

TAXONOMIC CHANGES, REVISED OCCURRENCE RECORDS AND NOTES ON THE CULICIDAE OF THAILAND AND NEIGHBORING COUNTRIES.¹

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ABSTRACT. Published mosquito records for Thailand listed in the world mosquito catalog and supplements and in several recently published checklists are reviewed and revised based upon specimens deposited in the National Museum Natural History, Washington, DC, USA, and the Department of Medical Entomology, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand. A total of 410 valid species/subspecies are considered valid records for Thailand. This represents 63 more species/subspecies than listed in the world mosquito catalog and supplements, and 32 more valid species/subspecies than given in the most recent published checklist for Thailand. Numerous older species records were also re-evaluated for possible inclusion in the list. Distribution and collection data are provided for the new records, with notes on the location of the specimens. Notes and distribution extensions are also provided for 34 important or rarely collected species already known from Thailand. Five subspecies are elevated to species: *Anopheles baileyi*, *An. nilgircus*, *An. paraliae*, *Aedes greenii* and *Ae. leonis*. Three species/subspecies are synonymized: *Aedes albotaeniatus mikiranius*, *Ae. greenii kanaranus* and *Ae. hegneri*. The distributions of 8 species are restricted to specific areas outside of Thailand: *Anopheles aikenii* to India and Sri Lanka; *An. filipinae* to the Philippines; *An. nilgircus* to southern India; *Aedes aureostriatus* to eastern Indonesia and the New Guinea area; *Ae. macdougalli* to southern India and Sri Lanka; *Ae. niveus* to the Philippines; *Uranotaenia maculipleura* to Malaysia and *Ur. recondita* to southwestern India. A total of 164 references were used in decision making and are cited to assist readers.

INTRODUCTION

During the last 5 years, lists of the mosquitoes occurring in certain regions (Miyagi et al. 1986) or all of Thailand (Apiwathnasorn 1986, Tsukamoto et al. 1987) have been published. Tsukamoto et al. (1987) recorded 377 valid species or subspecies and 7 unnamed species in Thailand, which represents a 48.3% increase over the 259 species reported 31 years ago (Thurman 1959), and roughly 12 % of the world mosquito fauna (Knight and Stone 1977, Knight 1978a, Ward 1984, Gaffigan and Ward 1985). This large concentration of species occurs in an area extending between 6° and 21°N latitude, that is roughly 1,600 km long and approximately the same size as the state of California in the United States. Such an abundance of mosquito species is almost certainly due to concentrated collection efforts and to the unique geographic location of Thailand in Asia. Mosquitoes originating from at least 5 separate zoogeographic elements or origins may be found in Thailand, i.e., (1) endemic, (2) Indian, (3) Chinese, (4) Malay-Indonesian, and (5) species introduced by man. Tsukamoto et al. (1987) list 54 species (14.1 %) as endemic members

of the Thailand fauna. Representatives of the other zoogeographic elements have not been categorized except for the *Anopheles* (*Anopheles*) (Harrison and Scanlon 1975), and the relationships between the Thailand, Philippine and Japanese faunas (Tsukamoto et al. 1987).

Regardless of the current size of the Thailand mosquito fauna, many additional species remain undiscovered. Nearly every collection trip conducted by the Department of Medical Entomology, Armed Forces Research Institute of Medical Sciences (AFRIMS), Bangkok, produces new country records and/or new species. Many of these records have remained unpublished for years. This paper reports: (1) confirmed new country records for species based on collections prior to 1982; (2) recently described new species; (3) additional information regarding species recently detected and recorded in published literature; (4) notes, changes and/or new distribution records for certain uncommon or important species; and (5) comments/corrections for certain records in the lists of Apiwathnasorn (1986), Miyagi et al. (1986) and Tsukamoto et al. (1987).

MATERIALS AND METHODS

The collection of mosquito immature stages is the primary method used by AFRIMS personnel during bio-systematic field surveys in Thailand. A majority of collected larvae and pupae are reared to adults and the associated 4th instar larval and pupal exuviae are preserved for study along with the adult. Any remaining immatures are preserved for slide preparation. Less frequently, biting or landing collections are made with

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selected females subsequently isolated for oviposition and production of progeny broods. Every effort is made to rear and identify specimens during the field surveys rather than after the trips. This enables the systematists to locate the precise habitat(s) of uncommon species and to collect additional specimens. After the field surveys, curated specimens are sorted and retained in the Department of Medical Entomology (AFRIMS) collection, or sent to the Walter Reed Biosystematic Unit (WRBU) for deposit in the National Museum of Natural History (NMNH) collections at the Museum Support Center, Smithsonian Institution, Washington, DC. Detailed collection records are maintained by both organizations with the specimens to provide precise collection and habitat data. Persons interested in additional biological and collection data for species listed herein should base their requests on any collection numbers provided here.

Records and information for species reported in this publication are grouped into 5 sections, as outlined in the introduction. New distribution records are based on all available specimens (including the exuviae of larvae and pupae) and were confirmed by comparison with voucher specimens from the world mosquito collection in the NMNH. Many of our new records are from the unpublished identifications and records of Dr. K.L. Knight, who studied the *Aedes (Finlaya)* of Southeast Asia for over 25 years. The specimens and Dr. Knight's notes from that study are located at the NMNH, and he has kindly consented to their use in this paper. In a few cases, the specimens responsible for records are no longer available for examination, however, we are confident in the identifications entered into the collection records for those species.

The generic and subgeneric abbreviations used are those of Reinert (1975, 1982). Abbreviations used for the immature stages and exuviae are: pupal exuviae (Pe), larval exuviae (Le), pupa (P) and larva (L).

The world mosquito catalog of Knight and Stone (1977) and supplements (Knight 1978a, Ward 1984, Gaffigan and Ward 1985) served as the basis for the taxonomic nomenclature and sequence used here. Abbreviated subgeneric names have been included to assist the reader in following the sequence in the catalog and supplements. Varietal names published prior to 1961 have been corrected to subspecies per article 45g of the International Code of Zoological Nomenclature (1985). Distribution records for species included in the world mosquito catalog and supplements were considered of secondary importance and recognized by those authors as incomplete due to the lack of voucher specimens in recognized depositories. Consequently, certain records of species in Thailand were not included in the catalog and supplements, as noted by Tsukamoto et al. (1987). In this publication we have cautiously evaluated certain older species records (in the absence of Thailand specimens) for accuracy of identifica-

tion. The evaluations were based on general mosquito knowledge available to the original author(s) at the time the record was established, the recognized distributions of species at present, and the tremendous increase in the number of recognized mosquito species since the records were established.

RESULTS

I. Confirmed new occurrence records for species in Thailand.

There are 18 previously described species/subspecies that we recognize here as new to the Thailand fauna: *Anopheles (Ano.) lindesayi cameronensis* Edwards, *Aedes (Dic.) franciscoi* Mattingly, *Aedes (Fin.) ganapathi* Colless, *Aedes (Fin.) inermis* Colless, *Aedes (Fin.) jugraensis* (Leicester), *Aedes (Fin.) leonis* Colless, *Aedes (Fin.) lophoventralis* (Theobald), *Aedes (Fin.) novoniveus* Barraud, *Aedes (Fin.) pexus* Colless, *Aedes (Fin.) pseudoniveus* (Theobald), *Aedes (Fin.) subniveus* Edwards, *Aedes (Fin.) unicinctus* Edwards, *Aedes (Fin.) vanus* Colless, *Heizmannia (Mat.) catesi* Lien, *Uranotaenia (Ura.) hebes* Barraud, *Uranotaenia (Ura.) macfarlanei* Edwards, *Uranotaenia (Ura.) micans* Leicester, and *Uranotaenia (Ura.) subnormalis* Martini. More specific taxonomic and collection data are presented below.

1. *Anopheles (Anopheles) lindesayi cameronensis* Edwards. There are no previous records of members of the Lindesayi Complex from Thailand. Reid (1968), the last major reviewer of *An. lindesayi sensu lato* recognized 6 subspecies and one closely related species distributed as follows: *lindesayi* Giles (northern India), *l. benguetensis* King (Philippines), *l. cameronensis* Edwards (peninsular Malaysia), *l. japonicus* Yamada (Japan, Korea and People's Republic of China), *l. nilgircus* Christophers (southern India), *l. pleccau* Koidzumi (Taiwan), and *An. wellingtonianus* Alcock (peninsular Malaysia). Ma (1981) described a new species, *An. menglangensis*, from Yunnan Province, People's Republic of China, that is very similar to *wellingtonianus*. We consider both *menglangensis* and *wellingtonianus* to be members of the Lindesayi Complex, as Reid (1968) considered *wellingtonianus* identical to *l. cameronensis* except for 2 adult characters.

Anopheles lindesayi sensu stricto is recorded across northern India to the Khasi and Jaintai Hills in Meghalaya (Christophers 1933) and Manipur (Mortimer 1946), the northern part of the Union of Myanmar (= Burma) (Khin-Maung-Kyi 1971), Yunnan Province in the People's Republic of China (Robertson 1940, 1941) to the mountainous upper reaches of the Red River in Vietnam (Toumanoff 1933). *Anopheles l. cameronensis* and *wellingtonianus* are known only from the mountainous central highlands of peninsular Malaysia. Thailand is between the Union of Myanmar and peninsular Malaysia, thus, the presence of a

member of the *Lindesayi* Complex in Thailand should be expected.

In 1978, 4 collections of a member of the *Lindesayi* Complex were made on the tallest mountain in Thailand, Doi Inthanon, Chiang Mai Province. Two of these collections also contained members of the Gigas Complex (see p. 208-209). In 1981, an additional 16 collections were made of *lindesayi sensu lato* on Doi Inthanon, including 2 with the member of the Gigas Complex. The elevations for the *An. lindesayi sensu lato* collections ranged from 1,270 to 2,540 m. A total of 468 specimens (1♂, 8♀, 8Pe, 34Le, 28P and 389L) were examined. Chiang Mai, Chom Tong District, Doi Inthanon, collection 07892, 4 July 1978, seepage bog, 2,540 m, just below radar station, (20L); collection 07893, 4 July 1978, seepage bog, 2,540 m, just below radar station, (1Le, 1P, 33L); collection 07894, 4 July 1978, seepage bog, 2,540 m, just below radar station, (4♀, 4Pe, 9Le, 5P, 60L); collection 07895, 4 July 1978, seepage bog, 2,540 m, just below radar station, (13L); collection 07896, 4 July 1978, seepage bog, 2,540 m, just below radar station, (1♂, 1♀, 2Pe, 2Le, 20L); collection 07906, 7 July 1978, flood pool, 1,535 m, (1L); collection 08390, 21 April 1981, stream pools below seepage bog, 2,540 m, (1Le, 1P, 13L); collection 08391, 21 April 1981, stream pools below seepage bog, 2,540 m, (1Le, 1P, 33L); collection 08396, 23 April 1981, stream margin below seepage bog, 2,530 m, (1Le, 1P, 1L); collection 08399, 23 April 1981, marshy bog beside water unit for radar station, 2,530 m, (3L); collection 08400, 23 April 1981, stream pool on right side of road going up, between km 43 - km 44 signposts, 2,314 m, (3Le, 3P, 28L); collection 08401, rest the same as 08400, (7L); collection 08402, 23 April 1981, stream margin and pockets with dead leaves, rest the same as 08400, (4Le, 4P, 9L); collection 08403, 23 April 1981, stream margin, rest the same as 08400, (9Le, 9P, 18L); collection 08404, 23 April 1981, seepage pool beside stream, rest the same as 08400, (24L); collection 08405, 23 April 1981, stream bog, 1,633 m, beside road up Doi Inthanon, between km 36 - km 37 signposts, just before junction for road going to Mae Chaem, (28L); collection 08406, rest the same as 08405, (4L); collection 08408, rest the same as 08405, (1Le, 2P, 4L); collection 08421, 24 April 1981, buffalo footprints in seepage bog, 1,270 m, (1L); collection 08444, 27 April 1981, stream pool beside road, rest the same as 08405, (1♀, 1Pe, 1Le); collection 08447, 28 April 1981, stream margin, beside road between km 41 - km 42, 2,100 m, (13L); collection 08448, rest the same as 08447, (1♀, 16L); collection 08449, rest the same as 08447, (13L); collection 08450, rest the same as 08447, (1♀, 1Pe, 1Le, 1P, 25L); collection 08452, 28 April 1981, rest the same as 08447 except 1,960 m, (2L).

The immature habitat for *lindesayi cameronensis* in Thailand essentially is identical to that used by all members of the *Lindesayi* Complex, i.e., cold clear water in bogs, marshes, stream pools, seeps, etc., at high elevations.

This species was found in association with the following species: *Anopheles* (*Ano.*) *baileyi* Edwards, *An.* (*Ano.*) *bengalensis* Puri, *An.* (*Cel.*) *aconitus* Doenitz, *An.* (*Cel.*) *maculatus sensu lato*, *An.* (*Cel.*) *splendidus* Koidzumi, *Culex* (*Cui.*) *sasai* Kano, Nitahara and Awaya, *Cx.* (*Cui.*) sp., *Cx.* (*Cux.*) *edwardsi* Barraud, *Cx.* (*Cux.*) *fuscocephala* Theobald, *Cx.* (*Cux.*) *jacksoni* Edwards, *Cx.* (*Cux.*) *mimeticus* Noe, *Cx.* (*Cux.*) *mimulus* Edwards, *Cx.* (*Cux.*) *whitei* Barraud, *Cx.* (*Eum.*) *oresbius* Harbach and Rattananarithkul, *Cx.* (*Lop.*) *aculeatus* Colless, and *Uranotaenia* (*Ura.*) sp. The live *lindesayi* larvae were easily separated from the *baileyi* larvae, as the latter were unicolorous gray-brown, while the former were banded with the head and segments 5 and 10 pale yellow and the rest of the body dark brown. Rearing these larvae proved extremely difficult, as reported by Reid (1968). Even though the rearing facilities were at 1,270 m elevation and cold rain water was used, few specimens survived the pupal stage. However, in the natural habitats *lindesayi cameronensis* was much more abundant and widely distributed on Doi Inthanon than *baileyi*.

The specimens (adults, pupae and larvae) from Doi Inthanon clearly show more similarity to *l. cameronensis*. There are minor differences between the Thai and Malaysian specimens, but they are not sufficient to recognize, without further study, the Thai specimens as distinct. Accordingly, we have decided to call it subspecies *cameronensis*.

The previously mentioned records of *lindesayi* from Meghalaya and Manipur (India), Union of Myanmar, Yunnan Province (People's Republic of China) and Vietnam did not specify the subspecies involved. Therefore, we cannot be certain that they were referring to *lindesayi* Giles. In fact, Kalaw (southern Shan State) in the Union of Myanmar (Khin-Maung-Kyi 1971) is the nearest record of "*lindesayi*" to Doi Inthanon. These 2 sites are only approximately 290 km apart, compared to 1,600 km apart for Doi Inthanon and the *l. cameronensis* sites in Malaysia. Thus, the "*lindesayi*" specimens upon which the eastern Indian, Union of Myanmar and southern China records were based may have been more similar to the Thai and Malaysian subspecies than the nominotypical subspecies. An examination of 3 specimens in the NMNH from Vietnam, collected by Toumanoff, revealed they are closer to *l. pleccaui*.

Ma and Xu (1983), following Tanaka et al. (1979), were unable to differentiate *l. japonicus* from *l. pleccaui*, and recommended that they be called "*lindesayi*". If synonymy is involved in this situation, *japonicus* is the senior synonym. The other 4 subspecies, viz., *l. lindesayi*, *l. cameronensis*, *l. benguetensis* and *l. nilgircus* are readily identified by morphology as well as their distributions. In fact, based on an examination and comparison of the various life stages of these subspecies and their type specimens in the Natural History Museum (NHM), London, we are

here elevating *nilgircus* Christophers to species status. Recently, Darsie and Pradhan (1990) reported *nilgircus* (as a subspecies of *lindesayi*) from Nepal. Previous authorities (Christophers 1933, Ramachandra Rao 1984) considered *nilgircus* as restricted to southern India. Based on specimens examined we concur with the southern India distribution and cannot accept the Nepal record. *Anopheles nilgircus* is a southern Indian (not Sri Lankan) species that is readily differentiated from the other members of the *Lindesayi* Complex by a substantial number of adult, pupal and larval characters.

