

BODY OF REPORT

SEATO Medic Study No. 47 Mosquito Fauna of Thailand

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S. E. Asia

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S. E. Asia

Subtask 01: Military Medical Research Program
SEASIA (Thailand)

Reporting Installation: US Army-SEATO Medical Research Laboratory
APO San Francisco 96346

 Division of Medical Research Laboratories

 Department of Medical Entomology

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Objective: To collect, identify, catalog and redescribe all of the mosquitoes of Thailand. Information is also assembled on the distribution, larval habitats, and other aspects of the bionomics 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 and the later inclusion of this material into a larger monographic work on the mosquitoes of Southeast Asia.

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 associated larvae, pupae and

* Departed for CONUS June 1964. Now at WRAIR, Washington, D. C.

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adults for illustration and for other detailed studies. All of the material collected is assigned a collection number for use in file cards and record books which are kept as permanent records of the distribution and bionomics of the species concerned. Reared immature stages are provided with an additional sub-number to assure accurate association and reference of larval skins, pupal skins, adults and genitalia. 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 project headquarters at the U.S. National Museum for description and eventual inclusion in the final monograph. As specimens of sufficiently good quality are accumulated at project headquarters, they are sent to the 406th Medical Laboratory in Japan for illustration by a team of biological illustrators. A representative reference collection of specimens collected during the year were retained in the SEATO Medical Research Laboratory.

Progress: The program in Thailand was continued in the pattern established in the previous years; however, the emphasis in certain areas was shifted. A greater emphasis was placed on the collection of immature stages, reared series, and sibling series than in the previous years. Trap collections were used almost exclusively for gathering distribution data and in support of the various disease studies. With few exceptions the material used in the taxonomic studies was from reared series. A reappraisal of laboratory and field collecting methods was made and several new techniques for field and laboratory use were initiated. A greater emphasis was placed on technician training during the year. Closer supervision and training of field teams has resulted in more adequate coverage of designated study areas and improvement in the quality of specimens collected. Field collectors of the taxonomic team achieved facility in the field identification of important vector species as well as some of the complex species groups.

General Remarks and Curatorial Report:

During the year 3,938 adults were pinned and added to the collection. Slides were prepared from 7,328 larvae and 1,016 male and female genitalia. The majority of slide preparations were matched series of larval and pupal skins, and the genitalia of associated adults. The preparation of genitalia slides during the year was more than double that of the previous years. These consisted mostly of terminalia from species belonging to the genera Toxorhynchites and Culex (Lophoceraomyia). Detailed studies of Thai species belonging to these two genera were initiated during the year. A major project undertaken during the same period was the transfer from Bangkok to the project headquarters in Washington of specimens collected in Thailand since 1962. By the end of the year 160 Schmidt boxes of pinned adults and 138 slide boxes of immature stages and adult genitalia, representing several hundred species and several thousand specimens were successfully transferred with only a negligible loss of specimens. Much emphasis was placed on the development of improved techniques for collecting, transporting and rearing live material while in the field. In this respect much attention was given to the use of compact, yet adequate shipment and materials.

Table 1

LIST OF SPECIES COLLECTED FOR TAXONOMIC PURPOSES DURING 1964-1965.

| Type Collection Species - Number of collections | Light | | | Resting |
|--|---------------|------------|---------------|---------|
| | Larvae 867 | Trap 87 | Biting 117 | |
| <u>Anopheles (Anopheles)</u> | | | | |
| aithkeni bengalensis | + | | | |
| amandalei interruptus | + | | | |
| argyropus | + | + | + | + |
| berbirostris | + | + | + | |
| berumbrosus | + | | | |
| beezai | + | | | |
| crawfordi | + | | | |
| hodgkini | + | | | |
| indiensis | + | + | + | |
| letifer | + | | | |
| lesteri | + | | | |
| montenus | + | | | |
| nigerrimus | + | | | |
| roperi | + | | | |
| peditaenistatus | + | | | |
| sinensis | + | | | |
| separatus | + | | | |
| polliceris | + | | | |
| sp. n. | + | | | + |
| <u>Anopheles (Cellia)</u> | | | | |
| aconitus | + | + | + | |
| annularia | + | + | | |
| bala bacensis | + | | | |
| hackeri | + | | | |
| introlatus | + | | | |
| jamesi | + | | | |
| kochi | + | | | |
| karwari | + | | | |
| maculatus | + | | | |
| minimus | + | | | |
| pujutensis | + | | | |
| philippinensis | + | | | |
| ramsayi | + | | | |
| riperis macarthuri | + | | | |

