REPORT OF THE INITIAL OPERATION OF A MOSQUITO LIGHT TRAP IN NORTHERN THAILAND

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The operation of a light trap (New Jersey type) in connection with the malaria control program in northern Thailand, expanded through American cooperation initiated in 1951, had a two-fold purpose: (1) To demonstrate the instrument in an area where it had not been used, particularly to show the malaria control officials and technical trainees the methods of operating the trap and handling the collections; and (2) to sample the mosquito population as to species, density, seasonal distribution, phototropism, and nocturnal flight activities.

This report, based on the first year of operation of a light trap in Chiengmai, northern Thailand, is presented with the hope that it will serve to assist additional light trap studies now in progress. Subsequent to the period of this report, New Jersey type light traps have been operated in Chiengmai and other areas, including three northern, twelve northeastern, three central and two southern locations. The collections to date have been largely obtained during variable periods of relatively short duration, though one of the traps in Bangkok has been operated since late March, 1952. All of these additional collections are now under study in Thailand, and further light trap investigations are being continued (Griffith, 1955).

A portable light trap, adapted to current from a 6-volt battery, was designed and constructed by the authors for use in northern areas where electricity was not available. This trap was operated on six occasions in the foothills of Doi (mountain) Sutep, Chiengmai Province, and once in the municipality of Chiengmai. The species attracted were the same as those taken in the New Jersey type trap in Chiengmai. The number of specimens and names of species have been included in the general tabulation, as the number of collections was too few to warrant separate evaluation.

After the mosquitoes were removed from each trap collection, the remaining insects were sorted to order and forwarded to specialists in the United States National Museum and military and academic agencies, or the collections of residue were forwarded in entirety to the interested agencies. This report deals only with the mosquitoes recovered.

During the 1951 spray-season of the expanded Thailand malaria control program, it was not possible to operate a light trap due to the insufficient supply of municipal electricity. The first trap was operated inside the Thurmans' residential compound in the city of Chiengmai. The beginning collections, one in March and six in April, 1952, were made utilizing the electricity as available, usually for not more than three hours a night. After April 16, a 24-hour supply of electricity was fairly constant, though the current fluctuated. Between this date and April 15, 1953, depending on the supply of electricity, the trap was operated during 282 nights. A total of 28,962 mosquitoes was identified, of which there were

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Facilities of the United States National Museum were utilized by the junior author to complete this report, one of a series of papers that was in preparation at the time of the sudden death of the senior author. Mr. Thurman died April 18, 1953, nine days prior to the completion of his assignment in Northern Thailand where he had spent more than two years.

17,377 females and 11,585 males (1.5 times as many females as males). There were 5,273 *Anopheles* collected.

Anopheles minimus Theobald, 1901, the only known vector of malaria in northern Thailand, was not collected in the trap, and in the same period this species was not collected in repeated larval collections and house inspections within the Chiengmai municipality. *A. minimus* was abundant in the Chiengmai area prior to the 1951 malaria control operations by DDT residual house-spraying. Larvae and adults were present concurrently in uncontrolled areas some 10 kilometers from the municipality.

Causey (1937) reports operating light traps in houses in Bangkok during 1933 from which he collected 3,817 *Anopheles* including one specimen of *A. minimus.* However, the degree of attractiveness of a New Jersey type light trap to *A. minimus* in Thailand remains to be ascertained. It would seem that if *A. minimus* is attracted to such a light trap, it could have been expected to appear in the Chiengmai trap in considerable numbers had the area not been subjected to DDT residual house-spraying during the previous year.

Mosquitoes were captured throughout the year with the exception of 15 nights during late December and mid-January when the pre-dawn temperatures dropped below 45° F. Northern Thailand is subjected to the monsoons with the rainy season beginning in late May or early June and continuing until mid-October, with September usually being the month for floods. November through January constitutes the dry-cool season, and February through April the dry-hot season. A few scattered showers (little monsoon) may occur in late March or early April.

Population trends of the culicines, as shown in Figure 1, seem to be correlated with the seasons. This is demonstrated by an increase from 14 culicines per trap-night in May to 283 in August. With the onset of the September floods followed by the dry-cool season, the culicine population diminished rapidly, dropping to 5 per trap-night in January. Species of *Culex* predominated throughout the year. Species of *Aedes* were most abundant during June and July.

The anopheline density peak of 61 per trap-night was reached in November. This peak was preceded by a peak of 50 per trap-night for August after a continuous increase from 2 per trap-night in May.