The members of the *Lindesayi* Complex exhibit nearly all of the attributes of a superspecies, i.e., a monophyletic group of closely related and largely or entirely allopatric species (Mayr 1969:52). We suspect that with additional study the current subspecies of *lindesayi* will prove to be full species. At this time, however, *lindesayi cameronensis* should be added to the list of *Anopheles* in Thailand, and *nilgircus* should be listed as a species in the world catalog.

2. *Aedes (Diceromyia) franciscoi* Mattingly. Mattingly (1959) described this species based on 2 specimens from Kampong Sireh, Selangor, Malaysia (holotype) and P. Blakang Mati, Singapore (paratype). Reinert (1970) redescribed *franciscoi* and discussed an additional 8 adults (7 with larval and pupal exuviae) from Ratau Panjang, Selangor, Malaysia. There is a single female of *franciscoi* from Thailand in the NMNH with the following data: Surat Thani Province, Ko Samui, Wat Sammut Song, Collection 03424-106, 2 January 1969, 70 m, Kol and team. This specimen was reared from a bamboo cup set in a orchard plantation.

3. *Aedes (Finlaya) ganapathi* Colless. This species was described by Colless (1958) based on specimens from Pahang, Malaysia and additional specimens seen from Selangor, Malaysia. Since then *ganapathi* has been considered confined to Malaysia, although Gould et al. (1968) reported specimens of a species near *ganapathi* from Surat Thani Province in southern Thailand. There are specimens of *ganapathi* identified by K.L. Knight in the NMNH from the following provinces of Thailand: Chumphon, Surat Thani and Trat. The last province is in southeastern Thailand and is far removed from the other 2 southern provinces. Trat Province is adjacent to Kampuchea, suggesting the possible extension of *ganapathi* into that country. Colless (1958) suggested that *ganapathi* might be a coastal species, and the 3 collection sites in Thailand are either coastal or insular.

4. *Aedes (Fin.) inermis* Colless. Colless (1958) described this species from Singapore specimens, and reported additional specimens from Selangor and Pahang states, peninsular Malaysia. There are specimens of *inermis* identified by K.L. Knight in the NMNH from the following provinces of Thailand: Chiang Mai, Nakhon Nayok, Nakhon Ratchasima, Narathiwat, Ranong and Trang.

5. *Aedes (Fin.) jugraensis* (Leicester). This species was described from Jugra, Selangor, Malaysia by Leicester (1908). Knight (1968) redescribed this species and listed specimens seen from Indonesia (Java), Malaysia (Perak, Sabah and Selangor), the Philippines (Balabac Island) and Singapore. There are 7 males and 7 females of *jugraensis* with associated larval and pupal exuviae from Ranong Province, Thailand, in the NMNH. These specimens (collections 02156 and 02165, 18 July 1967) came from bamboo internodes. This species is easily recognized from the other members of the *Chrysolineatus* Group by the scutal acrostichal row of golden scales not forking just anterior to the prescutellar space, but extending posteriorly across the prescutellar space as a median golden scale row to the scutellum.

6. *Aedes (Fin.) leonis* Colless. Previously, *leonis* has been considered a subspecies of *Ae. niveus* (Ludlow) known only from Malaysia and Singapore, as described by Colless (1958). Colless considered *leonis* to be the "local representative of *Ae. niveus*, closely resembling the Philippine type form in most features of its morphology." We are here elevating *leonis* to species status and agree with the comment by Colless. There are specimens of *leonis* identified by K.L. Knight in the NMNH from the following provinces of Thailand: Chumphon, Nakhon Nayok, Ranong, Surat Thani and Trang. K.L. Knight's unpublished study of the *Niveus* Group revealed that *Ae. niveus sensu stricto* does not occur in Thailand.

7. *Aedes (Fin.) lophoventralis* (Theobald). Knight and Stone (1977) recorded this species from India and Pakistan. However, the Pakistan listing is an oversight as the source for this was Barraud (1934), who listed "Eastern Bengal (Chittagong)," now Bangladesh. There are 3 specimens of *lophoventralis* in the NMNH from Thailand. These specimens (2♀, 1♂) were collected in Phra Phutthabat, Sara Buri Province in central Thailand in 1962. These specimens key easily to *lophoventralis* based on the restriction of sternal scale tufts to sterna V-VII and the unusual character of broad white scales completely covering the entire scutellum, and not localized to the 3 lobes as on related species. There are also several specimens of *lophoventralis* in the NMNH from Vietnam.

8. *Aedes (Fin.) novoniveus* Barraud. This species was described from the Darjeeling District, West Bengal, India, by Barraud (1934). Colless (1959) redescribed *novoniveus* and reported specimens from Pahang (Fraser's Hill) and Selangor, Malaysia, as well as the records from Assam, Meghalaya and West Bengal (Barraud 1934). There are specimens of *novoniveus* identified by K.L. Knight in the NMNH from the following provinces of Thailand: Chiang Mai, Chon Buri, Lampang, Nakhon Nayok, Nakhon Si Thammarat and Ranong.

9. *Aedes (Fin.) pexus* Colless. Colless (1958) described *pevus* based on specimens from Sabah and Sarawak, Malaysia, and Singapore (holotype). There are specimens of

pexus identified by K.L. Knight in the NMNH from the following provinces in Thailand: Chiang Mai, Nakhon Nayok and Nakhon Ratchasima.

10. *Aedes* (Fin.) *pseudoniveus* (Theobald). Theobald (1905) described *pseudoniveus* from a female collected in Singapore. Colless (1959) redescribed this species and reported specimens from Sabah and Selangor, Malaysia and Singapore. There are specimens of *pseudoniveus* identified by K.L. Knight in the NMNH from Lampang and Ranong provinces, Thailand.

11. *Aedes* (Fin.) *subniveus* Edwards. This species was described by Edwards (1922a) based on females from Sarawak, Malaysia (holotype) and Singapore. Barraud (1934) considered *subniveus* a synonym of *Ae. pseudoniveus*, however, Colless (1959) elevated *subniveus* to species status based on the lack of evidence to confirm its synonymy with *pseudoniveus*. There are immature specimens of *subniveus* from Thailand in the NMNH with the following collection data: Trang Province, Muang District, collection TG-13, 7 October 1964, tree hole, (1Pe, 1Le); collection TG-42, 8 October 1964, tree hole, (1L). The reality of a jungle cycle of dengue virus in Malaysia (Knudsen 1977) and that *subniveus* is probably the mosquito vector in that jungle cycle (Rudnick et al. 1986) suggests that more interest and research should be considered for *subniveus* in Thailand.

12. *Aedes* (Fin.) *unicinctus* Edwards. Edwards (1922a) described this species from the western Himalayan locality of Simla, Himachal Pradesh, India, based on a male reared from a tree hole collection. Barraud (1934) described the larva and added eastern Himalayan records from Kurseong, West Bengal, India. There are 18 specimens (3♂, 4♀, 9Pe and 2Le) of *unicinctus* in the NMNH from Thailand. These specimens have the following data: Chanthaburi Province, Khao Sai Dao, collection 00873, 15 March 1966, root hole, 1,300 m, (2♀, 3Pe, 2Le); collection 00874, 15 March 1966, tree hole, 1,300 m, (1♂, 2♀, 4Pe); collection 00880, 15 March 1966, tree hole, 1,300 m, (1♂, 1Pe); collection 00892, 17 March 1966, tree hole, 1,450 m, (1♂); collection 00897, 17 March 1966, tree hole, 1,633 m, (1Pe). The discovery of these specimens in southeastern Thailand on the third highest mountain in the country suggests that *unicinctus* should be found on the mountains in northern Thailand. The *unicinctus* specimens found on Khao Sai [Soi] Dao apparently represent an isolated population existing in a high elevation - primary forest refugium. The Thailand specimens of *unicinctus* agree well with the Himalayan specimens, except that the scutal pale scales are silver-white instead of pale yellow. The larval characters are very similar to those described by Barraud (1934). The pupa has not been described previously, but appears unique in the *Aedes* (Fin.) because seta 1-I is fan-like with only 8 - 10 lightly aciculate branches (setae on 9 pupae counted). *Aedes* (Fin.) *reinerti* Rattanakrithikul and Harrison pupae have only 4 - 12 basal branches, but each branch is aciculate - dendritic beyond the base.

13. *Aedes* (Fin.) *vanus* Colless. This species was described from Singapore by Colless (1958). Colless also mentioned a questionable specimen from Selangor, Malaysia. Specimens from Ulu Langat, Selangor, Malaysia were collected by Rudnick et al. (1986) and confirmed by K.L. Knight. There are also specimens of *vanus* identified by K.L. Knight in the NMNH from the following provinces of Thailand: Kanchanaburi, Nakhon Nayok, Nakhon Ratchasima and Trat.

14. *Heizmannia* (Mattinglyia) *catesi* Lien. This species was described by Lien (1968) and used as the type by original designation for a new genus, *Mattinglyia* Lien. Subsequently, Mattingly (1970) reduced this genus to a subgenus of *Heizmannia* Ludlow, and noted that *catesi* was recorded only from Taiwan. During filariasis studies in the mid-1970s Gould et al. (1982) reported on numerous biting collections of forest mosquitoes made in Sangkhlaburi District, Kanchanaburi Province. Two females from that study that are deposited in the NMNH collection clearly key to *catesi*. Both females fit the description of *catesi* very closely, except that one (07370) has an alveolus (seta missing) on the lower mesepimeron, which Mattingly (1970) indicated is not present on *catesi*. We feel this seta is an anomaly on this specimen as the other female has no evidence of a seta (or alveolus) on the lower mesepimeron. These 2 females do not fit the descriptions of *H. achaetae* (Leicester) and *H. thelmae* Mattingly, which also occur in Thailand, or *H. discrepans* (Edwards) and *H. tripunctata* (Theobald) from India which were placed in subgenus *Mattinglyia* by Reinert (1973a). Support for *catesi* to occur in Thailand comes from Mattingly (1970) who reported that 3 other *Heizmannia* species described by Lien (1968), and previously known only from Taiwan, occurred in Thailand, viz., *chengi* Lien, *macdonaldi* Mattingly (=syn. *nivirostris* Lien) and *reidi* Mattingly (=syn. *cheni* Lien). The collection data for the *catesi* specimens are: Kanchanaburi Province, Sangkhlaburi District, Ban La Wa, collection 07295, 24 October 1974, biting man in bamboo grove, 1430-1751 h, 160 m, (1♀); Ban Nong Plang Khong, collection 07370, 3 November 1974, biting man in bamboo grove, 1400-1530 h, 160 m, (1♀).

15. *Uranotaenia* (Uranotaenia) *hebes* Barraud. An examination of the Thurman collection and other Thai specimens in the NMNH mosquito collection revealed 17 specimens of this species (6♂, 1♂ genitalia, 2♀, 2Pe, 3Le, 3L). Collection data for these specimens follows. Chiang Mai: Doi Suthep, collection T1092, 19 March 1962, stream pool, (1♀); collection T1307, 5 June 1962, resting in forest, (1♂); collection T1162, 30 April 1962, elephant footprint, (1Le, 1L); collection M416, 15 January 1953, pond deep in valley woods, elevation 1,067 m, (2L); collection 405, 7 January 1953, resting on tree, (1 slide with ♂ genitalia, adult lost); collection 423, 15 January 1953, resting on tree, (1♂); collection 462, 5 February 1953, (2♂); collection 05568, 10 December 1969, stream pool, 640 m, (1♂, 1♀, 2Pe, 1Le). Chanthaburi: Khao Sai [Soi] Dao Tai, collec-

tion 00886, 16 March 1966, seepage pool, 1,100 m, (1♂, 1Le). The male genitalia slide (collection 405) from Doi Suthep was incorrectly labeled as *Ur. stricklandi* Barraud by Thurman. In addition, the 2 larvae in collection M416 were incorrectly labeled as *recondita* Edwards by Thurman.

16. *Uranotaenia (Ura.) macfarlanei* Edwards. This species has on occasion been misidentified in Thailand as *Ur. campestris* Leicester, or as *Ur. campestris* var. *zelena* Barraud. An examination of the type specimens of *macfarlanei*, *campestris* and var. *zelena* in the NHM [= BM(NH)] by Peyton (1972) showed that *macfarlanei* and *campestris* var. *zelena* were conspecific, with *macfarlanei* being the senior synonym. Although Knight and Stone (1977) record the synonymy of Peyton (1972), they erred in listing var. *zelena* in bold type instead of italics indicating synonymy. The entry in the list of mosquitoes for Thailand should be *macfarlanei* Edwards. *Uranotaenia macfarlanei* is one of the most common and widely distributed species in Thailand. It is represented in the NMNH and AFRIMS files by 176 separate collections (5 adult and 171 immature) with 175 males, 176 females and slide mounts of 256Pe, 92Le and 191L. It is known from 22 provinces of Thailand, including one or more border provinces in the south, northeast, southeast and west.

17. *Uranotaenia (Ura.) micans* Leicester. There is no question of the identity of this species in Thailand. We have examined the type specimens of *micans* and *Ur. bimaculiala* Leicester in the NHM for comparison with Thailand specimens. We here confirm the identification of *bimaculiala* in southern Thailand reported by Iyengar and Menon (1956) through the examination of their specimens (5♀, Nakhon Si Thammarat, Tha Rua, 13 January 1952, *Nipa* marsh) deposited in the NHM. Apparently these were misidentified as *micans* by Iyengar (1953). We also confirm the identification of *micans* by Thurman and Thurman (1955) based on the Thurman specimens (collections MLT 121 and MLT 126) from Chiang Mai that are in the NMNH. Ninety-five specimens (26♂, 54♀, 12Pe, 3Le) of *Ur. micans* were examined, and have the following collection data. Chiang Mai: Chang Kien, collection T1877, 2 November 1962, captured resting, (1♀); collection T1485, 14 August 1962, captured resting, (1♀); Chiang Mai, collection MLT 121, 27 October 1952, light trap, (2♂, 3♀); collection MLT 126, light trap, (1♂, 1♀). Chon Buri: Khao Mai Kheo, collection CL 25, 9 October 1963, captured resting, (1♀), Siricha; collection 800, 3 December 1957, biting man (2400-0100), (1♀). Narathiwat: Khok Kien, collection NV 60, 18 January 1965, coastal *Nipa* swamp, (2♂, 5♀, 11Pe, 3Le). Phra Nakhon: Bangkok, collection 10893, 17 November 1962, light trap, sea level, (1♀); collection 10421, 1962, light trap, sea level, (1♀); collection 6993, 6 July 1963, light trap, sea level, (1♀); collection LT-1-24, 1955, light trap, sea level, (10♂, 33♀); November-December 1954, light trap, (5♂, 3♀). Phuket: Ban Bora; collection 02550, 1 March 1968, swamp, 15 m, (1♂,

1Pe). Sara Buri: Ban Pukae, 10 April 1970, resting in crab hole, 30 m, (1♀). Udon Thani: collection T5275, 30 July 1963, light trap, (2♂, 1♀); collection T5286, 13 August 1963, light trap, (3♂). For counting purposes in the Appendix, we consider *micans* to be the same as "sp. 1 (near *micans*)" of Miyagi et al. (1986) and Tsukamoto et al. (1987).

18. *Uranotaenia (Ura.) subnormalis* Martini. Five specimens (1♂, 3♀, 1Le) of this species were found in the NMNH with the following collection data. Chanthaburi: Ban Bo Phu, collection 00559, 26 October 1965, Shannon trap, 20 m, (2♀). Narathiwat: Bue Mang, collection NV39, 16 January 1965, spring fed bog, (1♂, 1Le). Trat: Ko Chang, Khao Yai Yai, 12 December 1967, resting on vegetation, 240 m, (1♀).

II. Recently described new species from Thailand.

Since Tsukamoto et al. (1987), 5 new species have been described with their type localities in Thailand. These species and their distributions follow.

1. *Anopheles (Cellia) nemophilous* was described by Peyton and Ramalingam (1988). This species is the formal recognition for the taxon previously called "Frasers Hill Form" of *balabacensis* of many authors. The type locality for *nemophilous* is in Phangnga Province in southern Thailand. This species has been collected in the following widely distributed provinces of Thailand: Chanthaburi, Chon Buri, Kanchanaburi, Nakhon Nayok, Nakhon Si Thammarat, Phangnga, Ranong, Songkhla and Tak.

2. *Aedes (Fin.) mikrokopion* was described by Knight and Harrison (1988). This species had been recognized in the adult stage for years, but adults associated with larval and pupal exuviae did not become available until the Gould et al. (1982) filariasis studies in western Thailand. The type locality for *mikrokopion* is in Kanchanaburi Province and additional collections were made in the following provinces: Nakhon Nayok, Narathiwat, Phangnga and Ranong. Specimens of this species were also examined from the states of Pahang, Perak, Perlis and Selangor, Malaysia.