Table 1 (Contd)

| Type Collection Species - Number of collections | Light | | | Resting |
|--|---------------|------------|---------------|---------|
| | Larvae 867 | Trap 87 | Biting 117 | |
| <u>Anopheles (Cellia) cont.</u> | | | | |
| splendidus | | | + | |
| stephensi | + | | | |
| sundaicus | + | | | |
| subpictus | + | + | + | |
| tessellatus | + | + | + | |
| varuna (cf.) | + | | | |
| vagus | + | + | + | + |
| <u>Aedeomyia</u> | | | | |
| caraticta | + | + | | |
| <u>Culex (Culicicomyia)</u> | | | | |
| nigropunctatus | + | + | | |
| pallidothorax | + | + | + | |
| <u>Culex (Lophoceraomyia)</u> | | | | |
| rubithoracis | | + | | |
| infantulus | + | | | |
| sp. | + | + | + | + |
| <u>Culex (Neoculex)</u> | | | | |
| brevipalpis | + | + | + | |
| <u>Culex (Mochthorenes)</u> | | | | |
| crastensis | + | | | |
| sp. | + | | | |
| <u>Culex (Culex)</u> | | | | |
| annulus | + | | | |
| bitaeniorhynchus | + | + | + | + |
| fuscocephalus | + | + | + | + |
| gelidus | + | + | + | + |
| hutchinsoni | + | | | |
| mimulus | + | | | |
| quinquefasciatus | + | + | + | + |
| pseudovishnui | + | + | + | + |
| sinensis | + | | | |
| sitiens | + | | | |
| vishnui group | + | + | + | + |
| whitmorei | + | + | + | + |
| tritaeniorhynchus | + | + | + | + |

Table 1 (Contd)

| Type Collection Species - Number of collections | Larvae 867 | Light Trap 87 | Biting 117 | Resting 165 |
|--|---------------|---------------------|---------------|----------------|
| <u>Culex (Lutziæ)</u> | | | | |
| fuscus | + | + | + | + |
| halifaxi | + | | | |
| raptor | + | | | |
| <u>Armigeres (Armigeres)</u> | | | | |
| malayi | + | + | + | |
| malayi (cf.) | + | | | |
| jugraensis (cf.) | + | | + | |
| subalbatus | + | + | | |
| kuchingensis | + | | | |
| <u>Armigeres (Leicesteria)</u> | | | | |
| annulitarsis | + | | | |
| dentatus | + | | | |
| digitatus | + | + | + | |
| flavus | + | | | |
| longipalpis | + | | | |
| magnus | + | | | |
| omissus | + | | | |
| <u>Aedes (Neomelaniconion)</u> | | | | |
| lineatopennis | | + | | |
| <u>Aedes (Stegomyia)</u> | | | | |
| albopictus | + | + | + | + |
| albolineatus | + | | | |
| albolineatus (cf.) | + | | | |
| ægypti | + | | + | |
| annandalei | + | | | |
| scutellaris group | + | | | |
| vittatus | + | | | |
| w-albus | + | | | |
| <u>Aedes (Lorraineæ)</u> | | | | |
| amesi | + | | | |
| fumidus | + | | + | |
| <u>Aedes (Mucidus)</u> | | | | |
| ferinus | + | | | |
| laniger | + | | | |
| <u>Aedes (Cancraedes)</u> | | | | |
| sp. | | | + | + |