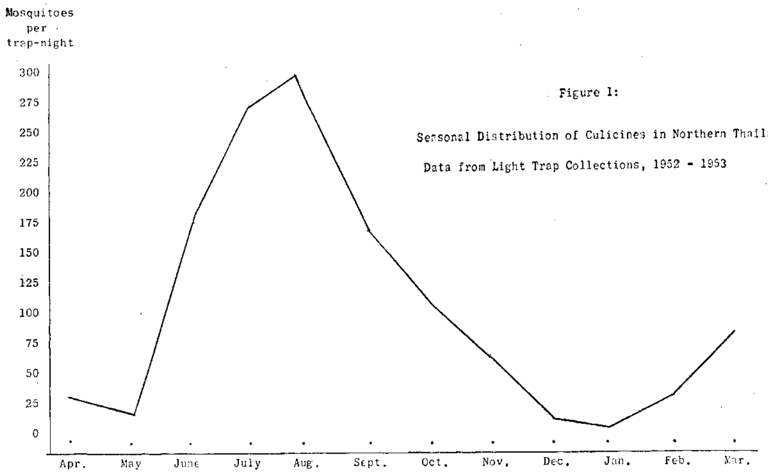


Figure 1:

Seasonal Distribution of Culicines in Northern Thailand

Data from Light Trap Collections, 1952 - 1953

March, April, and May were the months in which malaria control teams sprayed the sleeping quarters of the houses with a 5 percent DDT suspension. During the September floods, anopheline catches were reduced to 16 per trap-night. The November peak was followed by a sharp decline to 3 per trap-night for December and to less than 1 for January, as is shown in Figure 2.

Before the mosquitoes were removed from a trap collection, the volume of the entire collection was measured in cubic centimeters. During the month of November, mosquitoes averaged 7.9 per cc. while during December the mosquitoes averaged 2.4 per cc.

Nocturnal flight activities of the mosquitoes were studied on four occasions by operating the trap for intervals of 3 hours between 6:00 p.m. and 6:00 a.m. Of the anophelines, 52 percent were captured between 6.00 and 9:00 p.m.; 29 percent from 9:00 p.m. to midnight; 11 percent between midnight and 3:00 a.m.; and 7 percent from 3:00 to 6:00 a.m. Culicine flight activity declined less abruptly during the four periods, from 31 percent to 17 percent as shown in Figure 3.

Of the 18 genera and estimated 200 species of mosquitoes occurring in Thailand, 11 genera (60%) and 66 species (33%) were represented in the total trap collection. (See ¶ 5 on p. 218). Of these, one genus and 11 species of six genera constitute new occurrence records for the country. (See ¶ 4 on p. 223). The *Culex* spp. constituted 78 percent of the total collection; *Anopheles* 18 percent; and the remaining nine genera, 4 percent.

Of the 43 species and subspecies of *Anopheles* reported for Thailand, of which 28 are known from northern Thailand, 13 were collected in the light trap. *Anopheles vagus* Dönitz, 1902, was the most abundant (37%), and was the only species collected during all the months of the year. *Anopheles philippinensis* Ludlow, 1902 (20%), *Anopheles aconitus* Dönitz, 1902 (13%), *Anopheles nigerrimus,* Giles, 1900 (13%), and *Anopheles sinensis* Wiedemann, 1828 (12%) were collected in abundance. Other species collected rarely, comprising 5 percent of the anophelines, are listed under the heading *Species of Mosquitoes Captured* in order of frequency of occurrence.

All 13 *Anopheles* trapped in northern Thailand have been reported as experimental or natural vectors of malaria for countries of the Indo-Australian Region (Bonne-Wepster and Swellengrebel, 1953). However, after repeated dissections, only *A. minimus* has been found naturally infected with sporozoites in Thailand (Bhayung, 1935; Sambasivan, Bhatia, Pranich, and Notananda, 1952). *A. barbirostris, A. nigerrimus,* and *A. sinensis* have been reported as vectors of filariasis in southern Thailand (Iyengar, 1953).

In the culicines, the genus *Culex* predominated (80%). *Culex fuscocephalus* Theobald, 1907; *Culex pipiens* Linneaus, 1758—*Culex quinquefasciatus* Say, 1823, complex; *Culex tritaeniorhynchus* Giles, 1901; *Culex vishnui* Theobald, 1901; and *Culex gelidus* Theobald, 1901, constituted 96 percent of the *Culex* collected. Other *Culex* species taken less frequently are listed in the order of frequency.