3. *Aedes (Fin.) reinerti* was described by Rattanakul and Harrison (1988) from specimens collected on 4 mountains in Chiang Mai Province. This species is very similar to *Ae. formosensis* Yamada, but can be differentiated in the adult, pupal and larval stages. *Aedes reinerti* is known only from Chiang Mai Province, and the type locality is on Doi Inthanon, the tallest mountain in Thailand.

4. *Culex (Eumelanomyia) oresbius* was described by Harbach and Rattanakul (1988) from specimens collected on Doi Inthanon, Chiang Mai Province. The records of *Cx. macrostylus* Sirivanakarn and Ramalingam from Doi Inthanon by Miyagi et al. (1986) and Tsukamoto et al. (1987) actually refer to this species. *Culex macrostylus* is not found in Thailand and currently is restricted to peninsular Malaysia. *Culex oresbius* is known only from the type locality on Doi Inthanon.

5. *Topomyia* (*Suaymyia*) *suchariti* was described by Miyagi and Toma (1989). The larva of this rare species was found in an erect green bamboo internode with a small hole made by a beetle. The type locality is in Trak Nong (Khao Makok) National Park, Chanthaburi Province, in southeastern Thailand.

III. Additional information on species recently detected and published from Thailand.

During the last 8 years several records of species in Thailand have been published which do not appear in Apiwathnasorn (1986), Miyagi et al. (1986) and Tsukamoto et al. (1987), or these records were published since these authors. Comments regarding these species follow.

1. *Anopheles* (*Cel.*) *leucosphyrus* A. The only references to *leucosphyrus* in Thailand that can be confirmed as referring to the *Leucosphyrus* Complex are Baimai et al. (1988b) and Peyton and Ramalingam (1988). Both of these are based upon the collections reported here for the first time. Baimai et al. (1988b) determined through cytogenetic and crossing studies that there were 2 allopatric species involved in the present concept of *leucosphyrus*, which they designated *leucosphyrus* A and B. The letter A was applied to the *leucosphyrus* species found in southern peninsular Thailand, Malaysia, and Kalimantan, Indonesia. The letter B was applied to *leucosphyrus sensu stricto* found in Sumatra, Indonesia. These 2 species, along with *An. balabacensis* Baisas and *An. introlatus* Colless, belong to the *Leucosphyrus* Complex of the *Leucosphyrus* Subgroup in the classification scheme of Peyton (1990). From available evidence it is clear that *leucosphyrus* A does not extend northward into Thailand beyond 11°N, and consequently any previous report of this species north of this line almost certainly would pertain to one of the members of the *Dirus* Complex, of which 4 are known to occur above 11°N in Thailand.

Considerable confusion continues to surround the earlier records of *leucosphyrus* in Thailand. Since this species is a known vector of human malaria parasites in other parts of Southeast Asia, we believe it is important to clarify its status in Thailand. Many of the early records of "*leucosphyrus*" are difficult to interpret because prior to Colless (1956, 1957) everything reported from Thailand and countries to the north, east and west of Thailand was considered to be *leucosphyrus*. We now know that these reports could have referred to any of 10 species in the *Leucosphyrus* Group that have since been documented from Thailand (e.g., *dirus* Peyton and Harrison, *dirus* species B to D, *hackeri* Edwards, *introlatus* Colless, *leucosphyrus* A, *macarthuri* Colless, *nemophilous* Peyton and Ramalingam and *pujutensis* Colless. Following Colless (1956, 1957) it was possible to make clear distinctions between all species, except those treated as "*balabacensis*," which in Thailand we now know represent the *Dirus* Complex of the *Leuco-*

sphyrus Subgroup (Peyton and Ramalingam 1988, Peyton 1990) with at least 7 species, of which 5 are found in Thailand. Fortunately, all of the latter are rather easily sorted out because a large number of voucher specimens were preserved in various agencies or museums and were available to us for study. In addition, there are a few scattered specimens from earlier collections, and all of these, combined with recent studies, provide a more complete understanding of the distribution of each of the 10 species within the country. They also help to further sort out early records. It has been amply documented that *balabacensis* does not occur on the mainland of Southeast Asia (Peyton and Harrison 1979, 1980; Peyton and Ramalingam 1988; Peyton 1990).

We have examined and confirmed 201 specimens of *leucosphyrus* A (30♂, 48♀, 57Pe, 45Le, 21L) in the NMNH from Thailand, with the following collection data: Chumphon: Pathiu, Ban Chong Mut #3, collection 08003, 13 Sept 78, biting man, 120 m, (2♀); Pathiu, Ban Chong Mut #3, collection 08007(3), 18 September 1978, biting man, 120 m, (1♂, 1♀ parent, 1Pe, 1Le, progeny); collection 08007, same data, (5♀); Nakhon Si Thammarat: Tung Song, Tambon Nam Tok, collection TS39 (F2), 1985, biting man, (3♂, 1♀, 5Pe, 5Le, 3L, progeny); collection TS104, June 1985, biting man, (3♂, 3Pe, 3Le, progeny); collection TS301, 10 November 1986, biting man, (1♂, 4♀, 5Pe, 5Le, progeny); Tung Yai, Ban Tham Phae Dan, collection TY001, 3-8 December 1985, biting man, (2♂, 2♀, 4Pe, 3Le, progeny); collection TY14, December 1985, biting man, (1♀); collection TY26, December 1985, biting man, (1♀); collection TY23, December 1985, biting man, (1Pe, 1Le, progeny). Narathiwat: Waeng, Collection NV80, 12 February 1965, elephant footprint, (2♂, 1Pe, 1Le); collection NV97, 2 March 1965, pool at margin of stream (2♀, 1Pe, 1Le); Waeng, Khau Lau, collection 00445, 7 September 1965, elephant footprint, 75 m, (1♀); collection 00446, 7 September 1965, elephant footprints (3), 75 m, (2♂, 2♀, 4Pe, 2Le); collection 00447, 7 September 1965, elephant footprints (6), 76 m, (3♀, 1Pe); collection 00451, 8 September 1965, stream pool, 150 m, (1L); collection 00465, 8 September 1965, elephant footprint, 150 m, (1♂, 1Pe); collection 00473, 9 September 1965, flood pool, 230 m, (3♂, 2Pe, 1Le, 12L). Phangnga: Ban Bang Kaeo, collection 08161, 25 May 1980, sandy pool, bank of stream, 400 m, (9♂, 6♀, 16Pe, 12Le); collection 08162, 25 May 1980, very small, shallow, running stream, 400 m, (2♂, 3♀, 6Pe, 5Le, 1L); collection 08163, 25 May 1980, biting man, 400 m, (1♀); collection 08167, 26 May 1980, elephant footprint, 520 m (1L); collection 08190, 29 May 1980, biting man, 300 m, (1♀); collection 08197, 30 May 1980, biting man, 400 m, (1♀); collection 08204, 31 May 1980, biting man, 400 m, (3♀); collection 08212, 2 June 1980, biting man, 400 m, (2♀); collection 08223, 4 June 1980, biting man, 520 m, (2♀); Ban Bang Ra Ko, collection 08167, 26 May 1980, elephant footprint, 520 m, (1L). Satun: Klaung Baraket,

Collection 00527, 20 September 1965, seepage pool, 76 m (1L). **Songkhla:** Sadao, Padang Besar, collection PB53, 12 December 1986, biting man, (1♂, 4♀, 5Pe, 4Le, 2L, progeny, cytotyped, species A). **Yala:** Kampong Baraket, 20 September 1965, seepage pool, 76 m, (1L).

The specimens from collections listed above from the provinces of Narathiwat and Yala during 1965 were not recognized as *leucosphyrus* when first collected and reported by Scanlon et al. (1967). On the contrary, these specimens were confused with specimens of *An. introlatus* which were present in some of the same collections. In the 1967 report it was stated: "...several collections from the Waeng District of Narathiwat Province included adults which could not be placed in either subspecies [*balabacensis balabacensis* and *balabacensis introlatus*] with confidence. Most specimens for which associated larval and pupal skins were available were identified as *b. introlatus*, but a significant percentage were intermediate. Specimens from these collections appeared to fit the criteria of an intermediate population as outlined by Mayr et al. (1953), and lend further weight to Colless' (1957) decision to regard *introlatus* as a subspecies of *balabacensis*. Additional collecting will be needed to define precisely the line of demarcation of the two subspecies." In Scanlon et al. (1968) this hypothesis was reinforced by the following statement: "...where there are morphologically distinguishable forms in different areas, the areas where the two forms meet or intergrade should be studied to see if there has been interbreeding, as was done for *balabacensis balabacensis* and *b. introlatus* in South Thailand (Scanlon et al. 1967), or whether in fact they behave as two species." Reid (1968) restates the findings of Scanlon et al. (1967) as: "This suggests that interbreeding does occur so that the two forms are subspecies (p. 403), but further investigation is needed." We state here unequivocally that the very specimens upon which the Scanlon et al. (1967) study was based represent 2 very distinct species, *introlatus* and *leucosphyrus* A, and that each is quite distinct in the adult, pupal and larval stages and none suggests hybrid origin. Based on this information and the study of additional material of *introlatus*, Hii et al. (1988) elevated subspecies *b. introlatus* to species status.

2. *Anopheles (Cel.) minimus* Theobald. This species has been recorded from Thailand since Barnes (1923) and has been recognized as a primary vector of malaria in Thailand since Payung-Vejjasatra (1935). Harrison (1980) conducted a 7-year morphological study of the members of the *Myzomyia* Series (includes *minimus*) and concentrated on variations found within each species as well as the overlap of variations between the species. He found the adults of *minimus* highly variable, often having the phenotypic appearance of several of the other species, and identifiable by morphology in the adult female at about the 90 - 95% level. Sucharit et al. (1988) reported a new sibling species in the *Minimus* Complex, species C, from Kancha-

naburi Province based on electrophoretic data, that also could be separated from *minimus* A by morphological characters on the wing. Green et al. (1990) further defined *minimus* C on the basis of electrophoretic characters, however, they determined that the wing characters used by Sucharit et al. (1988) for *minimus* C were not diagnostic and led to a 37% identification error when used to separate *minimus* A and *minimus* C. To date no reliable morphological characters have been found to differentiate these 2 species in Thailand. Based on these findings and the discovery of *minimus* B, another member of the complex in Hainan Island, People's Republic of China (Yu and Li 1984), *minimus* Theobald must be deleted from the Thailand list of species and should be replaced with 2 species, *minimus* A and *minimus* C.

3. *Aedes (Aedimorphus) lowisii* (Theobald). This species was reported from Thailand as an associate of *An. nemophilous* (Peyton and Ramalingam 1988). The identification of *lowisii* was made in the early 1960s and based on a single female (GP-80). Reinert (1973b) reexamined that female and determined that the earlier identification was incorrect. He identified this specimen (in the NMNH) as *Ae. orbitae* Edwards. Therefore, the record of *lowisii* in Thailand (Peyton and Ramalingam 1988) is incorrect.

4. *Aedes (Fin.) litoreus* Colless. Gould et al. (1982) recorded this species as collected in Kanchanaburi Province during their filariasis studies. *Aedes litoreus* was described by Colless (1958) from Blakang Mati Island in Singapore Harbor. Colless also examined a female that he considered to be this species from Selangor State, peninsular Malaysia, and considered this species to be influenced by extreme coastal environments or even the tidal zone. The collection of this species in a mountainous valley in western Thailand suggests that Colless' interpretation of *litoreus* as being a coastal species was wrong. In addition to the Kanchanaburi record, there are also specimens of *litoreus* identified by K.L. Knight in the NMNH from Ranong and Trang provinces.

5. *Aedes (Fin.) prominens* (Barraud). Gould et al. (1982) recorded this species from Kanchanaburi Province in western Thailand. Knight and Stone (1977) listed the distribution of *prominens* as India (Assam, Meghalaya and West Bengal), Indochina (Vietnam), China and Celebes (Indonesia). Apparently the record of *prominens* from Kuala Lumpur, Malaysia (Macdonald 1957) was overlooked. As these records surround Thailand, it is logical that *prominens* should occur in Thailand. There are confirmed specimens of *prominens* from Kanchanaburi, Nakhon Nayok, Nakhon Ratchasima, Nan, Ranong, Surat Thani and Trang provinces in the NMNH, and this species should be added to the Thailand list of species.

6. *Armigeres (Armigeres) maximus* Edwards. Gould et al. (1982) listed less than 20 specimens of this species collected in Kanchanaburi Province in western Thailand. This species was described from Sumatra, Indonesia.

Macdonald (1957) reported *maximus* from Selangor State, Malaysia, and Knight and Stone (1977) listed its distribution as Sumatra and Java (Indonesia) and Malaysia. The extension northward into forested western Thailand seems logical. We have not found the specimens on which this record is based.

7. *Armigeres (Arm.) moultoni* Edwards. Gould et al. (1982) recorded this species from Kanchanaburi Province in western Thailand. More recently, Harbach and Rattanarithkul (1988) recorded this species as associated with *Cx. (Eum.) oresbius* and *Ar. (Arm.) subalbatus* (Coquillett) in a bamboo stump (here corrected to banana stump) on Doi Inthanon, Chiang Mai Province in northern Thailand. That collection (07851) was made in 1978 at 1,500 m and contains a large series of adults reared with associated larval and pupal exuviae. A single larva was also collected (07907) from a clay jar at 2,565 m on the top of Doi Inthanon.

8. *Heizmannia (Heizmannia) taiwanensis* Lien. Gould et al. (1982) recorded this species from Kanchanaburi Province. No specimens are available to confirm this record, although collection records 07020, 07021, 07022 and 07023 made in July 1974 in Sangkhlaburi District of Kanchanaburi record females of this species biting man. The specimens apparently were dissected during the Gould et al. filariasis study. Mattingly (1970) considered *taiwanensis* to be confined to Taiwan. However, as discussed under *Hs. catesi* (see p. 200), most of the *Heizmannia* found in Taiwan have also been found in Thailand. In addition, one of us (BAH) collected a single female (deposited in the NMNH) of *taiwanensis* in Perak State, Malaysia in 1987. Lu and Gong (1986) described a new species, *Hs. menglianensis*, from Yunnan Province, People's Republic of China, which is closely related to *taiwanensis*. Although we are convinced the record of *taiwanensis* from Thailand is valid, this should be confirmed by a comparison of Thailand specimens with specimens or the description of *menglianensis* and *taiwanensis*.

9. *Culex (Culex) edwardsi* Barraud. Harbach and Mongkolpanya (1989) listed this species as collected on Doi Inthanon in Chiang Mai Province. *Culex edwardsi* is listed in Knight and Stone (1977) as occurring in India, Sri Lanka, New Guinea (Papua) and Queensland, Australia, and Cagampang-Ramos (1979) reported *edwardsi* on Luzon Island, Philippines. Typically this species is reported from high elevations, however, one site in the Philippines was reported as 500 ft. The specimens from Doi Inthanon, Thailand, occurred in several collections between 1,270 and 1,440 m. Forty-one specimens (5♂, 10♀, 10Pe, 6Le, and 10L) are in the NMNH from the following collections in Chiang Mai Province, Chom Thong District, Doi Inthanon, vicinity of Siriphum Waterfalls: collection 07845, 29 June 1978, marshy seepage bog, 1,440 m, (1♂, 1♀, 1Pe); collection 08420, 24 April 1981, buffalo footprints in seepage bog, 1,270 m, (2♀, 1Pe, 1Le); and collection 08421, 24 April 1981, buffalo footprints in seepage bog, 1,270 m, (4♂,

7♀, 8Pe, 5Le, 10L). Other species associated with *edwardsi* in these habitats were: *Anopheles (Ano.) aberrans* Harrison and Scanlon, *An. (Ano.) bengalensis*, *An. (Ano.) lindesayi cameronensis*, *An. (Cel.) aconitus*, *An. (Cel.) maculatus s.l.*, *An. (Cel.) splendidus*, *Culex (Cui.) sasai*, *Cx. (Cux.) jacksoni*, *Cx. (Cux.) mimulus*, *Cx. (Cux.) vishnui* Theobald, *Cx. (Eum.) richei* Klein, and *Uranotaenia (Ura.)* species. The specimens of *edwardsi* from Thailand match the characters for this species provided by Marks (1971) and Sirivanakarn (1976). Besides the postspiracular patch of pale scales, the adults possess complete pale stripes on the anterior surfaces of the femora and tibiae of the mid- and hindlegs, and pale scales on the posterior margin of the costa, frequently on the subcosta and infrequently on the anterior margin of the radius. These pale scales may extend only a short distance beyond the remigium or out beyond the subcosta-costa junction. The pupa has seta 5-VII moderately stout and long, and the larva exhibits seta 1-X single and seta 1-S in 3 ventrolateral pairs (infrequently 4) and 2 dorsolateral pairs. A comparison of these specimens of *edwardsi* with Thai specimens of *Cx. barraudi* Edwards reveals they are distinct species, and supports the elevation of *edwardsi* to species level by Marks (1971) and Sirivanakarn (1976) after Bram (1967) synonymized *edwardsi* under *barraudi*.