Table 1 (Contd)

| Type Collection Species - Number of collections | Larvae 867 | Light Trap 87 | Biting 117 | Resting 165 |
|--|---------------|---------------------|---------------|----------------|
| <u>Aedes (Aedimorphus)</u> | | | | |
| albocutellatus | + | | + | |
| caecus | + | | | |
| lowissi (cf.) | + | | + | |
| mediolineatus | | + | + | |
| taeniorhynchoides | | + | + | |
| vexans | | + | + | |
| <u>Aedes (Rhinoskuseæ)</u> | | | | |
| longirostris | | | | + |
| <u>Aedes (Aedes)</u> | | | | |
| butleri | + | + | | |
| dux | + | + | | |
| sp. | + | | + | |
| <u>Aedes (Ochlerotatus)</u> | | | | |
| sp. | + | | | |
| <u>Aedes (Finlayæ)</u> | | | | |
| albotaeniatatus | + | | | |
| aureostriatus | + | | | |
| assamensis | + | | | |
| chrysolineatus group | + | | | |
| dissimilis | + | | | |
| elsiae | + | | | |
| feegradei | + | | | |
| formosensis | + | + | | |
| kochi group | + | | | |
| gubernatoris group | + | | | |
| harveyi | + | | | |
| inermis (cf.) | + | | | |
| khazani | + | | | |
| litoreus (cf.) | + | | | |
| macfarlanei | + | | | |
| niveus group | + | | | |
| niveoides (cf.) | + | | | |
| novoniveus (cf.) | + | | | |
| poicilius | + | | | |
| prominens | + | | | |
| pexus (cf.) | + | | | |
| pseudoniveus (cf.) | + | | | |
| saxicola | + | | | |
| subniveus (cf.) | + | | | |
| sintoni (cf.) | + | | | |
| sp. | + | | | |

