

SEATO MEDICAL RESEARCH STUDY ON MOSQUITOES

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STUDY REPORTS

1. Title : Mosquito Fauna of Thailand

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Objective : To collect, identify, catalog and redescribe all of the mosquito species of Thailand. Information is also assembled on the distribution, larval habitats, and other aspects of the bionomics of the various species. The eventual goal is the production of a monograph on the mosquitoes of the area, together with keys, handbooks and other identification aids for use of workers in public health and associated fields and the later inclusion of this material into a larger monographic work on the mosquitoes of Southeast Asia. Since the final monographs will not be completed for several years, periodic papers with keys, descriptions and distribution of important groups will be made available as soon as practical. The immediate objective is to make available as much information as possible on the Anopheles of Thailand. The training of competent Thai personnel in the identification and bionomics of the mosquito fauna of Thailand is also a major concern.

Description : Mosquitoes are collected from many areas of Thailand in connection with various studies on arthropod-borne viruses and malaria. Additional collections of a specialized nature are made to obtain correlated series of larvae, pupae and adults for illustration and for other detailed studies. New species and other material of significant interest and good condition are identified and cataloged at the SEATO Medical Research Laboratory in Bangkok. The majority of these specimens are then transferred to the U.S. Army Mosquito Project headquarters at the U.S. National Museum for confirmation. Some of the specimens are returned to SMRL for the permanent reference collection, while others are retained at project headquarters for description and eventual inclusion in the final monograph. The program was continued in the same pattern established in the previous years, although collecting activities were more closely coordinated with specific disease studies conducted by the department. The taxonomic field team has preceded or accompanied the malaria field teams in almost all areas selected for malaria studies. The collection of immatures and reared series was nearly double the previous years volume. Trap collections were used almost exclusively for gathering distribution data and in support of the various disease studies. A very small number of specimens from trap collections were retained for taxonomic studies. With few exceptions, the material used in the taxonomic studies was from reared series. Continued modification

and improvement in field collecting techniques has increased the quality and quantity of material collected. Emphasis placed on the training of field technicians in laboratory techniques has considerably enhanced the processing of material upon return from the field and has also produced a more qualified and effective field team. The associate investigator spent six months at the U.S. National Museum working with material from Thailand and examining type material from neighboring countries. Since very little literature on the mosquitoes of Thailand is available, the study of material at the U.S. National Museum has provided the department with much needed information on the mosquito fauna of Thailand.

Progress - During the year 976 larval collections from 11 different provinces of Thailand were made. From these collections 6,697 adults were pinned and added to the collection. Each of these were reared individually and are represented by matched larval and pupal skins. Slide mounts were prepared from 10,375 larvae and larval skins and 45 male genitalia. Slides of male genitalia were made only in the case of unknown specimens this year. The transfer of material to the U.S. National Museum during the year included 107 Schmidt boxes of pinned adults and 119 slide boxes of immature stages and adult genitalia, representing several hundred species and several thousand specimens.

Many Thai species not previously represented were added to the department collection during the year. Many of these are new records for Thailand, while several others require confirmation by examination of type material at the U.S. National Museum before a specific determination can be made. A list of species not included in previous reports for this study is presented in Table I. All of the species listed were collected as immatures and are represented by adults with matched larval and pupal skins. A few of these were collected in previous years, but a specific determination was not possible until this report period. It is also probable that as other groups are examined more closely, additional previously undetected species will be discovered in the collection.

An illustrated key to the Anopheles of Thailand has been completed and as soon as the arrangement of illustrations on the final plates is complete, the key will be submitted for publication. The completion of this key to the Anopheles of Thailand is a significant contribution since it is the first complete and up to date key available for this part of Southeast Asia. A manuscript with a revised list of the Anopheles of Thailand with known distribution and bionomics has also been completed and will be published soon. The key together with this list of Anopheles should be of great assistance to the increased numbers of workers in malaria studies in this region and is expected to eliminate much of the confusion and misunderstanding associated with Anopheles studies in the past.

Detailed studies during this period were continued on species belonging to Anopheles, Culex (Culiciomyia), Culex (Lophoceraomyia), Toxorhynchites and Uranotaenia by various workers at SMRL and at the U.S. National Museum. Material discussed in detail in this report was retained specifically for taxonomic purposes and does not represent all of the material collected by the department during the year. The majority of specimens collected through the use of light trap, animal trap, biting and resting collections were sacrificed through animal inoculations or dissections for recovery of disease organisms and are reported under separate sections of this report.