The high densities of *Culex tritaeniorhynchus* and *C. pipiens* are significant in that the species are known to be vectors of Japanese B encephalitis (Mackie, Hunter, and Worth, 1954), and the disease is known to occur in countries adjacent to Thailand. Virus of Japanese B encephalitis has been recovered recently from *C. gelidus* and *C. tritaeniorhynchus* in Malaya by personnel of the U. S. Army Medical Research Unit (McCrumb, Diercks, Pond, Keegan, and Barnett, 1954).

Aedes lineatopennis (Ludlow, 1905) represented 37 percent of the *Aedes* collected; *Aedes mediolineatus* (Theobald, 1901) 28 percent; *Aedes vexans* (Meigen, 1830) 20 percent and *Aedes albopictus* (Skuse, 1895) 9 percent. Other *Aedes* collected are listed in the order of abundance.

Figure 2:

Seasonal Distribution of Anophelines in Northern Thailand

Data from Light Trap Collections, 1952 - 1953

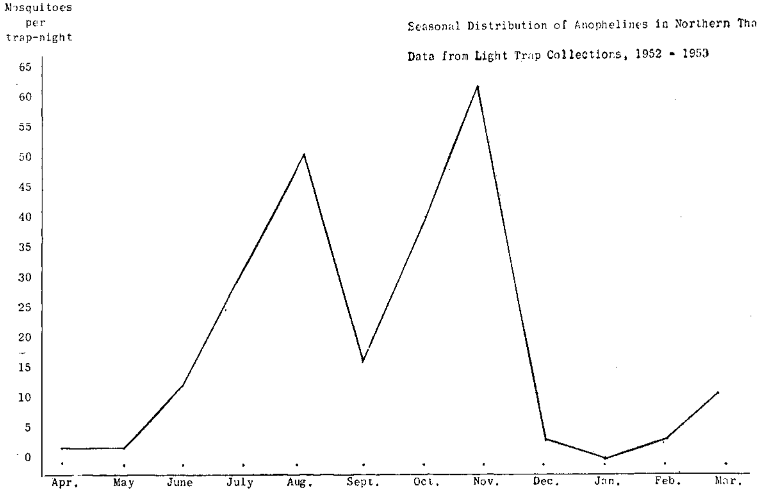
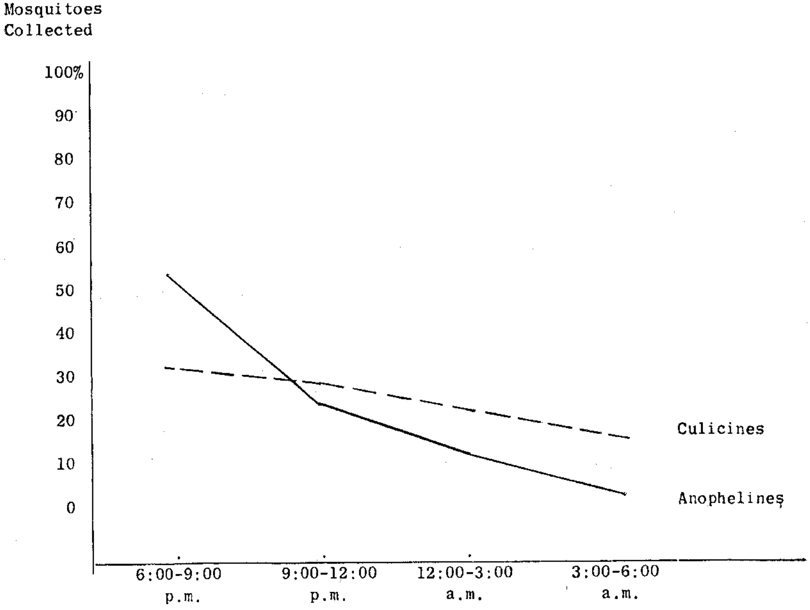


Figure 3: Comparison of Nocturnal Flight Activities of Anophelines and Culicines in Northern Thailand

Data from Light Trap Collections, 1952 - 1953



In the genus *Aedes* there are numerous species known to be vectors of yellow fever, dengue, and the encephalitides. *A. vexans* is reported as a vector for eastern equine encephalitis in the eastern United States (Doughty, 1953). *A. albopictus* is listed by Fergurson (1954) as a laboratory vector of western equine encephalomyelitis and St. Louis encephalitis.

Mansonia indiana Edwards 1930, *Mansonia annulifera* (Theobald, 1901), and *Mansonia uniformis* (Theobald, 1921) comprised 90 percent of the *Mansonia* captured. These three species are known to be vectors of filariasis in southern Thailand (Iyengar, 1953). Other *Mansonia* represented in the collections were: *Mansonia crassipes* (Van der Wulp, 1892); *Mansonia ochracea* (Theobald, 1903); and *Mansonia novochracea* (Barraud, 1927).