10. *Culex (Eum.) richei* Klein. This species was collected on Doi Inthanon, Chiang Mai Province, and redescribed by Harbach and Mongkolpanya (1989). Previous to these collections, *richei* was known only from the holotype male from Kampot Province, Democratic Kampuchea (Klein 1970), and specimens reported from Fujian Province, People's Republic of China (Xu 1984). The Thailand specimens permitted the first descriptions of the female, pupal and larval stages of this rarely collected species.

11. *Mansonia (Mansonioides) annulata* Leicester. Leicester (1908) described this species from Kuala Lumpur, Selangor, Malaysia. Wharton (1962) revised the *Mansonia* of Malaysia and reported the distribution of *annulata* from Indonesia, Malaysia and the Philippines. Although *annulata* previously has not been recorded from Thailand, Gass et al. (1982, 1983) reported this species to be the dominant *Mansonia* species in their study site in Chumphon Province in southern Thailand. There is only a single female of *annulata* in the NMNH from Thailand. This specimen is labelled: South of Thailand, September 14, 1962.

IV. Notes, changes and/or new distribution records for certain uncommon or important species in Thailand.

1. *Anopheles (Ano.) aberrans* Harrison and Scanlon. Previously, this species was recorded from Chanthaburi, Chiang Mai, Chon Buri, Mae Hong Son, Nakhon Sawan, Phrae, Ranong, Songkhla and Trat provinces of Thailand (Harrison and Scanlon 1975) and from Malaysia (Cheong

and Mahadevan 1978, Reid 1979). In November 1979, *aberrans* larvae were collected and reared from Huai Nong Bon and Ban Phu Rat, Sai Yok District, Kanchanaburi Province, western Thailand.

2. *Anopheles (Ano.) fragilis* (Theobald). No additional specimens of this species have been reported from Thailand since Harrison and Scanlon (1975). The listing of *fragilis* larvae associated with *An. nemophilous* larvae by Peyton and Ramalingam (1988) was based on older material from Nakhon Si Thammarat Province already reported by Harrison and Scanlon (1975). This species is basically confined to Malaysia, Indonesia and the Philippines, although it occurs in southern Thailand and southern Myanmar (Reid 1965). Recently, Darsie and Pradhan (1990) recorded *fragilis* from Nepal based on 2 males. However, Harrison and Scanlon (1975:153, 160) clearly pointed out that the number of basal stems forming the club on the dorsal lobe of the claspette in *An. aberrans* and *An. bengalensis* Puri overlapped with those of *fragilis* and could not be used to identify the males of these 3 species. The occurrence of *fragilis* in Nepal, far removed from its previously known distribution is highly doubtful. We consider the record of *fragilis* in Nepal (Darsie and Pradhan 1990) as highly questionable and needing confirmation based on the more reliable immature characters of *fragilis*.

3. *Anopheles (Ano.) kyondawensis* Abraham. Besides the original collection of this species by Abraham (1947) in Burma (now Union of Myanmar), the only other published record is based on a single larva collected from a freshwater crab hole in Nan Province, Thailand (Harrison and Scanlon 1975). In November 1979, another larva of this species was collected from a stream with many crab holes along the margin in Huai Kop, Sai Yok District, Kanchanaburi Province, western Thailand. The adults and pupa of this species remain unknown.

4. *Anopheles (Ano.) separatus* (Leicester). Harrison and Scanlon (1975) reported this species from Narathiwat and Trang provinces based on specimens in the NMNH. The earlier reports of this species from Chon Buri and Phra Nakhon (Bangkok) mentioned by Scanlon et al. (1968) have not been verified. Their Chanthaburi record was based on a single female biting man (collection 00574) on 6 October 1965 between 1900 - 2200 h in an orchard at 20 m in Ban Tha Mai, Tha Mai District, Chanthaburi. This specimen is non-extant. On 21 May 1979, 42 females of *separatus* were collected biting man between 1900-2100 h near an old tin pit at 100 m in Ban Nai Sang Mu-1, Takua Pa District, Phangnga Province. The characterization of *separatus* immatures occurring between the inner fringe of brackish water inland to approximately 100 m elevation in Malaysia (Hodgkin 1950) apparently also applies to this species in Thailand.

5. *Anopheles (Ano.) tigerti* Scanlon and Peyton. This rarely collected species is known only from Thailand and was listed by Harrison and Scanlon (1975) as occurring in Chanthaburi, Nakhon Ratchasima, Prachin Buri and Tak

provinces. More recently specimens were collected as immatures in Huai Kum, Chon Buri Province (1979) and in Ban Bang Ra Ko and Khao Nang Hong, Phangnga Province (1980). Previously, immatures of *tigerti* have been found only in fresh water crab holes, however, larvae were found in a rock pool on Khao Nang Hong in Phangnga. There were numerous crab holes from which *tigerti* immatures were collected adjacent to the rock pool.

6. *Anopheles (Cel.) culicifacies* B. See p. 209 for a discussion of this sibling species complex. Apparently only *culicifacies* B is known from Thailand and it was recorded from Ayutthaya, Chiang Mai, Chiang Rai, Chon Buri, Kanchanaburi, Lampang, Lamphun, Mae Hong Son, Nan and Tak provinces by Harrison (1980). This species was also collected in 1980 in Loei and Udon Thani provinces in northeastern Thailand.

7. *Anopheles (Cel.) macarthuri* Colless. Previously, this species was considered a subspecies of *An. riparis* King and Baisas, however, Hii et al. (1988) considered *macarthuri* to be sufficiently distinct morphologically and zoogeographically to warrant species status. Scanlon et al. (1968) listed *macarthuri* from Nakhon Si Thammarat, Narathiwat, Phatthalung and Trang provinces. Since then numerous specimens have been collected in Phangnga, Phuket, Ranong, Songkhla and Yala provinces. The immatures of this species often can be found in the thousands in rock pools along usually shallow, hill/mountain streams in southern Thailand, yet adults have never been collected biting man in Thailand. Researchers in Malaysia discovered that adults of this species (as *riparis*) are very abundant in the forest canopy (U.S. Army Medical Research Unit-Malaysia 1970) and may attempt to bite man in the canopy (U.S. Army Medical Research Unit-Malaysia 1972).

8. *Anopheles (Cel.) pampanai* Buettiker and Beales. This uncommon member of the Minimus Group was described from the Union of Myanmar (Burma) and Democratic Kampuchea (Cambodia), and was first reported in Thailand by Peyton and Scanlon (1966). Harrison (1980) examined specimens in the NMNH from Buriram, Chanthaburi, Chiang Mai, Lampang, Phayao and Prachin Buri provinces. In 1980, immatures of *pampanai* were collected and reared from stream pools near the base of Phu Kradung, Loei Province, and from stream margins in Nong Bua Lumphu District of Udon Thani Province.

9. *Anopheles (Cel.) philippinensis* Ludlow. This species has been reported from all over Thailand (e.g., Scanlon et al. 1968). However, since the removal of *An. nivipes* Theobald from synonymy with *philippinensis* and its reestablishment to distinct species status (Reid 1967), and the discovery that "*nivipes*" is at least 2 species, it has become increasingly evident that the Nivipes Complex (see discussion of this sibling complex on p. 208) is more abundant and widely distributed in Thailand than *philippinensis*. Although only 85% of adults of *philippinensis* and the Nivipes Complex species can be identified in the absence of associated larval and pupal exuviae, when associated

exuviae are present nearly 100% can be identified using the characters in Reid (1968). Based on adults with associated larval and pupal exuviae we have found *philippinensis* in only 16 Thailand provinces: Chiang Mai, Chon Buri, Chumphon, Kanchanaburi, Nakhon Nayok, Nakhon Ratchasima, Nakhon Si Thammarat, Phangnga, Phayao, Prachin Buri, Ranong, Rayong, Sara Buri, Surat Thani, Trat and Uthai Thani. Members of the Nivipes Complex have been confirmed from over 20 Thai provinces.

10. *Anopheles (Cel.) stephensi* Liston. Although this species is renowned in the Middle East and parts of India as a primary vector of human malaria parasites, in Thailand it is rare and not considered a vector. Previously it was recorded only from Chiang Mai and Chiang Rai provinces (Scanlon et al. 1968). Between 1969 - 81 additional adults and larvae were collected in Hang Dong District, Chiang Mai Province and Mae Hong Son and Mae Sariang Districts of Mae Hong Son Province. Immatures were collected in grassy stream pools, while adults were collected biting man and cattle and in a light trap.

11. *Anopheles (Cel.) varuna* Iyengar. Thurman (1959) initially reported this species from Thailand, but did not retain specimens. In 1977 and 1978 specimens of this species were confirmed from Chiang Mai and Lampang provinces (Harrison 1980). In 1981 a large number of *varuna* adults were examined by us from Bo Phloi District, Kanchanaburi Province, and immatures were collected and reared from Ban Lat District, Phet Buri Province. The Phet Buri specimens (collection 08557, 2L; collection 08562, 1♀, 1Pe, 1Le, 1L) are deposited in the NMNH. The addition of Kanchanaburi and Phet Buri extends the distribution of *varuna* southward along the western border of Thailand to the beginning of the peninsula.

12. *Aedes (Bothaella) helenae* Reinert. Previously, Reinert (1973c) listed the distribution of this species as restricted to Chiang Mai, Lampang and Nan provinces in northern Thailand. Knight and Harrison (1988) listed *helenae* as associated with *Ae. mikrokopion* in bamboo internodes from a July 1974 collection (06907) made in Ban Nong Plang Khong, Sangkhlaburi District, Kanchanaburi Province. This extends the distribution of *helenae* southward along the western border of Thailand.

13. *Aedes (Dic.) iyengari* Edwards. Previous records of this species in Thailand (Thurman 1959, Scanlon and Esah 1965, Reinert 1970) are based on specimens collected in Chiang Mai Province in northern Thailand. In 1981, 2 immature collections (08463, 08464) of *iyengari* were made and reared to adults from a hollow in a teak log in Ban Huai Kha, Mae Hong Son Province in the northwest corner of Thailand. These adults, with their associated larval and pupal exuviae, are in the NMNH.

14. *Aedes (Dic.) whartoni* Mattingly. Reinert (1970) recorded this species from Lampang, Nan, Phangnga, Ranong and Tak provinces. Knight and Harrison (1988) listed *whartoni* as associated with *Ae. mikrokopion* in a

bamboo cup set out in a bamboo grove in 1974 in Ban La Wa, Sangkhlaburi District, Kanchanaburi Province. We have been unable to locate the specimens of *whartoni* reported by Gould et al. (1982). They were probably dissected for the detection of filarial parasites.

15. *Aedes (Fin.) harinasutai* Knight. Knight (1978b) described this species after extensive epidemiological studies (Harinasuta et al. 1970, Gould et al. 1982) revealed that it is the primary vector of subperiodic *Wuchereria bancrofti* (Cobbold) to villagers along the Khwae Noi River in Sangkhlaburi District, Kanchanaburi Province. Until recently, *harinasutai* was known only from Kanchanaburi Province, however, work in Tak Province has revealed another focus of this disease and its vector, *harinasutai* (Khamboonruang et al. 1987). *Aedes harinasutai* is now known from 2 western Thailand provinces that border with Myanmar.

16. *Aedes (Isoaedes) cavaticus* Reinert. The monotypic subgenus *Isoaedes* Reinert of *Aedes* is based on *cavaticus*, which was described from a single cave in Kanchanaburi Province in western Thailand (Reinert 1979). In 1980 and 1981, immature specimens of this species were collected and reared from 2 additional limestone caves in Kanchanaburi. These collections were made in Srisawad District about 120 km northwest of the type locality. Adults with associated larval and pupal exuviae and 4th instar larvae are deposited in the AFRIMS collection from: Srisawad District, Ban La Mut, collection 08263, September 1980, from rock pool inside cave; Srisawad District, Tambol Tha Kradan, Ban Plai Huai Kaeng Riang Mu 3, Wat Tham Phra Tad (Cave), collections 09110-09112, June 1981, pools in cave floor. We anticipate that as more collecting is done in limestone caves in western Thailand, the distribution of *cavaticus* will be extended to adjacent provinces of Thailand.

17. *Heizmannia (Mat.) thelmae* Mattingly. This rarely collected species was previously described and known only from Ban Chatri, Ranong Province in peninsular Thailand (Mattingly 1970). During the filariasis studies in Kanchanaburi Province documented by Gould et al. (1982), numerous *Heizmannia* species were collected. There are records for at least 8 females and one larva of *thelmae* collected during these studies in 1974. While 4 females were apparently dissected at that time, the other 4 specimens were pinned. Two females in the AFRIMS collection came from collections 07034 and 07198, while 2 females in the NMNH came from collections 07332 and 07334. Females 07034 and 07332 came from Ban La Wa, while female 07198 came from Ban Kupadu and female 07334 came from Ban Nong Plang Khong. These 3 villages are in Sangkhlaburi District, Kanchanaburi Province in western Thailand. These 4 females clearly match the description for *thelmae* (Mattingly 1970).

18. *Culex (Cux.) barraudi* Edwards. In Bram (1967) this species was confused with *Cx. edwardsi* (see p. 204) in

Thailand, thus the distribution records for *barraudi* in Thailand from Chiang Mai and Prachuap Khiri Khan provinces may be inaccurate. Sirivanakarn (1976) reported *barraudi* in Thailand only from Chiang Mai Province, and did not comment on the specimens from Prachuap Khiri Khan in Bram (1967). In 1980, a series of *barraudi* adults were reared from larvae collected in Udon Thani Province in northeastern Thailand. Thirty-three specimens (9♂, 2♀, 12Pe, 7Le and 3L) are deposited in the NMNH from Udon Thani Province, Nong Bua Lamphu District, Huai Sao Khua, collection 08324, 21 October 1980, rockpool, 340 m. The only other species associated with *barraudi* in this collection was a member of the Maculatus Complex of *Anopheles*. As noted previously (Marks 1971), adults of *barraudi* are considerably smaller than those of *edwardsi*, have more silvery scales on the scutum and have incomplete stripes on the anterior surface of the femora and tibiae of the mid- and hindlegs. The thinner and shorter seta 5-VII on the pupa readily separates *barraudi* from *edwardsi* in that stage. Approximately 50% of the *barraudi* larvae had at least one seta 1-X forked near the base, while this seta was invariably single on *edwardsi* larvae. The larvae of *barraudi* from Udon Thani possess 3 pairs of ventrolateral and 2 pairs of dorsolateral seta 1-S, as do most of the *edwardsi* larvae from Chiang Mai Province. Marks (1971) noted considerable variation in the pattern and numbers of seta 1-S on *edwardsi* and *barraudi*. Further study is needed to determine if the variation seen in seta 1-S (particularly on *edwardsi* throughout its distribution) is indicative of additional cryptic species.

19. *Uranotaenia (Pseudoficalbia) enigmatica* Peyton. Peyton (1977) described this species on the basis of 5 adults, 2 whole larvae and 7 larval or pupal exuviae collected from 2 crab holes in Nan Province, northern Thailand. In 1978 an additional collection of *enigmatica* was made from a crab hole over 1,000 km south of the type locality in Nan. This collection resulted in 15 specimens (1♂, 4♀, 4Pe, 4Le, 1P, 1L) and had the following collection data: Chumphon Province, Ban Chong Om No. 4, collection 07955, 7 September 1978, freshwater crab hole.

20. *Uranotaenia (Pfc.) gouldi* Peyton and Klein. Peyton (1977) listed this species in Thailand from the following provinces: Chiang Mai, Chon Buri, Narathiwat, Phangnga and Trang. An additional 7 specimens (2♂, 1♀, 1Pe, 1Le, 2P) were collected in 1978 in peninsular Thailand with the following data: Chumphon Province, Ban Chong Mut, No. 3, collection 07999, 13 September 1978, from a seepage hole.