Most of the collecting efforts during this report period were concentrated in the southern peninsula of Thailand where very few collections have been made by the department. A comparison of areas where the greatest number of collections have been made can be seen in Figure 1. Approximately 90% of the 976 larval collections made during this period were made in forested areas ranging from 25 to 5,400 ft in elevation. It can be noted from Figure 1 that collections have not been made from most of the central portion of Thailand as yet. A few of the more significant groups of mosquitoes collected during the year are discussed separately below.

Anopheles: As noted earlier in this report much attention has been given to the Anopheles during the year. Because of apparent errors in previous reports from several different sources, the identification of Anopheles of Thailand has been extremely difficult and confusing. Through the efforts of SMRL and U.S. Army Mosquito Project Headquarters an effort has been made to clarify the status of Anopheles in Thailand. A working check list of the Anopheles of Thailand is presented in Table. 2. The list in Table 2 reflects the latest consensus on the species of Anopheles present in Thailand. There are 59 species listed, 55 of which have been collected and examined by SMRL and confirmed at the U.S. National Museum. Anopheles bulkleyi is known from Thailand but only from the original description. Anopheles (Anopheles) albotaeniatus, An. (Cellia) fluviatilis and An. (C.) majidi are doubtful records but are left on the list for the time being pending further investigations. Of the 55 species collected by SMRL, there are three which are clearly identifiable as Anopheles (Cellia) filipinae, varuna and maculatus willmori; however as additional specimens are collected a closer study of these three species is planned. One additional species listed as a new species was collected by SMRL in Prachinburi province during January 1966 and the identification has been verified at the U.S. National Museum. This species which belong to the Anopheles (Anopheles) aitkenii group will be described during the next report period. Specimens of this species were collected from several holes of small land crabs along the margin of a hill stream at an elevation of about 200 feet. Other species which were collected by SMRL during the year and constitute new records for Thailand are Anopheles (Anopheles) asiaticus, donaldi, and fragilis. Several collections of asiaticus were made in Tak province from split bambao at elevations between 1500 and 2100 feet. The species is reported to occur in Malaya under similar conditions. The distribution of asiaticus is probably highly restricted in Thailand since several thousand bamboo collections have been made throughout the country in the past without revealing this species. An. donaldi was collected in Narathiwad province in shaded stream pools and also while biting man. An. fragilis was discovered in the collection upon reexamination of several hundred larvae of the aitkenii group collected previously from several different localities in Thailand. Adult females of the aitkenii group are indistinguishable at present and the species within the group must be identified by larval or male genitalia characters. Anopheles balabacensis larvae were collected from all areas visited this year in connection with malaria studies. Much additional information on the distribution and bionomics of this species was gained during the year. During the rainy season this species can be found under many unusual circumstances far removed from hill streams where it is most commonly found. In Kanjanaburi province near the Burmese border, larvae were collected in several shallow temporary rain pools in deep jungle at rather low elevations. Many collections were also made from extremely small rock pools along the face of steep mountain sides. Other situations under which balabacensis larvae were collected in this locality included wheel ruts and rock pools in volcanic rock formations outside the town of Nam Tok. In Tha Mai, Chantaburi province many larvae were collected in pits dug for sapphire mining in groves of various types of fruit and rubber trees. The species is well established in this area and on one occasion larvae were collected from a small collection of water in a fallen banana leaf. In each of the cited situations the water was quite fresh and usually contained dead tree leaves and other debris. This species was found in these situations only during the rainy season. At the end of rainy season as the rains become less frequent this species disappeared from these sites even though suitable-looking habitats remained well into the dry season. The only suitable habitats remaining during the dry season are fresh mountain stream pools and these habitats also become less numerous. The only area where balabacensis was not found, this year, was the island of Ko Samui off the coast of Surat Thani province. Several typical balabacensis habitats along mountain streams were examined. At the time of our studies it had been over a month since a measurable amount of rain fell. To rule the presence of balabacensis on this island, follow up collections will have to be made after the onset of rainy season. Malaria transmission does occur on the island and two potential vector species were collected at several different sites. Anopheles sundaicus was found in brackish water along the coastal areas and An. maculatus was collected in shallow

running streams at the lower elevations of the mountains and in numerous rock pools along streams at the higher elevations. The larvae of Anopheles balabacensis were collected in small numbers for the first time in Waeng, Narathiwat province where it is apparently replaced by the more common An. balabacensis introlatus. The exact southern limits of balabacensis balabacensis is not yet known but it is probable that the division occurs somewhere within this part of Thailand. An. (b) introlatus apparently plays no role in the transmission of malaria in this area. Even though breeding of this species in areas studied was heavy, no adults were taken, in any of the many biting collections made. Large numbers of balabacensis were collected in March at 3,700 ft. on the mountain of Khao Sai Dao, Chantaburi province. This is the highest elevation at which balabacensis has been encountered by SMRL personnel. This location was well above the areas where gibbon and monkey populations were common, and this collection raises the possibility that balabacensis in that area is feeding on non-primate hosts.