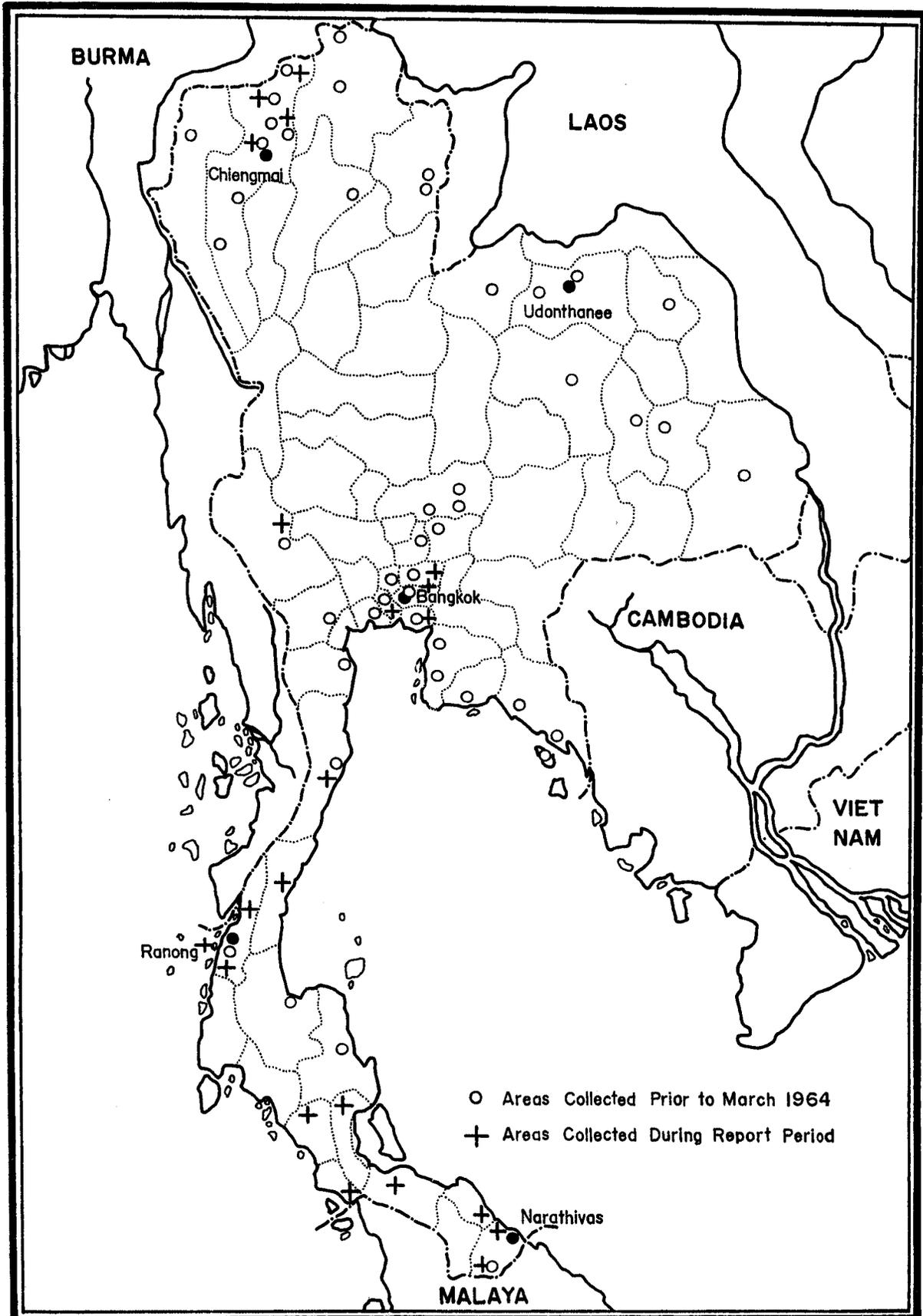
Table 1 (Contd)

| Type Collection Species - Number of collections | Larvae 867 | Light Trap 87 | Biting 117 | Resting 165 |
|--|---------------|---------------------|---------------|----------------|
| <u>Ayrakitia</u> griffithi | + | | | |
| <u>Ficalbia (Ravenalitea)</u> deguzmanae (cf.) | | + | | |
| <u>Ficalbia (Etorleptomylia)</u> luzonensis | + | + | | |
| <u>Ficalbia (Mionomyia)</u> chamberlaini metallica hybrida | + | + | | |
| <u>Ficalbia (Ficalbia)</u> minima | + | + | | |
| <u>Mansonia (Mansonoides)</u> annulata annulifera dives indiana uniformis | + | + | + | + |
| <u>Mansonia (Coquillettidia)</u> novochraecea crassipes | | + | + | + |
| <u>Malaya</u> genurostris jacobsoni | + | + | | |
| <u>Heizmannia</u> achaeta aureochaetae mattinglyi reidi sp. | + | | + | + |
| <u>Hodgesia</u> sp. | + | | | |
| <u>Orthopodomylia</u> andamensis anopheloides lemmonae albipes | + | | | |

Table 1 (Contd)

| Type Collection Species - Number of collections | Larvae 867 | Light Trap 87 | Biting 117 | Resting 165 |
|---|---------------|---------------------|---------------|----------------|
| <u>Toxorhynchites</u> graveleyi leicesteri magnificus splendens sp. | + | | | + |
| <u>Topomyia</u> sp. | + | | | |
| <u>Tripteroides</u> aracoides powelli or indicus | + | + | | + |
| <u>Uranotaenia</u> annandalei alboannulata (cf.) bicolor bicolor (cf.) campestris edwardsi lateralis macfarlanei (cf.) maculipleura mixima orientalis testacea trilineata sp. | + | + | + | + |

Figure 1



Limited hauling capabilities and work space in the field, especially in remote areas, was a strongly influencing factor. All adults collected or reared for taxonomic purposes were pinned in the field while fresh. This step has greatly improved quality of adult specimens and thus has eliminated two time consuming operations of packing individual specimens in pill boxes in the field and later relaxing the dried specimens in the laboratory prior to pinning. The latter two operations usually always contribute to a degree of damage to specimens. Most of the objectives in field operations were achieved and the capabilities for collecting, rearing, associating, pinning and recording of individual specimens was limited only by time.