V. Comments/corrections for certain records in the lists of Apiwathnasorn (1986), Miyagi et al. (1986) and Tsukamoto et al. (1987).

Aside from more recently described new species and new species records for Thailand, certain species records in the recent publications of Apiwathnasorn (1986), Miyagi

et al. (1986) and Tsukamoto et al. (1987) deserve additional comments or corrections.

A. Comments/corrections for certain records in Apiwathnasorn (1986) that were not treated by Tsukamoto et al. (1987).

1. *Anopheles (Ano.) aberrans* Harrison and Scanlon was listed as questionable for Malaysia, probably based on statements in Harrison and Scanlon (1975). However, Cheong and Mahadevan (1978) and Reid (1979) found specimens of *aberrans* in the collections of the Institute for Medical Research, Kuala Lumpur, the Natural History Museum and the London School of Hygiene and Tropical Medicine, London, that confirm this species from peninsular Malaysia.

2. *Anopheles (Ano.) aitkenii* James was listed as occurring in Burma, Malaysia, the Philippines and Thailand, with Indonesian records as questionable. Harrison and Scanlon (1975:150) restricted the distribution of *aitkenii* to the Indian Subregion. This action was based on the discovery that certain male genitalia and larval characters previously used to identify *aitkenii* were not diagnostic and could be found on certain specimens of *An. aberrans* and *An. bengalensis* Puri in northern Thailand. In addition, unique characters were discovered on *aitkenii* immatures (Harrison, unpublished) that have not been found on any member of the Aitkenii Group in Southeast Asia.

3. *Anopheles (Ano.) insulaeflorum* (Swellengrebel and Swellengrebel de Graaf) was listed as occurring in Burma, Cambodia, Indonesia, Malaysia, the Philippines, Thailand and Vietnam. Harrison and Scanlon (1974), however, determined that the "*insulaeflorum*" of the Philippines and eastern Indonesia (Ambon and Ceram) was a distinct new species, *An. pilinotum*, which they described. The records of *insulaeflorum* from Sulawesi, the Lesser Sunda Islands and the Molucca Islands still need confirmation as either *insulaeflorum* or *pilinotum*. Recently, Kulasekera et al. (1989) determined that the "*insulaeflorum*" from Sri Lanka is a new species which they described as *An. peytoni*.

4. *Anopheles (Cel.) balabacensis* Baisas was listed as occurring in Borneo, Burma, Cambodia, Indonesia, Laos, Malaysia, the Philippines, Thailand and Vietnam. However, it clearly has been documented by morphology, cytogenetics and crossing studies (Peyton and Harrison 1979, 1980; Baimai et al. 1984; Hii 1985, 1986; Baimai 1988; Peyton and Ramalingam 1988; Peyton 1990) that *balabacensis* does not occur on mainland Southeast Asia. This insular species is restricted to Indonesia (Java and Kalimantan), Malaysia (Sabah and Sarawak) and the Philippines (Balabac and Palawan islands). *Anopheles introlatus*, known from peninsular Malaysia and Thailand, was elevated from a subspecies of *balabacensis* to species status by Hii et al. (1988). *Anopheles balabacensis* "Fraser's Hill Form" also was recently described as a new species, *An. nemophilous*, by Peyton and Ramalingam (1988). The remaining taxa on the mainland that previ-

ously may have been called *balabacensis* are now considered members of the Dirus Complex (Peyton and Ramalingam 1988, Peyton 1990).

5. *Anopheles (Cel.) minimus* Theobald was listed from Borneo, Brunei, Burma, Cambodia, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand and Vietnam. However, the records for Borneo, Brunei, Indonesia and the Philippines apply to *An. flavirostris* (Ludlow), not *minimus* (Harrison 1980). The listing of Singapore must be an error, as neither *flavirostris* nor *minimus* have been collected from this island. In addition, since *minimus* is now known to be a complex of at least 3 sibling species (A, B, C), we are not certain which sibling actually represents Theobald's species. Preliminary evidence suggests that *minimus* A is Theobald's species.

6. *Anopheles (Cel.) nivipes* (Theobald) was listed only from Indonesia and Malaysia. However, Reid (1967) used specimens of *nivipes* from southern Thailand, Burma and Malaysia when he elevated *nivipes* from synonymy with *An. philippinensis* to species status. Also, Klein et al. (1982) discussed the colonization of 2 strains of *nivipes* from Nakhon Ratchasima and Phrae provinces of Thailand, and Klein et al. (1984) demonstrated a postmating sterility barrier in reciprocal crosses between *nivipes* from the Nakhon Ratchasima colony and a *philippinensis* colony started from specimens from Rayong Province. Although we currently have confirmed specimens of "*nivipes*" from at least 22 widely separated provinces, the taxonomy of this species is complicated by the presence of at least 2 cryptic (cytogenetic) species in the morphological species "*nivipes*" in Thailand (Green 1982⁴, Baimai et al. 1984, Green et al. 1985).

7. *Anopheles (Cel.) pampanai* Buettiker and Beales was listed from Burma, Cambodia and Thailand. Harrison (1980:103) confirmed the identity of a specimen of *pampanai* in the NMNH from Plei Djereng, Pleiku Province, Vietnam.

B. Comments/corrections for certain records in the list of Miyagi et al. (1986).

1. *Anopheles (Ano.) donaldi* Reid was listed as collected in Chiang Mai Province in northern Thailand. We feel this is an identification error as pointed out by Harrison et al. (1988). Previously, only a single confirmed female of *donaldi* had been seen from Thailand (Harrison and Scanlon 1975), and that specimen was from Narathiwat Province in extreme southern Thailand, nearly 1,500 km south of Chiang Mai. *Anopheles donaldi* is a Malaysian species that is most common in central and southern peninsular Malaysia, Sabah and Sarawak, and in Kalimantan, Indonesia. This is almost certainly a species that

extends only a short distance north of the Kangar-Pattani faunal and floral line (Whitmore 1984) along the border of Thailand and Malaysia.

2. *Anopheles (Ano.) lesteri paraliae* Sandosham was listed as collected in a rice field in Chiang Mai Province in northern Thailand. As noted by Reid (1968) and Harrison and Scanlon (1975), *lesteri paraliae* is a low elevation inhabitant of brackish and peaty coastal waters. During the preparation of Harrison and Scanlon (1975) numerous specimens previously identified as *lesteri paraliae* from rice field habitats in the central valley north of Bangkok and from the Chiang Mai Valley were examined and found to be misidentified specimens of *An. pursati* Laveran. We suspect that the Miyagi et al. (1986) record of *lesteri paraliae* from Chiang Mai falls in this category, i.e., a misidentification of *pursati*. *Anopheles pursati* is fairly common in the Chiang Mai area, but was not recorded in the collections of Miyagi et al. (1986).

Harrison and Scanlon (1975) elected to retain *paraliae* as a subspecies of *lesteri*. Now we are convinced that *paraliae* deserves species status, and it is elevated to that status here. *Anopheles paraliae* has a distinct apical fringe spot on the wing, utilizes low elevation coastal (brackish and/or peaty) immature habitats and has an allopatric distribution with regard to the other members of the *Lesteri* Complex. The distribution of *paraliae* is restricted to coastal areas of Malaysia (peninsular, Sabah and Sarawak), Brunei, Vietnam and Thailand. Klein (1977) did not list *paraliae* from Kampuchea, although it almost certainly exists there. A more thorough discussion of the biology of this species can be found in Harrison and Scanlon (1975).

C. Comments/corrections for certain records in the checklist of Tsukamoto et al. (1987).

1. *Anopheles (Ano.) aitkenii* James was listed in an uncertain status, with the suggestion that earlier records of this species in Thailand may have been misidentifications of other species in the *Aitkenii* Group. That suggestion is correct (see Harrison and Scanlon 1975:150). Also, see the previous comments about *aitkenii* on p. 207 and delete *aitkenii* from consideration for the Thai checklist of species.

2. *Anopheles (Ano.) gigas* Giles was reinstated in the list of species from Thailand based on specimens the authors collected on Doi Inthanon, Chiang Mai Province. Tsukamoto et al. (1987) considered the member of the *Gigas* Complex in Thailand as *gigas sensu lato*, noting that the 2 previous records from Thailand were doubtful. Actually, *gigas* has been reported previously from Thailand as 3 separate entities: (1) as *An. gigas* var. *formosus* Ludlow, by Barnes (1923) who indicated he was uncertain of his identification; (2) as *An. gigas* var. *sumatrana* Swellengrebel and Rodenwaldt, by Thurman (1959), only noting that specimen(s) were collected between 1950 - 56; and (3) as *An. gigas baileyi* Edwards, by Stojanovich and Scott (1966) who included *gigas baileyi* (without further comment) in a

⁴Green, C.A. 1982. Population genetical studies in the genus *Anopheles*. Ph.D. Thesis. Univ. of Witwatersrand, Johannesburg, South Africa. 107 pp.

list and an illustrated key to the *Anopheles* of Thailand. The 2 former taxa were considered doubtful records by Peyton and Scanlon (1966), Scanlon et al. (1968) and Rattanarithikul and Harrison (1973). The restriction of *gigas formosus* to the Philippines (Reid 1968) and *gigas sumatrana* to Sumatra, Indonesia (Bonne-Wepster and Swellengrebel 1953, Reid 1968), plus the absence of *gigas* specimens for examination, prompted Harrison and Scanlon (1975) to drop *gigas* from the Thailand list.

In 1978, larval specimens of a "*gigas*" member were collected by AFRIMS personnel from a sphagnum bog near the top of Doi Inthanon, Chiang Mai Province. This collection site, at approximately 2,540 m, is probably the same site where Tsukamoto et al. (1987) found *gigas* specimens in 1983. In 1981, additional specimens of *gigas sensu lato* were collected on Doi Inthanon in the same sphagnum bog and also in a stream bog area at a lower elevation. Based on the 1978 and 1981 collections and rearings, forty-one specimens (1♂, 6♀, 12Pe, 13Le, 5P and 4L) were examined from Chiang Mai Province, Chom Tong District, Doi Inthanon, collection 07892, 4 July 1978, seepage bog, 2,540 m, just below radar station, (1♂, 2♀, 4Pe, 4Le, 4P); collection 07893, 4 July 1978, seepage bog, 2,540 m just below radar station, (4♀, 4Pe, 4Le, 2L); collection 08399, 23 April 1981, marshy bog under trees, 2,530 m, just below radar station, (1Le, 1P); and collection 08408, 23 April 1981, stream bog, 1,633 m, beside road up Doi Inthanon, between km 36 and km 37 signposts, just before junction for road going to Mae Chaem, (4Pe, 4Le, 2L).

After a thorough study of these specimens and comparison (BAH) of the types of *gigas*, *gigas* var. *baileyi*, *gigas* var. *simlensis* (James), *gigas* var. *refutans* Alcock and *gigas crockeri* Colless in the Natural History Museum in September 1989, the Thailand member of the Gigas Complex definitely has been identified as *gigas baileyi*. The addition of Thailand fits very well into the currently known distribution of *gigas baileyi*, i.e., Tibet, India, Burma, Formosa, Indochina [Vietnam] and central China (Knight and Stone 1977). *Anopheles gigas baileyi* apparently is allopatric in regard to the other members of the complex, with the possible exception of an overlap with *gigas simlensis* in Nepal. Ramachandra Rao et al. (1973) and Bhat (1975a) clearly documented only *gigas simlensis* from Uttar Pradesh State, west of Nepal, while only *gigas baileyi* was found east of Nepal in Sikkim (Bhat 1975b). Earlier references listing members of this complex in Nepal only mention "*gigas*" (Brydon et al. 1961, Shrestha 1966, Ramachandra Rao 1984). However, Darsie and Pradhan (1990) have recorded larvae of *gigas gigas*, *gigas baileyi* and *gigas simlensis* from the same collection in Nepal. These records are highly questionable because subspecies should not retain morphologically distinctive characters in sympatry (Mayr 1969). Prior to Darsie and Pradhan (1990), *gigas gigas* has been considered as restricted to southern India (Christophers 1933), although Ramachandra Rao (1984:237-238)

did mention a 1979 personal communication from M.L. Shrestha informing him that *gigas gigas* and *gigas simlensis* occurred in Nepal. We suspect that the records of these different *gigas* members found in sympatry in Nepal are due to inadequate keys and taxonomic knowledge of the morphology of the Gigas Complex. Only through thorough morphological studies involving reared adults with associated larval and pupal exuviae can such inadequacies be overcome and records corrected.

Morphologically, the specimens of "*gigas*" from Thailand agree very well with previous descriptions of the various life stages of *gigas baileyi* (Edwards 1929; Christophers 1931, 1933; Rice and Datta 1936). The morphological uniformity of *gigas baileyi* over a wide distribution (including many isolated collection sites) suggests this taxon deserves species status. Accordingly, we are elevating *baileyi* Edwards to species status. The Gigas Complex of *Anopheles* also exhibits all of the characteristics of a superspecies, as defined previously under *lindesayi* on p. 199. *Anopheles gigas* should be removed from the Thailand list of species, and *baileyi* should be inserted into the list.

3. *Anopheles (Cel.) balabacensis introlatus* Colless was elevated to full species status by Hii et al. (1988). Thorough morphological studies of the species in the Leucosphyrus Group by ELP have clearly shown *introlatus* to be another mainland Southeast Asian species that is quite distinct from *balabacensis* (also see earlier discussion under *Anopheles leucosphyrus*). The entry in the Thailand list should show *introlatus* as a species.

4. *Anopheles (Cel.) culicifacies* Giles was recorded from Thailand, but no mention was made of this name including a complex of cytogenetic sibling species (Green and Miles 1980, Subbarao et al. 1983, Subbarao 1988). Apparently only one member occurs in Thailand, which is very similar to *culicifacies* B (Green 1982⁴). *Anopheles culicifacies* B is most common in the Indian Subregion and extends westerly into Pakistan. The other 3 species (A, C and D) are also from the Indian Subregion, with *culicifacies* A extending further west onto the Arabian Peninsula. The Thailand list should show that *culicifacies* is a complex and that only *culicifacies* B is known from Thailand.

5. *Anopheles (Cel.) dirus* Peyton and Harrison was recorded from Thailand, but no mention is made that this name currently includes 7 sibling species, of which 5 occur in Thailand (Peyton 1990). Besides *dirus* and *An. nemoophilous* Peyton and Ramalingam, there are 3 undescribed members in Thailand (*dirus* B, C and D) that are well defined morphologically, cytogenetically and by crossing studies (Baimai 1988, Baimai et al. 1988a, Peyton and Ramalingam 1988). The Thailand list should show that *dirus* is a complex, with at least 3 additional undescribed cryptic species known in Thailand.

⁴See footnote on page 208.

6. *Anopheles (Cel.) filipinae* Manalang was listed as a misidentification. Before Harrison (1980), the extent of morphological variation within and among species in the Minimus Group was poorly known. Variations in the adult morphology of species such as *An. aconitus* Doenitz, *An. flavirostris* and *An. minimus* are extensive and often overlap with or mimic morphological patterns that have classically defined the other members of the Group [e.g., *An. filipinae*, *An. fluviatilis* James, *An. mangyanus* (Banks) and *An. pampanai* Buettiker and Beales]. Accordingly, infrequent records have been published of Philippine members of the group occurring in mainland Southeast Asian and even Indian subregion countries. Harrison (1980) determined that the immature stages have the best diagnostic characters for differentiating the species in this group, and all records in Harrison (1980) were based on reared adults with associated larval and pupal exuviae. Despite occasional adults in Thailand exhibiting morphological characters like the Philippine species (*filipinae*, *flavirostris* and *mangyanus*), the pupae and larvae of these specimens clearly showed they were not these species. Thus, the record of *filipinae* from Thailand (Thurman 1959) is considered invalid, as is the record of *filipinae* from Nepal (Pradhan and Brydon 1960, Darsie and Pradhan 1990). *Anopheles filipinae* must be deleted from the Thailand and Nepal lists of species.

7. *Anopheles (Cel.) fluviatilis* James was listed as a doubtful species. Harrison (1980) found the situation for *fluviatilis* in Thailand to be the same as that explained above for *An. filipinae*. Thus, *fluviatilis* should be deleted from consideration for the Thailand list.

8. *Anopheles (Cel.) indefinitus* (Ludlow) was treated as a resurrection of a record. However, *indefinitus* has been recorded from Thailand since Stanton (1920:334) and was included in an earlier Thailand list (Scanlon et al. 1968) under *An. subpictus* Grassi, as var. *malayensis* Hacker, currently a synonym of *indefinitus*. This species has been acknowledged as present in Thailand for years, although published distribution records were not available. Kittayarak (1980)⁵ reported *indefinitus* from the following provinces of Thailand: Ayuthaya, Chachoengsao, Chon Buri, Rayong and Sara Buri. The authors have examined and identified hundreds of specimens of *indefinitus* from Thailand. Specimens are in the NMNH and AFRIMS collections.