Armigeres obturbans (Walker, 1860) [=*subalbatus* (Coquillett, 1898)] represented 99 percent of the genus; with *Armigeres annulitarsis* Leicester, 1908, and *Armigeres malayi* (Theobald, 1901) being the other species recovered. *A. obturbans* is listed as a laboratory vector of St. Louis encephalitis and western equine encephalomyelitis (Fergurson, 1945), and with *A. malayi* as natural vectors of filariasis (Horsfall, 1955).

Ficalbia minima (Theobald, 1901), was the most abundant (49%) of the *Ficalbia*. Additional species collected are listed in the order of the number collected.

Uranotaenia campestris Leicester, 1908, was the species most often collected in this genus. *U. campestris* and *Uranotaenia edwardsi* Barraud, 1926, totalled 91 percent of the *Uranotaenia*. Other species were: *Uranotaenia recondita* Edwards, 1922; *Uranotaenia micans* Leicester, 1908; *Uranotaenia zelena* Barraud, 1934; and *Uranotaenia trilineata* Leicester, 1908.

Aedeomyia catasticta (Knab, 1909), and *Aedeomyia* spp.; *Harpagomyia genurostris* (Leicester, 1908); *Tripteroides* spp.; *Topomyia* spp.; and an undescribed genus were also collected. There are a number of specimens of the less common species awaiting additional detailed study for specific determination.

SPECIES OF MOSQUITOES CAPTURED (1952–1953). (Genera in alphabetic order, species in order of abundance captured).

**Aedeomyia catasticta* (Knab, 1909), *Aedeomyia* spp.

Aedes: lineatopennis (Ludlow, 1905), *mediolineatus* (Theobald, 1901), *vexans* (Meigen, 1830), *albopictus* (Skuse, 1895), **pallidostriatus* (Theobald, 1907), *caecus* (Theobald, 1901), **vallistris* Barraud, 1928; *uncus* (Theobald, 1901), **pulchitarsis* (Rondani, 1872), **stenoetrus* (Theobald, 1907).

Anopheles: vagus Dönitz, 1902; *philippinensis* Ludlow, 1902; *aconitus* Dönitz, 1902; *nigerrimus,* Giles, 1900, *sinensis* Wiedemann, 1828; *tessellatus* Theobald, 1901; *kochi* Dönitz, 1901; *barbirostris* Van der Wulp, 1884; *pallidus* Theobald, 1901; *ramsayi* Covell, 1927; *maculatus* Theobald, 1901; *barbumbrosus* Strickland and Chowdhury, 1927; *jeyporienensis candidensis* Koidzumi, 1924.

Armigeres: obturbans (Walker, 1860), [=*subalbatus* (Coquillett, 1898)], *annulitarsis* Leicester, 1908; *malayi* (Theobald, 1901).

Culex: fuscocephalus Theobald, 1907; *quinquefasciatus* Say, 1823; *pipiens* Linneaus, 1758; *tritaeniorhynchus* Giles, 1901; *gelidus* Theobald, 1901; *vishnui* Theobald, 1901; *bitaeniorhynchus* Giles, 1901; *whitmorei* (Giles, 1904), *fuscanus* Wiedemann, 1820; *Culex (Lophoceratomyia)* spp., *Culex (Lutzia)* spp., *Culex malayi* (Leicester, 1908), **fuscitarsis* Barraud, 1924; *halifaxi* Theobald, 1903; *rubithoracis* Leicester, 1908; *sinensis* Theobald, 1903.

Ficalbia: minima (Theobald, 1901), *luzonensis* (Ludlow, 1905). *hybrida* (Leicester, 1908), *chamberlaini* Ludlow, 1904; *fusca* (Leicester, 1908), **metallica* (Leicester, 1908), **aurea* (Leicester, 1908), *Ficalbia* sp.

Harpagomyia genurostris (Leicester, 1908).

* New occurrence record for the country.

Mansonia: indiana Edwards, 1930; *annulifera* (Theobald, 1901), *uniformis* (Theobald, 1921), *crassipes* (Van der Wulp, 1892), *ochracea* (Theobald, 1903), **novochracea* (Barraud, 1927).

**Topomyia* spp.

Tripteroides spp.

Uranotaenia: campestris Leicester, 1908; *edwardsi* Barraud, 1926; *recondita* Edwards, 1922; *micans* Leicester, 1908; **zelena* Barraud, 1934; **trilineata* Leicester, 1908.