Taxonomic Progress: Many Thai species not previously represented were added to the collection in the department during the year. Many of these are new records for Thailand and many require confirmation by examination of type material which will be accomplished by the principle investigator at the U.S. National Museum. A list of species collected during the year for the purpose of this project is presented in Table 1. This list does not represent all species collected solely for the purpose of virus or malaria studies, nor does it represent the total number of light trap, biting and resting collections made by the department during the year. The majority of specimens collected by these methods were sacrificed through animal inoculations or dissections for the recovery of disease organisms and are reported under separate sections of this report. It can be noted from Table 1 that most of the species were collected as larvae and are therefore represented by matched series of adults with associated larval and pupal skins. Much of the material collected is being prepared for publication. A handbook to the Anopheles of Thailand with keys, descriptions and illustrations was near completion during the year. Descriptions for most of the species belonging to the genera Toxorhynchites, Culex (Lophoceraomyia) were also completed.

Biological and Distribution Studies: In previous years much of the collection effort has been in the northern half of Thailand. During this year efforts were directed to the southern peninsula of Thailand where very few previous collections had been made by the department. A comparison of areas where the greatest number of collections have been made can be seen in Figure 1. It can also be noted that vast areas of Thailand still remain to be covered in the collections. The transfer of attention to the south was based primarily on the need for additional information on the mosquito fauna of this important geographic area in the support of increased malaria studies conducted in that region by the Malaria Project and the Department of Medical Entomology. The southern peninsula is covered by extensive mountain ranges and vast undeveloped areas of primary tropical rain forest, and much of the area is largely inaccessible. Hill areas that have been cleared are devoted to cultivation of banana and rubber trees while rice is grown in the low flat lands. A more complete description of specific localities in the south can be found under the malaria sections of this report. It is interesting to note that many of the common species of northern Thailand were absent from the southern collection, while several Indomalayan species previously unreported from Thailand or species considered to be rare were found in considerable numbers.