9. *Anopheles (Cel.) leucosphyrus* Doenitz was listed as a doubtful record or misidentification. Baimai et al. (1988b) and Peyton and Ramalingam (1988), however, reported a member of the Leucosphyrus Complex from Thailand, based on AFRIMS collections during the last 25 years (see specific information under *leucosphyrus* on p.

202). Baimai et al. (1988b) determined that *leucosphyrus* is a complex of at least 2 cytogenetic sibling species, with only *leucosphyrus* A (non *leucosphyrus* Doenitz = B) occurring in Thailand. The Thailand list of species should record *leucosphyrus* A as present in the country, but not *leucosphyrus* Doenitz.

10. *Anopheles (Cel.) ludlowae* (Theobald) was listed as doubtful and needing further confirmation. Additional confirmation is not necessary. The old records of "*ludlowi*" by Barnes (1923), Barraud and Christophers (1931) and Thurman (1959) were based on misidentified specimens of *An. sundiacus* (Rodenwaldt) as noted by Scanlon et al. (1968). *Anopheles ludlowae* is an insular species, not found on mainland Southeast Asia, and should not be included in the Thailand list.

11. *Anopheles (Cel.) maculipalpis* (Giles) was listed as a probable misidentification. The early records (Barnes 1923, Barraud and Christophers 1931) of *maculipalpis* in Thailand resulted from confusion regarding the names *maculipalpis*, *An. indiensis* Theobald, 1903 [non Theobald, 1901] and *An. splendidus* Koidzumi. *Anopheles splendidus* is the correct name for the species in Thailand. *Anopheles maculipalpis* is confined to the Afrotropical Region (Gillies and de Meillon 1968), and should not be included in the list of Thailand species.

12. *Anopheles (Cel.) punctulatus* Doenitz was listed in the doubtful/misidentification section. As noted by Tsukamoto et al. (1987), this species is confined to the Australasian and South Pacific regions. *Anopheles punctulatus* should not be included in the list of Thailand species.

13. *Anopheles (Cel.) riparis macarthuri* Colless was listed as a subspecies. Hii et al. (1988) elevated *macarthuri* to species level, and it should be listed accordingly in the Thailand list (also see earlier discussion under *An. macarthuri* on p. 205).

14. *Aedes (Cancraedes) curtipes* Edwards was listed as an uncertain record because Knight and Stone (1977) and Apiwathnasorn (1986) listed *curtipes* as questionable in Thailand. Dyar and Shannon (1925) listed 2 females from Koh [Ko] Kut, Trat Province when they described *Ae. (Skusea) miachaetessa*. Knight and Hull (1953) reassigned *miachaetessa* to subgenus *Cancraedes*, but considered the 2 females from Koh [Ko] Kut to be representatives of *curtipes*. Mattingly (1958) revised the subgenus *Cancraedes* and used one of the 2 above females to describe *Ae. (Can.) kohkutensis* Mattingly, and assigned the second female (actually from Ko Klum) to another new species, *Ae. (Can.) indonesiae* Mattingly. Thus, both females from Thailand previously assigned to *curtipes* are now considered representatives of other species, and *curtipes* has been restricted to the Indonesian islands of Borneo and Sulawesi, and the Philippines (Mattingly 1958). *Aedes curtipes* should not be included in the list of species from Thailand.

15. *Aedes (Christophersiomyia) thomsoni* (Theobald) was incorrectly spelled in Tsukamoto et al. (1987).

⁵ Kittayarak, P. 1980. Intra-interspecific morphological variations in the Subpictus Group of *Anopheles* in Thailand. M.S. Thesis. Fac. Grad. Stud., Mahidol Univ., Bangkok, Thailand. 142 pp.

16. *Aedes* (Fin.) *alboniveus* Barraud. Although the Thurman (1959) record of this species in Thailand was overlooked by Knight and Stone (1977), Tsukamoto et al. (1987) were correct in suggesting that this species needed to be added to the Thailand list of species. There are numerous specimens of *alboniveus* identified by K.L. Knight in the NMNH from the following provinces of Thailand: Chanthaburi, Chiang Mai, Lampang, Nakhon Nayok and Prachin Buri.

17. *Aedes* (Fin.) *albotaeniatus* (Leicester) was listed as resurrected by Tsukamoto et al. (1987). This was probably due to the Gould et al. (1968) record of this species on Ko Samui, Surat Thani Province being overlooked by Knight and Stone (1977) and Apiwathnasorn (1986). Gould et al. (1982) also reported *albotaeniatus* from Kanchanaburi Province. Actually, there are specimens of *albotaeniatus* in the NMNH from the following provinces of Thailand: Chiang Mai, Kanchanaburi, Nakhon Nayok, Nakhon Si Thammarat, Phangnga, Ranong, Surat Thani, Tak and Trat. Edwards (1922a) described *mikiranus*, a variety (now a subspecies) of *albotaeniatus*, based on a different scutal color pattern on specimens from the Mikir Hills, Assam, India. Knight and Stone (1977) list the distribution of *mikiranus* as China and India. There are a substantial number of specimens of *mikiranus* in the NMNH from Thailand, and an even larger number of intermediates (females mostly) between *albotaeniatus* and *mikiranus*. These intermediates occur in a south/north cline, from an *albotaeniatus*-type scutum in the south to a *mikiranus*-type scutum in the north (primarily in the females). Intermediates begin to appear in the southern provinces of Phangnga and Surat Thani and specimens approximating *mikiranus* become increasingly common as you go north. In Chiang Mai Province the majority of adult females have the *mikiranus*-type scutum. Because of this cline and the absence of any other discernible characters to separate these 2 nominal taxa, we consider ssp. *mikiranus* nothing more than a clinal variation of *albotaeniatus*. There are also several specimens of the *mikiranus*-type from Yunnan Province, People's Republic of China, and they are identical to the Chiang Mai specimens. Accordingly, we here synonymize *mikiranus* under *albotaeniatus*, as it does not warrant subspecies status. *Aedes albotaeniatus* is now recorded from India, Indonesia, Malaysia, People's Republic of China, Sri Lanka and Thailand. The Sri Lanka record of Senior White (1920) has not been confirmed (Carter 1950; F.P. Amerasinghe 1990, personal communication) although it continues to be listed as occurring in Sri Lanka (Jayasekera and Chelliah 1981).

18. *Aedes* (Fin.) *aureostriatus* (Doleschall) was listed as a resurrected species. Earlier this species was reported from Chiang Mai Province (Scanlon and Esah 1965) and from Surat Thani Province (Gould et al. 1968). Recently, Rattanaarithikul and Harrison (1988) reported additional specimens from Chiang Mai Province. However, in this study we have examined *aureostriatus* more closely and

have determined that Doleschall's species does not occur in Thailand. *Aedes aureostriatus* was described from Ambon Island just west of Irian Jaya (New Guinea), Indonesia. Apparently, there is no type in existence for *aureostriatus*. There are 13 specimens in the NMNH from New Guinea that match the description of *aureostriatus* and that key easily to that species in Lee et al. (1982). These specimens do not match the supposed specimens of *aureostriatus* in the NMNH from Malaysia, the Philippines, Sri Lanka and Thailand. Differences in at least 3 characters on adult females will easily separate specimens from these 4 countries from *aureostriatus*, i.e., erect forked scales on the head (Knight and Hull 1951), scutal anterior dorsocentral rows of pale scales, and a scutal prealar patch of pale scales. The next available name for the Indian-Southeast Asian species is *greenii* (Theobald), described from Sri Lanka and currently considered a subspecies of *aureostriatus*. We are elevating *greenii* to species status to represent the species previously called *aureostriatus* in Malaysia, the Philippines, Sri Lanka and Thailand (see additional information under *greenii* on p. 212). *Aedes aureostriatus* must be deleted from the Thailand list of species. However, it remains a valid species restricted to the eastern Indonesian/Australian regions. We are not addressing the status of the *aureostriatus* subspecies *okinawanus* Bohart, *doonii* Wattal, Bhatia and Kalra, and *taiwanus* Lien in this paper, other than to suggest that they may be more closely related to *greenii* than to *aureostriatus*.

19. *Aedes* (Fin.) *christophersi* Edwards was listed as a doubtful record because Knight and Stone (1977) did not include the Thurman (1959) record. Gould et al. (1982) reported *christophersi* from Kanchanaburi Province, thus it should be added to the list of Thailand species.

20. *Aedes* (Fin.) *dissimilis* (Leicester) was listed as a doubtful record because Knight and Stone (1977) did not include the Thurman (1959) record. Gould et al. (1982) reported *dissimilis* from Kanchanaburi Province, and Rattanaarithikul and Harrison (1988) reported it from Chiang Mai Province. The Chiang Mai specimens came from collection CM 132, in a tree hole on Doi Suthep. *Aedes dissimilis* should be added to the list of Thailand species. Reinert [Contrib. Am. Entomol. Inst. 26(2):in press] has revised *dissimilis* and related species. Additional records of *dissimilis* and closely related species in Thailand will appear in that publication.

21. *Aedes* (Fin.) *feegradei* Barraud, originally described from Burma, was included in the list based on the record of Scanlon and Esah (1965). There are 2 females in the NMNH from Doi Suthep, Chiang Mai Province that are identified as *feegradei*. These females (T-1391, T-1393) were collected in July 1962, presumably as part of the Scanlon and Esah study. Using the key in Barraud (1934) one female (T-1391) clearly has a row of white scales on the midline of the head and should be considered *Ae. assamensis* (Theobald), while the second female (T-1393) lacks a distinct median white scale row, but has several

scattered pale scales along the midline. The second female could be considered *feegradei*, however, we suspect it may be a variable specimen of *assamensis*, which is abundant in the Chiang Mai area. In the absence of other discernable differences between *assamensis* and *feegradei* females and the lack of males or immatures of *feegradei*, we cannot resolve the record of *feegradei* in Thailand at this time. Therefore, *feegradei* should remain in the list of Thailand species, but it is a questionable record that requires confirmation based on male genitalia and/or immature characters.

22. *Aedes* (Fin.) *greenii* (Theobald) was not included in Tsukamoto et al. (1987). As discussed on p. 211, we have determined that the specimens previously called *aureostriatus* in western Indonesia, Malaysia, the Philippines, Sri Lanka and Thailand actually represent *greenii*, here elevated from subspecies status under *aureostriatus* to species. There is a large topotypic collection of *greenii* from Sri Lanka in the NMNH, and specimens from Malaysia, the Philippines and Thailand closely match those specimens. A variety of *greenii* was described as *kanaranus* by Barraud (1924) from Kanara, Karwar (Malabar Strip) India. Edwards (1932) corrected this *lapsus calami* to *kanaranus* since the type locality was Kanara. Although we have not seen specimens of *greenii* or *kanaranus* from India, we have seen specimens matching *kanaranus* mixed in with the normal *greenii* specimens from Malaysia, the Philippines and Thailand. The only described difference separating *kanaranus* and *greenii* is a variation in the pale scale pattern on the scutum. Because of variation we have seen in the scutal scale pattern of *greenii* from Sri Lanka, and because *greenii*, *kanaranus*-like and intermediate specimens are found together, particularly in northern Thailand, we cannot support the retention of *kanaranus* as a subspecies. We here synonymize *kanaranus* and consider specimens previously identified as *kanaranus* as nothing more than morphological variations of *greenii*. There are numerous specimens of *greenii* in the NMNH from the following provinces of Thailand: Chanthaburi, Chiang Mai, Chon Buri, Kanchanaburi, Lampang, Nakhon Nayok, Nakhon Ratchasima, Nakhon Si Thammarat, Phangnga, Phuket, Surat Thani, Tak and Trang. *Aedes greenii* must be added to the Thailand list of species.

23. *Aedes* (Fin.) *hegneri* Causey was listed as a valid species by Tsukamoto et al. (1987). This species was described by Causey (1937a) from 8 males and 4 females reared from larvae collected in rock pools in "Chang Siam" [probably Chong, Trang Province], with the type specimens listed as deposited in the U.S. National Museum. Unfortunately, the types for *hegneri* were never received by the NMNH and they are presumed lost, along with the type of *Anopheles bulkleyi* Causey. Since the original description, the identity of *hegneri* has been a puzzle to taxonomists working in Thailand, although the record of *hegneri* in Thailand has been continued (Thurman 1959, Knight and Stone 1977, Tsukamoto et al. 1987).

There are 6 specimens in the NMNH collected by Causey in 1933 with the following data: O.R. Causey, South Siam, August 1933 (one specimen has Trang on the label). These specimens are labelled *Aedes hegneri*, and have E. Thurman 1959 determination labels on them. Our examination of these revealed 2 specimens too oily and rubbed for identification, while the remaining 4 specimens are clearly *Ae. macfarlanei* (Edwards). A study of Causey's original description of *hegneri* reveals it is a description of *macfarlanei*, with Causey even stating "harpago and tenth sternite similar to those of *Aedes macfarlandi* [sic]." Accordingly, we here synonymize *hegneri* under *macfarlanei*, and eliminate an enigma that has bothered mosquito workers in Thailand for 53 years. *Aedes hegneri* must be removed from the Thailand list of species.

24. *Aedes* (Fin.) *macdougalli* Edwards was listed as a doubtful record because Knight and Stone (1977) did not list the Thurman (1959) record. Actually, no additional specimens have been collected in Thailand to confirm the Thurman record. There is a large topotypic collection of *macdougalli* in the NMNH from Sri Lanka. An examination of these specimens revealed that *macdougalli* is very distinct and easily identified from similar species, viz., *Ae. elisiae* (Barraud), *Ae. macfarlanei* and *Ae. pseudotaeniatatus* (Giles). A thorough search of *Aedes* (Finlaya) specimens (identified and undetermined) in the NMNH revealed no *macdougalli* collected from outside of Sri Lanka. In fact, a substantial number of specimens from Malaysia labelled *macdougalli* proved to be misidentified *macfarlanei*. Based on this study we feel *macdougalli* does not occur in Thailand and must therefore be removed from the Thailand list of species. Actually, *macdougalli* may be restricted to Sri Lanka and southern India, and records from Sumatra (Indonesia) and the People's Republic of China (Knight and Stone 1977) probably are based on misidentifications.

25. *Aedes* (Fin.) *niveoides* Barraud was listed as a doubtful record because Knight and Stone (1977) did not include the Thurman (1959) record. Gould et al. (1982) collected hundreds of specimens of this species biting man in Sangkhlaburi District, Kanchanaburi Province in western Thailand. Knight and Harrison (1988) list this species as collected biting in association with *Ae.* (Fin.) *harinasutai* and *Ae.* (Fin.) *mikrokopion* in a bamboo grove in the above area. Confirmed specimens from Chiang Mai, Kanchanaburi, Nakhon Nayok, Nakhon Si Thammarat, Nan, Phangnga, Ranong and Trat provinces are in the NMNH. *Aedes niveoides* should be added to the Thailand list of mosquito species.

26. *Aedes* (Fin.) *niveus* (Ludlow) was listed as a species recorded from Thailand based on the records of Causey (1937a) and Scanlon and Esah (1965). After studying the Niveus Group of *Aedes* (Fin.) for over twenty years, K.L. Knight considers *niveus* restricted to the Philippines, and *Ae. leonis* (see p. 199) as the species previously identified as *niveus* in Thailand. *Aedes niveus* must be removed from the Thailand list of species.

27. *Aedes (Ochlerotatus) pulcritarsis* (Rondani). Snow (1986) corrected the spelling of the name for this species from *pulchritarsis* to *pulcritarsis* (the original spelling). Although Snow primarily corrected the spelling of an *Orthopodomyia* species, he mentioned *Aedes pulcritarsis*. The original Thailand record for this species came from specimen(s) collected in light traps (Thurman and Thurman 1955). No additional specimens of *pulcritarsis* have since been collected in Thailand. Because *pulcritarsis* is a Palearctic species with the nearest confirmed specimens from Kashmir, Pakistan (Barraud 1934), we are convinced that the Thurman record is based on a misidentification. Accordingly, *pulcritarsis* should be deleted from the Thailand list.

