albus	9	5	-	-
Anopheles barbumbrosus	-	-	4	Rock pool
Anopheles maculatus	-	-	1	Rock pool
Armigeres annulitarsis	-	2	-	-
Armigeres durhami	19	4	-	
Armigeres flavus	-	2	-	
Armigeres magnus	15	3	-	
Armigeres subalbatus	47	31		
Armigeres sp.	1	-	-	-
Culex brevipalpis	14	3	-	-
Culex castrensis	-	2	-	-
Culex (Lophoceraomyia) sp.	-	1	6	Stream bed
Culex pallidothorax	-	-	1	Rock pool
Culex sp.	4	2	-	-
Topomyia sp.	3	-	-	-
Tripteroides aranoides	122	136	-	-
Tripteroides hybridus	7	12	-	-
Tripteroides powelli	72	40	-	-
Tripteroides serratus	-	1	-	-
Tripteroides sp.	176	277	1	Rock pool
Total Larvae			18	

collections on Doi Suthep. No Anopheles were taken in the bamboo pots, nor were any of the important Culex species which attack man. Neither of these groups was expected to occur, since their breeding patterns do not generally allow such behavior. Somewhat surprising was the fact that only one of the important Finlaya species was taken in the bamboo pots. Little difference was seen between the bamboo pots on the ground and those at the 5 foot level in trees. Tripteroides species were generally a little more abundant at the higher level, but the numbers of most of the larvae are too small to permit generalization.

At the higher altitude (table 4) the effect of drying was much less evident and 19 species appeared in natural habitats, as opposed to 20 in the artificial containers. The elephant footprints in particular produced large numbers of larvae. These were chiefly Culiciomyia species. This same association of this subgenus with elephant trucks has been noted many times in our collections. Clay pots were also used at this altitude, and the larvae of several of the Finlaya species were found in these, whereas they were not (as noted at the lower elevations) attracted to the bamboo sections. Aedes albopictus and Armigeres subalbatus again predominated among the man biting species, and the use of the artificial containers seemed to offer the most promise in searching for these species. Both of these species, together with the ubiquitous Tripteroides species, were found in bamboo pots from ground level to 85 feet from the ground. It is probable that much of the breeding of these species takes place at higher levels in the forest than can readily be surveyed.

The artificial containers seemed to offer some advantage in surveying for certain man biting mosquito species during the dry season when the adults are not prevalent, and when natural breeding is lacking or minimal. Some of the more important species bred from ground level to at least 85 feet, which is in the canopy.

Summary: A large number of specimens were added to the collection during the year including a number of new species, or species not previously known from Thailand. A large amount of information on biting habits, breeding places and distribution was also accumulated. Preliminary arrangements were made to extend the scope of the mosquito taxonomy and biology project beyond Thailand, and eventually to all of SE Asia. Detailed studies were made in species groups in Anopheles, Toxorhynchites and Culex. Preliminary results are presented on studies of mosquito biting and breeding habits in the Chiengmai area. Illustrations were prepared for a number of the Anopheles species of Thailand for inclusion in a planned handbook to the genus.

Table 4. Larvae in natural and artificial habitats, Doi Pui, 4,000 foot level. April - June 1963. (Evergreen forest in depression)

Species	Artificial				Larvae	Natural Habitat
	Bamboo ground	Bamboo 5 ft.	Bamboo 20-85 ft.	Clay bowl		
Aedes albopictus	139	18	7	64	3	Tree hole
Aedes aureostriatus	-	-	-	6	5	Tree hole
Aedes chrysolineatus	-	-	-	5	1	Fallen leaf
Aedes saxicola	-	-	-	8	-	-
Aedes (Finlaya) sp.	-	-	2	1	-	-
Aedes niveus	-	2	-	-	-	-
Armigeres durhami	5	2	-	-	--	-
Armigeres flavus	-	-	-	8		
Armigeres subalbatus	240	3	55	79		
Culex brevipalpis	-	-	-	8	-	-
Culex flavicornis	-	-	-	6	-	-
Culex nigropunctatus	-	-	-	-	8	Puddle, elephan track
Culex pallidothorax	-	-	-	-	71	" " "
Culex spathifurca	-	-	-	-	1	Elephant track
Culex (Culiciomyia)sp.	-	-	--	-	14	Puddle,elephant track
Culex (Lophoceraomyia) sp.	3	-	-	26	9	Elephant track, fallen leaf.
Culex (Lutzia) sp.	-	-	-	-	2	Puddle
Culex sp.(immature)	-	-	-	6		
Ficalbia fusca	-	-	-	-	1	Tree hole
Orthopodomyia andamensis	-	-	-	-	5	Tree hole
Orthopodomyia anopheloides	-	-	-	-	4	Tree hole
Topomyia cristata	-	-	-	-	2	Leaf axil
Topomyia inclinata	-	-	-	-	1	Leaf axil
Topomyia sp.	-	-	-	-	6	Leaf axil
Tripteroides aranoides	336	182	155	79	-	-
Tripteroides hybridus	2	3	4	-	-	-
Tripteroides indicus	-	2	-	-	-	-
Tripteroides powelli	47	9	3	1	1	Tree hole
Tripteroides serratus	2	-	-	-	-	-
Tripteroides sp.(several)	81	96	51	44	6	Tree hole, bana leaf axil
Toxorhynchites gravelyi	1	2	--	-	-	-
Uranotaenia recondita	-	-	-	-	1	Elephant track
Uranotaenia sp.	-	-	-	-	1	Elephant track
Total	856	317	277	341	140	

Conclusions: The mosquito fauna of Thailand is extremely complex, and a full understanding of it will require much additional collecting. Since many of the type localities for Thailand mosquitoes are located elsewhere in SE Asia, plans were made to extend the geographical scope of the project. There are a large number of species in forested areas which attack man, and which may be involved in the transmission of a number of disease agents. The potential mosquito vectors include species in the subgenera Stegomyia and Finlaya of the genus Aedes, and in the genera Armigeres and Heizmannia.