The following species and the genus *Topomyia* represented in the light trap collections are additions to the reported mosquito fauna of Thailand: *Topomyia* spp., *Aedeomyia catasticta* (Knab, 1909), *Aedes pallidostriatus* (Theobald, 1907), *Aedes pulchitarsis* (Rondani, 1872), *Aedes stenoetrus* (Theobald, 1907), *Aedes vallistris* Barraud, 1928; *Culex fuscitarsis* Barraud, 1924; *Ficalbia metallica* (Leicester, 1908), *Ficalbia aurea* (Leicester, 1908), *Mansonia novochracea* (Barraud, 1927), *Uranotaenia trilineata* Leicester, 1908 and *Uranotaenia zelena* Barraud, 1934.

SUMMARY. During the first year of operation of a light trap (New Jersey type) in the municipality of Chiengmai, Thailand, following one year of the expanded Thai malaria control operations using DDT residual house-spray, 28,962 mosquitoes were identified from 282 trap-night collections for the period between March, 1952–April, 1953.

Of the 18 genera and estimated 200 species of mosquitoes occurring in Thailand, 11 genera (60%) and 66 species (33%) were represented in the initial light trap collections in northern Thailand. Of these, one genus and 11 species from six genera constitute new occurrence records for the country. *Culex* spp. constituted 78 percent of the total collection: *Anopheles* spp., 18 percent. The most abundant *Anopheles* was *A. vagus* (37%), the only species collected during all the months of the year. *A. philippinensis, A. aconitus, A. nigerrimus,* and *A. sinensis* represented 58 percent of the *Anopheles*. The anophelines listed have been reported as natural or experimental vectors of malaria in countries of the Indo-Australian Region and the latter two have been reported to be vectors of filariasis in southern Thailand.

Anopheles minimus Theobald, 1901, the only known vector of malaria in northern Thailand, was not collected in trap, in house inspections, nor larval collections. Prior to malaria control measures beginning in 1951, *A. minimus* was abundant in the municipality of Chiengmai. The attractiveness of the New Jersey type light trap to this species in Thailand remains to be ascertained.

Among the most abundant *Culex* species were *C. tritaeniorhynchus, C. pipiens-quinquefasciatus,* and *C. gelidus,* vectors of Japanese B encephalitis. *Aedes vexans, Aedes albopictus,* and *Armigeres obturbans,* reported vectors of other encephalitides, were represented in the trap collections, as were *Armigeres malayi* and *A. obturbans,* vectors of filariasis in Ceylon and India. *Mansonia indiana, M. annulifera,* and *M. uniformis,* vectors of filariasis in southern Thailand, comprised 90 percent of the *Mansonia* collected. All other species collected are tabulated.

The anopheline and culicine populations increased with the progress of the rainy season (June–August) followed by a decline during the month of floods (September). The culicines continued to decline in density through the dry-cold season (November–January) while the anopheline density increased to a second and higher peak in November before a sharp decline during December and January.

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OVIPOSITION SITE PREFERENCE OF *AEDES* MOSQUITOES (CULICIDAE) IN THE LABORATORY

W. E. BECKEL [1]

INTRODUCTION. The problem of what characteristics of the substrate influence the female mosquito when she is ready to oviposit is of practical importance in the field from the point of view of where to find the eggs, and in the laboratory, in the effort to obtain the most eggs from blood-fed females. Some work has been done on where the eggs are found in the field (1, 2, 3 and 5) but this only indicates where the eggs are when the sampling is done and although there is a good chance that this represents where they were laid, the possibility of translocation by rain to a site not chosen by the adult must be considered, as pointed out by Filsinger (3). Beckel and Barlow (1) showed that *Aedes communis* (De Geer) in the field did not lay randomly around the pools; also Bodman and Gannon found this to be true of *Aedes vexans* (Meigen) (2). In both cases only speculation could be made as to what caused the discrimination. Where exactly the eggs of *Aedes hexodontus* Dyar are found in the field has not been discovered since such work presents some difficulty owing to the vast areas of damp and marshy terrain available in the sub-Arctic and Arctic in which these mosquitoes might lay. However, experiments have been carried out to find some of the things which influence the adult female in the laboratory and from this the possible influence in the field may be inferred. No attempt was made to evaluate the variation in the chemical make-up of the water. This type of approach was made with *Anopheles quadrimaculatus* Say. (6) but the results were relatively inconclusive. In the experiment to be described below, only the effects of temperature, brightness of the substrate, and its physical consistency were evaluated.

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