Table 2

A WORKING CHECKLIST OF THE ANOPHELES OF THAILAND ¹

| Subgenus (Anopheles) | Subgenus (Cellia) |
|--|---|
| 1. <i>aitkenii aitkenii</i> James, 1903 | 32. <i>aconitus</i> Dönitz, 1902 |
| 2. <i>aitkenii bengalensis</i> Puri, 1930 | 33. <i>annularis</i> Van der Wulp, 1884 |
| 3. <i>albotaeniatus</i> (Theobald, 1903) | 34. <i>balabacensis balabacensis</i> Baisas, 1936 |
| 4. <i>annandalei interruptus</i> Puri, 1929 | 35. <i>balabacensis introlatus</i> Colless, 1957 |
| 5. <i>argyropus</i> (Swellengrebel, 1914) | 36. <i>culicifacies</i> Giles, 1901 |
| 6. <i>baezai</i> Gater, 1933 | 37. <i>filipinae</i> Manalang, 1930 |
| 7. <i>barbirostris</i> Van der Wulp, 1884 | 38. <i>fluviatilis</i> James, 1902 |
| 8. <i>barbumbrosus</i> Strickland & Choudhury, 1927 | 39. <i>hackeri</i> Edwards, 1921* |
| 9. <i>brevipalpis</i> Roper, 1924 | 40. <i>jamesii</i> Theobald, 1901 |
| 10. <i>bulkleyi</i> Causey, 1937 | 41. <i>jeyporiensis jeyporiensis</i> James 1902 |
| 11. <i>campestris</i> Reid, 1962 | 42. <i>jeyporiensis candidiensis</i> Koidzumi, 1924 |
| 12. <i>crawfordi</i> Reid, 1953 | 43. <i>karwari</i> (James, 1903) |
| 13. <i>gigas formosus</i> Ludlow 1909 | 44. <i>kochi</i> Dönitz, 1901 |
| 14. <i>gigas sumatrana</i> Swellengrebel and Rodenwaldt, 1932 | 45. <i>ludlowae</i> (Theobald, 1903) |
| 15. <i>hodgkini</i> , Reid, 1952 | 46. <i>maculatus maculatus</i> (Theobald, 1901) |
| 16. <i>indiensis</i> Theobald, 1901 | 47. <i>maculatus willmori</i> (James, 1903) |
| 17. <i>insulaeflorum</i> (Swellengrebel & Swellengrebel, 1919) | 48. <i>majidi</i> Young and Majidi, 1928 |
| 18. <i>lesteri paraliae</i> Sandosham, 1959 | 49. <i>minus</i> Theobald, 1901 |
| 19. <i>letifer</i> Sandosham, 1944 | 50. <i>palidus</i> Theobald, 1901 |
| 20. <i>montanus</i> Stanton and Hacker, 1917 | 51. <i>pampanai</i> Büttiker and Beales, 1959 |
| 21. <i>nigerrimus</i> Giles, 1900 | 52. <i>philippinensis</i> Ludlow, 1902 |
| 22. <i>palmatus</i> (Rodenwaldt, 1926) | 53. <i>pujutensis</i> Colless, 1948* |
| 23. <i>peditaeniatus</i> (Leicester, 1908) | 54. <i>ramsayi</i> Covell, 1927 |
| 24. <i>pollicaris</i> Reid, 1962* | 55. <i>riparis macarthuri</i> Colless, 1956 |
| 25. <i>pursati</i> Laveran, 1902 | 56. <i>splendidus</i> Koizumi, 1920 |
| 26. <i>roperi</i> Reid, 1949* | 57. <i>stephensi</i> Liston, 1901 |
| 27. <i>separatus</i> (Leicester, 1908) | 58. <i>subpictus subpictus</i> Grassi, 1897 |
| 28. <i>sinensis</i> Wiedemann, 1828 | 59. <i>subpictus indefinitus</i> (Ludlow, 1904) |
| 29. <i>umbrosus</i> (Theobald, 1903) | 60. <i>subpictus malayensis</i> Hacker, 1921 |
| 30. <i>sintoni</i> (cf.) | 61. <i>sundaicus</i> (Rodenwaldt, 1925) |
| 31. <i>sp. n.</i> | 62. <i>tessellatus</i> Theobald, 1901 |
| | 63. <i>vagus</i> Dönitz, 1902 |
| | 64. <i>varuna</i> Iyengar, 1924 |

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

* Constitutes new records for Thailand.

Additional collections from the south are necessary before an accurate comparison between these two ecologically distinct areas can be made. In the north extensive collections have been made at elevations from sea level to 6,000 feet while all of the collections in the south were made below the 2,000 feet level. A few of the more significant species collected during the year are discussed separately below.