Aedes: All of the species listed in Table 1 are now collection records for SMRL or for Thailand. All were collected as larvae and reared to adults. One of the more significant collections was that of Aedes (Finlaya) togoi. This species was recently collected from tidewater rock pools in Chantaburi province. Recently collected specimens of apparently the same species from tidewater rock pools in Vietnam have also been examined. This is probably the salt water variety of togoi reported from Japan. Comparison with type material of this species from Japan will be necessary before the species can be listed as togoi with certainty. Specimens of what appear to be new species of Aedes (Finlaya) are listed as species 1, 2 and 3.

Culex: Several new records for this genus were also added for the year. Specimens of a new subgenus, Culex (Thaiomyia), were collected from Chiangmai, Ranong and Tak Provinces. The species is a bamboo breeder very closely resembling Culex (Culiciomyia) sp. in the adults. The larvae are quite unusual in that the siphon lacks pecten which are present on the larvae of all known species of the genus Culex.

Udaya argyrurus: This monotypic genus was originally described as a subgenus for Paraedes argyrurus Edwards 1934, and later referred to the subgenus Udaya by Thurman in 1954 and was elevated to generic rank by Mattingly in 1957. It has been considered rare in Thailand and the natural habitat of the immature stages was unknown. The larvae have been described from material reared from eggs obtained from a captured female. Several collections of larvae of this species were made in Kanjanaburi and Tak provinces from split bamboo sections and bamboo internodes with small insect holes. The species appears to be rather common in these areas where bamboo occupies a greater portion of the forest.

Uranotaenia: Two species are tentatively listed as new. Both were collected in Kanjanaburi province. One was collected from small pools inside a large cave near the river Kwae. The other was from a deep rock pool extending into the side of the mountain at Nam Tok. The larvae of the latter are unusual in that they closely resemble some of the Aedes (Finlaya) species.

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. Much additional information on biting habits, larval habitats and distribution was also accumulated. Detailed studies were made in species groups belonging to Anopheles, Culex (Culiciomyia), Culex (Lophoceraomyia), Toxorhynchites, and Uranotaenia. An illustrated key and a distribution list of the Anopheles of Thailand have been prepared for publication.

Table 1. Mosquito Species Collected during 1965 - 1966 not previously represented in SMAL Collection

*	<u>Anopheles (Anopheles) fragilis</u>	(Theobald, 1903)
*	" "	<u>asiaticus</u> (Leicester, 1904)
*	" "	<u>sintonoides</u> Ho, 1938
*	" "	<u>donaldi</u> Reid, 1962
	" "	sp. n.
*	<u>Culex (Thaiomyia)</u>	n. subg., n. sp.
	<u>Culex (Mochthogenes) foliatus</u>	Brug, 1932
	" "	<u>malayi</u> (Leicester, 1908) ●
*	<u>Culex (Culex) pseudosinensis</u>	Colless, 1955
	<u>Aedes (Mucidus) quasiferinus</u>	Mattingly, 1961
*	<u>Aedes (Aedimorphus) orbitae</u>	Edwards, 1922
	" "	<u>pallidostratus</u> (Theobald, 1907)
	<u>Aedes (Edwardsaedes) imprimens</u>	(Walker, 1861)
*	<u>Aedes (Finlaya) togoi</u>	(Theobald, 1907)
	" "	n. sp. 1
	" "	n. sp. 2
	" "	n. sp. 3
	<u>Aedes (Christophersiomyia) annulirostris</u>	(Theobald, 1905)
	<u>Ficalbia (Ravenalites) fusca</u>	(Leicester, 1908)
	<u>Hodgesia malayi</u>	Leicester, 1908
	" "	<u>baillyi</u> Barraud, 1929
	<u>Tripteroides (Tripteroides) similis</u>	(Leicester, 1908)
	<u>Udaya argyrurus</u>	(Edwards, 1934)
	<u>Uranotaenia</u>	n. sp. 1
	" "	n. sp. 2

* Not previously recorded from Thailand.