28. *Aedes (Stegomyia) edwardsi* Barraud was listed from Thailand based on specimens identified as this species from Ko Samui, Surat Thani Province (Gould et al. 1968). Huang (1977), however, determined that *edwardsi* is only known from the Andaman Islands, India. Thus, the specimens of *edwardsi* reported by Gould et al. (1968) must be considered misidentifications [probably of *Ae. gardnerii imitator* (Leicester) - see Huang (1977) for records of *gardnerii imitator* taken on Ko Samui during the Gould et al. study]. Accordingly, *edwardsi* must be deleted from the Thailand list.

29. *Aedes (Stg.) gardnerii imitator* (Leicester). The first published record of this species in Thailand was Mattingly (1965). Harrison et al. (1972) reported this species in Ang Thong, Lop Buri and Sara Buri provinces.

30. *Aedes (Stg.) pseudalbopictus* (Borel). The first published record of this species in Thailand was Harrison et al. (1972) from Ang Thong and Nakhon Sawan provinces.

31. *Aedes (Stg.) scutellaris malayensis* Colless. The record of *Ae. scutellaris* (Walker) from Surat Thani Province by Gould et al. (1968) was a misidentification. Their specimens actually represented *malayensis*. Huang (1972) elevated *malayensis* to species status; however, Colless (1973) felt it should be retained as a subspecies until decisive evidence was accrued. The current consensus, with which we concur, recognizes *malayensis* as a valid species (Dev 1987). Thus, *malayensis* should appear as a species in the Thailand list, and *scutellaris* should be removed from the list.

32. *Aedes (Stg.) subalbopictus* Barraud. Huang (1972, 1979) determined that *subalbopictus* is confined to India. The records of this species from Thailand (Thurman 1959, Scanlon and Esah 1965, Gould et al. 1968) must be considered misidentifications and *subalbopictus* must be deleted from the Thailand list.

33. *Armigeres (Arm.) kesseli* Ramalingam (1987) was included in the list of species based on previous references (Thurman 1959, Scanlon and Esah 1965, Gould et al. 1968) to *Ar. durhami* Edwards occurring in Thailand. The specimens responsible for the listing of "*Ar. sp. (near subalbatus)*" in Gould et al. (1982:562) were *kesseli* as

identified by a preliminary key provided by S. Ramalingam. Based on these references, *kesseli* has been collected in the following provinces of Thailand: Chiang Mai, Kanchanaburi and Surat Thani. Actually, it is probably widespread throughout the lower elevations of Thailand, where it is probably confused with *Ar. subalbatus* (Coquillett). With the description of *kesseli*, no evidence remains for the occurrence of *durhami* in Thailand.

34. *Armigeres obturbans* (Walker) was listed as present in Thailand based on the records of Causey (1937b) and Iyengar (1953). Thurman (1958) determined that the common *Armigeres* species on mainland Southeast Asia is *Ar. subalbatus* (Coquillett), which is the *obturbans* of Barraud (1934) and most other authors (*nec* Walker 1859). Thurman also thought that the use of the name *obturbans sensu* Walker should be restricted to specimens from around the type locality (Sulawesi), if it was used at all. Following this work, Stone et al. (1959) considered *Ar. obturbans* (Walker) a *nomen dubium*. Knight and Stone (1977) also listed this name as a *nomen dubium*. Having this status means the name is not available for taxonomic purposes. Accordingly, the name *Ar. obturbans* (Walker) must be deleted from the Thailand list.

35. *Heizmannia* (Hez.) *greenii* (Theobald) was listed as a doubtful record. The record of Causey (1937b) was repeated by Thurman (1959) who provided a description and noted that this species "should occur" in northern Thailand. Mattingly (1970) considered the Thailand record as based on misidentifications and thought *greenii* was confined to southern India and Sri Lanka. Recently, Amerasinghe (1989) redescribed *greenii* based on Sri Lankan (topotypic) specimens and noted "the evidence points to *greenii* being restricted to Sri Lanka and southern India." Amerasinghe also made the following comment about the Thailand record: "Thurman's (1959) record of *greenii* from Thailand is definitely not this species, as the postpronotum is described as dark-scaled (pale-scaled in true *greenii*)." Thus, *greenii* should not be included in the Thailand list of species.

36. *Culex (Cux.) cornutus* Edwards was listed as a doubtful species in Thailand. Sirivanakarn (1976) lists *cornutus* from India and Pakistan. The old record of this species in Thailand (Thurman 1959) should be considered a misidentification (Bram 1967), and *cornutus* should not be included in the list of Thailand species.

37. *Culex (Cux.) theileri* Theobald was listed as a doubtful species in Thailand because the specimen on which the record was based (Thurman 1959) was identified by Bram (1967) as *Cx. annulus* Theobald, now a synonym of *Cx. vishnui* Theobald. *Culex theileri* has a very wide distribution (Barraud 1934, Harbach 1988) and seems to be most common in parts of Africa, the Mediterranean area and southwestern Asia, however, it does extend eastward across northern India into Assam, Myanmar (Northern Shan States) and the southwestern portion of the People's Republic of China. The nearest confirmed speci-

men of *theileri* to Thailand is the holotype of synonym *Cx. pettigrewii* Theobald, which came from Assam State, north-eastern India. Considering the approximately 1,000 km between Assam and northern Thailand, and because we have not seen a *Culex* specimen similar to *theileri* in the 28 years of collecting by AFRIMS personnel in Thailand, we do not believe *theileri* occurs in Thailand. This species should not be included in the Thailand list.

38. *Culex (Cux.) univittatus* Theobald was listed as a doubtful record based on a Thurman (1959) record. Harbach (1988) has clearly shown that *univittatus* is an African species that extends eastward only onto the southwestern corner of the Arabian Peninsula. The species previously called *univittatus* in the Mediterranean area and eastward to Pakistan and the northwestern part of India (Barraud 1934) is *Cx. perexiguus* Theobald (Harbach 1988). *Culex perexiguus* does not extend across northern India to reach the Southeast Asian Subregion. Therefore, we feel the Thurman record of *perexiguus* (as *univittatus*) is a misidentification. Neither of these species should be included in the list of Thailand species.

39. *Culex (Culiciomyia) viridiventer* Giles was listed as a doubtful record because the specimens identified as this species by Thurman (1959) were misidentified and used by Bram (1967) to describe *Cx. thurmanorum* Bram. Sirivanakarn (1977a), however, redescribed *viridiventer* based on material from India and the People's Republic of China and noted that it may be conspecific with *Cx. spiculothorax* Bram, a Thailand and Malaysian species that has a larva very similar to that of *viridiventer*. If true, *spiculothorax* might become a synonym of *viridiventer* and the latter would be a valid record for Thailand. *Culex viridiventer* should be added to the Thai list and remain a questionable record until the relationship of *spiculothorax/viridiventer* is resolved.

40. *Culex (Mochthogenes) castrensis* Edwards was listed as a doubtful record. Sirivanakarn (1971) resurrected *Eumelanomyia* Theobald to subgeneric status and downgraded *Mochthogenes* to a species group in that subgenus. Sirivanakarn (1972) determined that *castrensis* is confined to India and Sri Lanka, thus it should not be included in the Thailand list.

41. *Culex (Eum.) khazani* Edwards was listed as a doubtful record. Sirivanakarn (1972) determined that this species only occurs in India, thus *khazani* should not be included in the Thailand list.

42. *Culex (Eum.) macrostylus* Sirivanakarn and Ramalingam was listed as occurring in Thailand based on the record of this species in Chiang Mai Province (Miyagi et al. 1986). However, the *macrostylus* of Miyagi et al. (1986) actually represents a new species described as *Cx. oresbius* by Harbach and Rattanakul (1988). *Culex macrostylus* should be deleted from the list of species occurring in Thailand.

43. *Culex (Lophoceraomyia) flavicornis* Barraud was listed as a misidentification by Thurman (1959), as deter-

mined by Bram and Rattanakul (1967). Sirivanakarn (1977b) determined that this species is known only from India, thus *flavicornis* should not be included in the Thailand list.

44. *Culex (Lop.) fraudatrix* (Theobald) was listed as a doubtful record because the early Causey (1937b) specimens were a mixture of 2 other species (Bram 1967). Knight and Stone (1977) list the distribution of *fraudatrix* as New Guinea, Australia and Indonesia. Colless (1965) showed that *Cx. variatus* (Leicester), a common species in Southeast Asia that previously was considered a synonym of *fraudatrix*, was a valid species, and Sirivanakarn (1977b) concurred with this. *Culex fraudatrix* is an Australasian species that should not be included in the Thailand list of species.

45. *Culex (Lop.) minutissimus* (Theobald) was listed in the regular list and as a doubtful record. The rationale for Tsukamoto et al. (1987) listing *minutissimus* in both places is unclear. Sirivanakarn (1977b) found specimens of this species from Phrae Province, thus its presence in Thailand has been confirmed.

46. *Culex (Lop.) uniformis* (Theobald) was listed as a doubtful record because Bram (1967) considered the specimens identified as *uniformis* by Thurman (1959) to be either *Cx. minor* (Leicester) or *Cx. spiculosus* Bram and Rattanakul. Sirivanakarn (1977b) demonstrated that *uniformis* is restricted to India and Sri Lanka, and that previous records of this species outside those 2 countries probably apply to *Cx. kuhnsi* King and Hoogstraal (for Philippine records), and *spiculosus*. *Culex uniformis* should not be included in the Thailand list.

47. *Mimomyia (Ravenalites) fusca* (Leicester) was listed in uncertain status because the record of this species in Thailand (Thurman and Thurman 1955, Thurman 1959) was not included in Knight and Stone (1977). This species has been recognized in Thailand since the Thurmans began their work in the Chiang Mai area, and numerous specimens have been collected since. There are 104 specimens of *fusca* (19♂, 12♀, 27Pe, 8Le, 1P, 37L) in the NMNH from the following provinces: Chanthaburi, Chiang Mai, Nakhon Nayok, Nakhon Si Thammarat and Narathiwat. Many of the adults have the abdominal terga and sterna similar to those described for *Mi. deguzmanae* Mattingly, however the associated exuviae clearly show they are *fusca*. White (1974) determined that subgenus *Ravenalites* Doucet is a junior synonym of *Ingramia* Edwards. Accordingly, *fusca* now belongs in subgenus *Ingramia* of *Mimomyia*, and must be added to the list of Thailand mosquito species.

48. *Coquillettidia (Coq.)* sp. (near *giblini*) was listed as occurring in Thailand based on the early records of Iyengar (1953), Iyengar and Menon (1956), Macdonald (1957) and Thurman (1959). Macdonald (1957) indicated that the Malaysian specimens did not agree well with *giblini* from the Australasian Region, and he suspected that 2 species may be involved in the name *giblini*. Macdonald's suspi-

cions were confirmed by Wharton (1962) who elevated *Cq. nigrosignata* (Edwards) to species status for the specimens previously identified as *giblini* in the Southeast Asian Subregion of the Oriental Region. Thus, the *giblini* of authors in Thailand refers to *nigrosignata*. One female of *Cq. nigrosignata* was collected biting man outdoors in southern Thailand by BAH in 1969. This female was collected between 1900-1959 h in Nakhon Si Thammarat Province, Tung Song District, Ban Champa Mu 2, on 4 February 69. The listing of *Cq. giblini* should be deleted and *Cq. nigrosignata* should be added to the list of species in Thailand.

49. *Uranotaenia* (Pfc.) *atra* Theobald was listed as a doubtful record with the record of Causey (1937b) being considered a misidentification. Although Causey (1937b) reported this species as widespread in Thailand, references to this species in any country in the Oriental Region should be viewed as a misidentification of *Ur. (Ura.) lateralis* Theobald. *Uranotaenia atra* has an Australasian distribution (Knight and Stone 1977). The confusion regarding *atra* traces to Edwards (1913) who incorrectly synonymized *Ur. ceylonica* Theobald with *atra*. Later Edwards (1922b) incorrectly synonymized *Ur. cancer* Leicester, *Ur. lateralis*, *Ur. propria* Taylor, and *Ur. caim-sensis* Taylor with *atra*. Stone (1957) removed *lateralis* from synonymy with *atra*. However, because Barraud (1934) is still the primary reference source for most culicines of mainland Southeast Asia and India, it is probably the source for most misidentifications of *lateralis* as *atra*. Barraud included the synonymies of Edwards (*supra cit.*) under *atra*, presented descriptions and keys to the female and male, and illustrations of the unique male foretarsus, midtarsomeres 4 and 5, the hindtibia and portions of the larva. These clearly match the type specimens of *lateralis* and its synonyms listed in Knight and Stone (1977). *Uranotaenia atra* should not be included in the list of Thailand species or that of any other country in the Oriental Region.

50. *Uranotaenia* (Pfc.) *maculipleura* Leicester was listed as doubtful, with the Thurman (1959) record probably due to a misidentification. Peyton (1977) was unable to verify this species outside of Malaysia. No specimens of *maculipleura* were found in the Thurman collection. The records of *maculipleura* from India, Thailand and Taiwan should be disregarded. This species should not be included in the list of species for Thailand.

51. *Uranotaenia* (Pfc.) *recondita* Edwards was included in the list of species in Thailand based on the early records of Iyengar (1953), Thurman and Thurman (1955) and Thurman (1959). We feel that both of these records were based on misidentifications, and we have confirmed that 2 larvae (Coll. No. M416) labeled as *recondita* in the Thurman collection are actually specimens of *Ur. hebes* Barraud. After an exhaustive study of many thousands of specimens of *Uranotaenia* from the Oriental Region by Peyton (1972, 1977), the only confirmed specimens of

recondita found were the holotype male and 2 paratype females from the type locality in Karwar, N. Kanara, southwest India. We therefore propose that the Thailand records of *recondita* were erroneous and should be disregarded. *Uranotaenia recondita* should be deleted from the Thailand list of species.

52. *Uranotaenia* (Ura.) *alboannulata* (Theobald) was listed (based on Thurman 1959) as a doubtful record because Knight and Stone (1977) listed its distribution as limited to India and Sri Lanka. The Thurman (1959) record of *alboannulata* from Thailand was based on misidentified specimens of *Ur. trilineata* Leicester. Thus, *alboannulata* should not be included in the list of species for Thailand.

53. *Uranotaenia* (Ura.) *macfarlanei zelena* Barraud was included in the list of Thailand species based on the Thurman (1959) record. However, as indicated earlier under *macfarlanei* Edwards (p. 201), *zelena* Barraud is a synonym of *macfarlanei* and must be deleted from the Thailand list of species.

54. *Uranotaenia* (Ura.) *micans* Leicester was listed as an uncertain record because of confusion with *Ur. bimaculiala* Leicester. As shown on p. 201, *micans* is a valid entry and must be added to the Thailand list of species.

55. *Uranotaenia* (Ura.) *orientalis* Barraud was listed as a questionable record because Knight and Stone (1977) overlooked the Causey (1937b) record and listed its distribution as limited to India. During extensive studies on this genus by ELP, a single female of *orientalis* was found from Khon Kaen Province in the Thurman or Griffith collection. This female was collected on 15-16 January 1954, and compares very favorably with the holotype male of *orientalis* from Golaghat, Assam, India, and 1 male and 3 females from Sanatput, Calcutta, India, in the NHM. It obviously is not a common species in Thailand. *Uranotaenia orientalis* must be added to the Thailand list of species.

DISCUSSION AND SUMMARY

Knight and Stone (1977), Knight (1978a), Ward (1984) and Gaffigan and Ward (1985) list 347 species/subspecies in Thailand (or as Oriental Region or Cosmotropical), while the checklist of Tsukamoto et al. (1987) lists 384 species/subspecies (described and undescribed) from Thailand. Our findings significantly alter those numbers, with certain species being deleted and many others added. Based on our results we consider the number of valid mosquito species/subspecies in Thailand to currently total 410 (see Appendix). This represents 63 more species/subspecies than listed in the world mosquito catalog and supplements and 32 more valid species/subspecies than given in the most recent published checklist for Thailand. To assist the reader we have added page numbers following the species names that refer to the location of the specific entries in the text.

Names of the following 19 species/subspecies are deleted from the Tsukamoto et al. (1987) checklist.