Anopheles: A check list of the species of Anopheles reported to occur in Thailand is presented in Table 2. The list presented in last year's report for Thailand listed 58 species and two species of undetermined status. During the past year four additional species were added to the list, bringing the total number of Anopheles reported to occur in Thailand to 64. In addition to the four species added for the country, larvae and adults of four, and larvae of two previously report species were collected by the department for the first time. The four species added to this years list are: Anopheles (Anopheles) pollicaris, A. (A) roperi, A. (Cellia) hackeri and A. (C.) pujutensis, A. pollicaris was collected in Songkhla province from a shaded, rocky steam pool in primary forest at an elevation of about 500 feet. A. roperi was collected in Narathivas province biting man and in Songkhla province from large, shaded, stagnant stream pools at the edge of primary forest at an elevation of about 300 feet. A. hackeri was collected in Songkhla province from a very large, shaded root hole at ground level in primary forest at an elevation of about 200 feet. A. pujutensis was collected from Narathivas province from small shallow, stagnant stream pools in primary forest near the base of the mountains. Species which were collected for the first time by the department were A. insulaeflorum (Songkhla Province), A. montanus (Songkhla and Narathivas province), A. separatus (Narathivas province), and A. riparis macarthuri (Narathivas, Pattalung, Trang and Songkhla provinces). The two species collected as larvae for the first time by the department were A. hodgkini (Narathivas, Ranong, Satun and Songkhla provinces) and A. karwari (Songkhla province). As far as can be determined these four new records have not been published elsewhere and are now being prepared for publication for this project.

Aedes: As can be seen in the Table 1, there are several species belonging to this genus which require confirmation before a specific discussion can be made. Two species of the A. (finlaya) kochi group, were collected for the first time by SMRL. Both species breed in the leaf axils of Pandanus (screw pine). A. poicilius, the only member of this group reported from Thailand, had not previously been collected by SMRL. It has been found frequently as larvae in several southern provinces and on a few occasions it was taken in light trap and biting collections in Songkhla province. The other member of the group appears to be close to flavipennis and avistyla, the former reported only from the Philippines and the latter from Malaya. Specimens of these species were collected in Chumphon and Trans provinces. Final status of these species will be determined by examination of type material. The collection of A. (Mucidus) laniger in Songkhla province constitutes a new record for Thailand. The immature stages of this species were previously unknown. Many of these very large and predacious larvae were collected in partially shaded temporary rain pools deep in primary forest at an elevation of about 200

feet. Previous to this collection only one species of the subgenus mucidus was known to occur in Thailand. Two species collected as larvae for the first time by SMRL were A. alboscuteclatus (Songkhla province), and A. albotaeniatus (Ranong province).

Ayurikitia: This monotypic genus was described from adults collected in Thailand by Thurman (1959) with type species griffithi. The immature stages of this species were unknown. Larvae and pupae were collected the first time from the leaf axils of Pandanus in Chiangmai, Panga, Trang and Kanjanaburi provinces.

Armigeres: The immature stages of A. dentatus had not previously been collected by SMRL. Numerous larvae and pupae of this species were collected from bamboo internodes in Chiangmai and Ranong provinces.

Orthopodomyia: The collection of O. albipes from Trang province constitutes a new record for Thailand. This species is a tree-hole breeder and was collected from tree-holes in primary mountain forest. Larvae, pupae and adults were obtained from these collections.

Uranotaenia: Specimens of U. testacea had not previously been collected by SMRL. Larvae, pupae and adults were obtained from larvae collected from stream pools in Narathivas province. Several additional species collected and not specifically discussed above under the various genera represent new species and others constitute new records for Thailand. The status of these species have not been definitely determined.

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. The scope of the mosquito taxonomy and biology project was extended to include all of Southeast Asia. Headquarters for the project is the Department of Entomology, United States National Museum. Detailed studies were made in species groups in Anopheles, Toxorhynchites and Culex. Results are presented on material collected mostly in the southern areas of Thailand.

Conclusions: The mosquito fauna of Thailand is extremely complex and a full understanding of it will require much additional collecting. The larval habitats of many species still remain unknown. Several of the areas already visited have not been adequately collected and others remain to be collected. It will be necessary to revisit several areas at different times of the year to study seasonal population trends and other aspects of the bionomics. A large number of species in forested areas attack man and may be involved in the transmission of a number of disease agents. The potential mosquito vectors include species of the subgenera Stegomyia and Finlaya of the genus Aedes, and in the genera Armigeres and Heizmannia.