Table 2. A working check list of the Anopheles of Thailand

	Species	First published record	Notes
	<u>Subgenus (Anopheles)</u>		
1.	Bengalensis Puri, 1930	Vejasatra (1935)	a
2.	albotaeniatus (Theobald, 1903)	Iyengar (1953)	
3.	annandalei interruptus Puri, 1929	*Sandhinand (1951)	
4.	argyropus (Swellingrebel, 1914)	Barraud & Christophers (1931)	
5.	asiaticus (Leicester, 1904)	SMRL	
6.	baezai Gater, 1933	Iyengar (1953)	
7.	barbirostris Van der Wulp, 1884	Theobald (1910)	
8.	barbumbrosus Strickland & Choudhury, 1927	Vejasatra (1935)	
9.	bulklevi Causey, 1937	Causey (1937)	
10.	campestris Reid, 1962	Reid (1962)	
11.	crawfordi Reid, 1953	SMRL	
12.	donaldi Reid, 1962	SMRL	
13.	fragilis (Theobald, 1903)	SMRL	
14.	hodgkini, Reid, 1962	Reid (1952)	
15.	indiensis Theobald, 1901	Thurman (1959)	
16.	insulaeflorum (Swellingrebel & Swellingrebel, 1919)	Vejasatra (1935)	
17.	lesteri paraliae Sandosham, 1959	Reid (1963)	
18.	letifer Sandosham, 1944	Iyengar and Newson (1953)	b
19.	montanus Stanton and Hacker, 1917	SMRL	
20.	nigerrimus Giles, 1900	Barraud & Christophers (1931)	
21.	palmatus (Rodenwaldt, 1926)	Vejasatra (1935)	
22.	peditaeniatus (Leicester 1908)	Stanton (1920)	
23.	pollicaris Reid, 1962	SMRL	
24.	pursati Laveran, 1902	Reid (1963)	
25.	reperi Reid, 1950	SMRL	
26.	separatus (Leicester, 1908)	Iyengar (1953)	
27.	sinensis Wiedemann, 1828	Theobald (1910)	
28.	sintonoides Ho, 1938	Reid (1963)	
29.	umbrosus (Theobald, 1903)	Iyengar (1953)	
30.	sp. n. (aitkenii group)	SMRL	

	Species	First published record	Notes
	Subgenus <u>Cellia</u>		
31.	aconitus Dönitz, 1902	Barnes (1923)	
32.	annularis Van der Wulp, 1884	Stanton (1920)	
33.	balabacensis balabacensis Baisas, 1936	Barnes (1923)	
34.	balabacensis introlatus Colless, 1957	SMRL	b
35.	culicifacies Giles 1901	Barnes (1923)	
36.	filipinae Manalang 1930	Thurman (1959)	
37.	fluviatilis James, 1921	Barnes (1923)	a
38.	hackeri Edwards, 1921	SMRL	
39.	jamesii Theobald 1901	Barnes (1923)	
40.	jeyporiensis candidjensis Koizumi. 1924	Sandhinand (1951)	
41.	karwari (James, 1903)	Barnes (1923)	
42.	kochi Donitz 1901	Barnes (1923)	
43.	maculatus maculatus Theobald, 1901	Barnes (1923)	
44.	maculatus willmori (James, 1903)	Barnes (1923)	
45.	majidi Young and Majid, 1928	Thurman (1962)	a
46.	minimus Theobald, 1901	Barnes (1923)	
47.	pallidus Theobald, 1901	Vejasatra (1935)	
48.	pampanai Buttike and Beales, 1959	SMRL	b
49.	philippinensis Ludlow, 1902	Stanton (1920)	
50.	pujutensis Colless, 1948	SMRL	
51.	ramsayi Covelj, 1927	Barraud and Christophers (1931)	
52.	riparis macarthuri Colless, 1956	SMRL	b
53.	splendidus Koizumi, 1920	Barnes (1923)	
54.	stephensi Liston, 1901	Thurman (1959)	
55.	subpictus subpictus Grassi, 1899	Vejasatra (1935)	
56.	sundaicus (Rodenwaldt, 1925)	Barnes (1923)	
57.	tessellatus Theobald, 1901	Stanton (1920)	
58.	vagus Donitz, 1902	Theobald (1910)	
59.	varuna Iyengar, 1924	Thurman (1962)	

a. Doubtful records, no specimens available for examination.

b. Also in the files of the Thai Ministry of Public Health.