<i>An. (Ano.) gigas</i> (p. 208)	<i>Ae. (Fin.) aureostriatus</i> (p. 211)	<i>Cx. (Eum.) macrostylus</i> (p. 214)
<i>An. (Ano.) lesteri paraliae</i> (p. 208)	<i>Ae. (Fin.) hegneri</i> (p. 212)	<i>Cq. (Coq.) sp. (near giblini)</i> (p. 214)
<i>An. (Cel.) balabacensis introlatus</i> (p. 202-203, 207, 209)	<i>Ae. (Fin.) niveus</i> (p. 212)	<i>Ur. (Pfc.) recondita</i> (p. 215)
<i>An. (Cel.) culicifacies</i> (205, 209)	<i>Ae. (Och.) pulcritarsis</i> (p. 213)	<i>Ur. (Ura.) macfarlanei zelena</i> (p. 201, 215)
<i>An. (Cel.) minimus</i> (p. 203, 208)	<i>Ae. (Stg.) edwardsi</i> (p. 213)	<i>Ur. (Ura.) sp. 1 (near micans)</i> (p. 201, 215)
<i>An. (Cel.) riparis macarthuri</i> (p. 205, 210)	<i>Ae. (Stg.) scutellaris malayensis</i> (p. 213)	
	<i>Ae. (Stg.) subalbopictus</i> (p. 213)	
	<i>Ar. obturbans</i> (p. 213)	

The following 51 species/subspecies are added to the Tsukamoto et al. (1987) checklist.

<i>An. (Ano.) baileyi</i> (p. 208-209)	<i>Ae. (Fin.) ganapathi</i> (p. 199)	<i>Ar. (Arm.) maximus</i> (p. 203)
<i>An. (Ano.) lindesayi cameronensis</i> (p. 197-199)	<i>Ae. (Fin.) greenii</i> (p. 211-212)	<i>Ar. (Arm.) moultoni</i> (p. 204)
<i>An. (Ano.) paraliae</i> (p. 208)	<i>Ae. (Fin.) inermis</i> (p. 199)	<i>Hs. (Hez.) taiwanensis</i> (p. 204)
<i>An. (Cel.) culicifacies B</i> (p. 205, 209)	<i>Ae. (Fin.) jugraensis</i> (p. 199)	<i>Hs. (Mat.) catesi</i> (p. 200)
<i>An. (Cel.) dirus B</i> (p. 209)	<i>Ae. (Fin.) leonis</i> (p. 199)	<i>Cx. (Cux.) edwardsi</i> (p. 204)
<i>An. (Cel.) dirus C</i> (p. 209)	<i>Ae. (Fin.) litoreus</i> (p. 203)	<i>Cx. (Cui.) viridiventer</i> (p. 214)
<i>An. (Cel.) dirus D</i> (p. 209)	<i>Ae. (Fin.) lophoventralis</i> (p. 199)	<i>Cx. (Eum.) oresbius</i> (p. 201)
<i>An. (Cel.) introlatus</i> (p. 202, 207, 209)	<i>Ae. (Fin.) mikrokopion</i> (p. 201)	<i>Cx. (Eum.) richei</i> (p. 204)
<i>An. (Cel.) leucosphyrus A (non leucosphyrus Doenitz)</i> (p. 202-203, 210)	<i>Ae. (Fin.) niveoides</i> (p. 212)	<i>Mi. (Ing.) fusca</i> (p. 214)
<i>An. (Cel.) macarthuri</i> (p. 205, 210)	<i>Ae. (Fin.) novoniveus</i> (p. 199)	<i>Cq. (Coq.) nigrosignata</i> (p. 214)
<i>An. (Cel.) minimus A</i> (p. 203, 208)	<i>Ae. (Fin.) pexus</i> (p. 199)	<i>Ma. (Mnd.) annulata</i> (p. 204)
<i>An. (Cel.) minimus C</i> (p. 203-208))	<i>Ae. (Fin.) prominens</i> (p. 203)	<i>Ur. (Ura.) hebes</i> (p. 200)
<i>An. (Cel.) nemophilous</i> (p. 201, 207)	<i>Ae. (Fin.) pseudoniveus</i> (p. 200)	<i>Ur. (Ura.) macfarlanei</i> (p. 201, 215)
<i>Ae. (Dic.) franciscoi</i> (p. 199)	<i>Ae. (Fin.) reinerti</i> (p. 201)	<i>Ur. (Ura.) micans</i> (p. 201, 215)
<i>Ae. (Fin.) christophersi</i> (p. 211)	<i>Ae. (Fin.) subniveus</i> (p. 200)	<i>Ur. (Ura.) orientalis</i> (p. 215)
<i>Ae. (Fin.) dissimilis</i> (p. 211)	<i>Ae. (Fin.) unicinctus</i> (p. 200)	<i>Ur. (Ura.) subnormalis</i> (p. 201)
	<i>Ae. (Fin.) vanus</i> (p. 200)	<i>To. (Sua.) suchariti</i> (p. 202)
	<i>Ae. (Stg.) malayensis</i> (p. 213)	

The following 20 species were not included in the Thailand checklist by Tsukamoto et al. (1987), but their status in Thailand was questionable or doubtful, or they were considered misidentifications. Our review of each of these species reveals they should not be included in the Thailand checklist.

<i>An. (Ano.) aitkenii</i> (p. 207-208)	<i>Ae. (Fin.) macdougalli</i> (p. 212)	<i>Cx. (Lop.) flavicornis</i> (p. 214)
<i>An. (Cel.) filipinae</i> (p. 210)	<i>Hs. (Hez.) greenii</i> (p. 213)	<i>Cx. (Lop.) fraudatrix</i> (p. 214)
<i>An. (Cel.) fluviatilis</i> (p. 210)	<i>Cx. (Cux.) cornutus</i> (p. 213)	<i>Cx. (Lop.) uniformis</i> (p. 214)
<i>An. (Cel.) ludlowae</i> (p. 210)	<i>Cx. (Cux.) theileri</i> (p. 213)	<i>Ur. (Pfc.) atra</i> (p. 215)
<i>An. (Cel.) maculipalpis</i> (p. 210)	<i>Cx. (Cux.) univittatus</i> (p. 214)	<i>Ur. (Pfc.) maculipleura</i> (p. 215)
<i>An. (Cel.) punctulatus</i> (p. 210)	<i>Cx. (Eum.) castrensis</i> (p. 214)	<i>Ur. (Ura.) alboannulata</i> (p. 215)
<i>Ae. (Can.) curtipes</i> (p. 210)	<i>Cx. (Eum.) khazani</i> (p. 214)	

Additional notes, distribution extensions and other comments were also provided for the following 34 species that are part of the Thailand fauna.

<i>An. (Ano.) aberrans</i> (p. 204, 207)	<i>An. (Cel.) nivipes</i> (p. 208)	<i>Ae. (Fin.) greenii</i> (p. 212)
<i>An. (Ano.) donaldi</i> (p. 208)	<i>An. (Cel.) pampanai</i> (p. 205, 208)	<i>Ae. (Fin.) niveoides</i> (p. 212)
<i>An. (Ano.) fragilis</i> (p. 205)	<i>An. (Cel.) philippinensis</i> (p. 205)	<i>Ae. (Isa.) cavaticus</i> (p. 206)
<i>An. (Ano.) insulaeflorum</i> (p. 207)	<i>An. (Cel.) stephensi</i> (p. 206)	<i>Ae. (Stg.) gardnerii imitator</i> (p. 213)
<i>An. (Ano.) kyondawensis</i> (p. 205)	<i>An. (Cel.) varuna</i> (p. 206)	<i>Ae. (Stg.) pseudalbopictus</i> (p. 213)
<i>An. (Ano.) paraliae</i> (p. 208)	<i>Ae. (Bot.) helenae</i> (p. 206)	<i>Ar. (Arm.) kesseli</i> (p. 213)
<i>An. (Ano.) separatus</i> (p. 205)	<i>Ae. (Chr.) thomsoni</i> (p. 210)	<i>Hs. (Mat.) thelmae</i> (p. 206)
<i>An. (Ano.) tigertti</i> (p. 205)	<i>Ae. (Dic.) iyengari</i> (p. 206)	<i>Cx. (Cux.) barraudi</i> (p. 206)
<i>An. (Cel.) culicifacies B</i> (p. 205, 209)	<i>Ae. (Dic.) whartoni</i> (p. 206)	<i>Ur. (Pfc.) enigmatica</i> (p. 207)
<i>An. (Cel.) indefinitus</i> (p. 210)	<i>Ae. (Fin.) alboniveus</i> (p. 211)	<i>Ur. (Pfc.) gouldi</i> (p. 207)
<i>An. (Cel.) macarthuri</i> (p. 205, 210)	<i>Ae. (Fin.) albotaeniatus</i> (p. 211)	
<i>An. (Cel.) minimus</i> (p. 203, 208)	<i>Ae. (Fin.) feegradei</i> (p. 211)	

Aedes (Adm.) lowisii (Theobald) was inadvertently listed as occurring in Thailand by Peyton and Ramalingam (1988). This record should not be included in the checklist of Thailand mosquitoes because the record was based on a specimen misidentified in the early 1960s.

The following 6 undetermined species that were in Tsukamoto et al. (1987) and that were listed but undescribed by Miyagi et al. (1986) are not included in our checklist.

Aedes (Cnecraedes) sp. (near *thurmanae*)

Topomyia (Suaymyia) sp. 1 (near *decorabilis*)

Topomyia (Topomyia) sp. 2 (near *aenea*)

Topomyia (Topomyia) sp. 3 (near *svastii*)

Topomyia (Top.?) sp. 4

Uranotaenia (Uranotaenia) sp. 2

Ur. (Ura.) sp. 1 (near *micans*) is considered equal to *micans* in the appendix.

Besides the above faunal changes and distribution extensions for Thailand, the following actions were taken in this paper:

1. Five subspecies were elevated to species: *An. baileyi* Edwards (p. 209), *An. nilgircus* Christophers (p. 199), *An. paraliae* Sandosham (p. 208), *Ae. greenii* (Theobald) (p. 211), and *Ae. leonis* Colless (p. 199).

2. Three species/subspecies were synonymized: *Ae. hegneri* Causey is a synonym of *Ae. macfarlanei* (Edwards) (p. 212), *Finlaya greeni* var. *kanaranus* Barraud is a synonym of *Ae. greenii* (Theobald) (p. 212), and *Ae. mikiranus* Edwards is a synonym of *Ae. albotaeniatus* (Leicester) (p. 211).

3. The distributions of 8 species were restricted to specific areas outside Thailand: *An. aikenii* James to India/Sri Lanka [reemphasis of Harrison and Scanlon (1975:150)], *An. filipinae* Manalang to the Philippines, *An. nilgircus* Christophers to southern India, *Ae. aureostriatus* (Doleschall) to eastern Indonesia/New Guinea area, *Ae. macdougalli* Edwards to Sri Lanka and southern India, *Ae. niveus* (Ludlow) to the Philippines, *Ur. maculipleura* Leicester to Malaysia, and *Ur. recondita* Edwards to southwestern India (Malabar Strip).

4. Three new records were established for species outside of Thailand: *An. pampanai* Buettiker and Beales in Vietnam (reemphasis of Harrison 1980:103) (p. 208), *Ae. lophoventralis* (Theobald) in Vietnam (p. 199), and *Hs. taiwanensis* Lien in peninsular Malaysia (p. 204).

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APPENDIX. CHECKLIST OF THE CULICIDAE FOUND IN THAILAND

Anopheles (Anopheles)

1. *aberrans* Harrison and Scanlon
2. *argyropus* (Swellengrebel)
3. *asiaticus* Leicester
4. *baezai* Gater
5. *baileyi* Edwards
6. *barbirostris* Van der Wulp
7. *barbumbrosus* Strickland and Chowdhury
8. *bengalensis* Puri
9. *bulkeleyi* Causey
10. *campestris* Reid
11. *crawfordi* Reid
12. *donaldi* Reid
13. *fragilis* (Theobald)
14. *hodgkini* Reid
15. *insulaeflorum* (Swellengrebel and Swellengrebel de Graaf)
16. *interruptus* Puri
17. *kyondawensis* Abraham
18. *letifer* Sandosham
19. *lindesayi cameronensis* Edwards
20. *montanus* Stanton and Hacker
21. *nigerrimus* Giles
22. *nitidus* Harrison, Scanlon and Reid
23. *palmatius* (Rodenwaldt)
24. *paraliae* Sandosham
25. *peditaeniatus* (Leicester)
26. *pollicaris* Reid
27. *pursati* Laveran
28. *roperi* Reid
29. *separatus* (Leicester)
30. *sinensis* Wiedemann
31. *sintonoides* Ho
32. *stricklandi* Reid
33. *tigerti* Scanlon and Peyton
34. *umbrosus* (Theobald)
35. *whartoni* Reid

Anopheles (Cellia)

36. *aconitus* Doenitz
37. *annularis* Van der Wulp
38. *culicifacies* B
39. *dirus* Peyton and Harrison
40. *dirus* B
41. *dirus* C
42. *dirus* D
43. *dravidicus* Christophers
44. *hackeri* Edwards
45. *indefinitus* (Ludlow)
46. *introlatus* Colless
47. *jamesii* Theobald
48. *jeyporiensis* James

49. *karwari* (James)
50. *kochi* Doenitz
51. *leucosphyrus* A
52. *macarthuri* Colless
53. *maculatus* Theobald
54. *minimus* A
55. *minimus* C
56. *nemophilous* Peyton and Ramalingam
57. *nivipes* (Theobald)
58. *notanandai* Rattananarithikul and Green
59. *pampanai* Buettiker and Beales
60. *philippinensis* Ludlow
61. *pseudojamesi* Strickland and Choudhury
62. *pseudowillmori* (Theobald)
63. *pujutensis* Colless
64. *sawadwongporni* Rattananarithikul and Green
65. *splendidus* Koidzumii
66. *stephensi* Liston
67. *subpictus* Grassi
68. *sundaicus* (Rodenwaldt)
69. *tessellatus* Theobald
70. *vagus* Doenitz
71. *varuna* Iyengar
72. *willmori* (James)

Aedeomyia

73. *catasticta* Knab

Aedes (Aedimorphus)

74. *alboscuteallatus* (Theobald)
75. *caecus* (Theobald)
76. *culicinus* Edwards
77. *mediolineatus* (Theobald)
78. *orbitae* Edwards
79. *pallidostriatus* (Theobald)
80. *pampangensis* (Ludlow)
81. *pipersalatus* (Giles)
82. *vexans* (Meigen)
83. *vittatus* (Bigot)

Aedes (Alanstonea)

84. *treubi* (De Meijere)

Aedes (Ayurakitia)

85. *griffithi* Thurman
86. *peytoni* Reinert

Aedes (Bothaella)

87. *eldridgei* Reinert
88. *helenae* Reinert

Aedes (Cancraedes)

- 89. *indonesiae* Mattingly
- 90. *kohkutensis* Mattingly

Aedes (Christophersiomyia)

- 91. *annulirostris* (Theobald)
- 92. *ibis* Barraud
- 93. *thomsoni* (Theobald)

Aedes (Diceromyia)

- 94. *franciscoi* Mattingly
- 95. *iyengari* Edwards
- 96. *pseudonummatus* Reinert
- 97. *scanloni* Reinert
- 98. *whartoni* Mattingly

Aedes (Edwardsaedes)

- 99. *imprimens* (Walker)

Aedes (Finlaya)

- 100. *albolateralis* (Theobald)
- 101. *alboniveus* Barraud
- 102. *albotaeniatus* (Leicester)
- 103. *assamensis* (Theobald)
- 104. *christophersi* Edwards
- 105. *chrysolineatus* (Theobald)
- 106. *dissimilis* (Leicester)
- 107. *elsiae* (Barraud)
- 108. *feegradei* Barraud
- 109. *flavipennis* (Giles)
- 110. *formosensis* Yamada
- 111. *ganapathi* Colless
- 112. *greenii* (Theobald)
- 113. *harinasutai* Knight
- 114. *harveyi* (Barraud)
- 115. *inermis* Colless
- 116. *jugraensis* (Leicester)
- 117. *khazani* Edwards
- 118. *leonis* Colless
- 119. *litoreus* Colless
- 120. *lophoventralis* (Theobald)
- 121. *macfarlanei* (Edwards)
- 122. *mikrokokion* Knight and Harrison
- 123. *niveoides* Barraud
- 124. *novoniveus* Barraud
- 125. *pexus* Colless
- 126. *poicilius* (Theobald)
- 127. *prominens* (Barraud)
- 128. *pseudoniveus* (Theobald)
- 129. *pseudotaeniatus* (Giles)
- 130. *pulchriventer* (Giles)
- 131. *reinerti* Rattanarithikul and Harrison

- 132. *saxicola* Edwards
- 133. *shortti* (Barraud)
- 134. *simlensis* Edwards
- 135. *subniveus* Edwards
- 136. *togoi* (Theobald)
- 137. *unicinctus* Edwards
- 138. *vanus* Colless

Aedes (Isoaedes)

- 139. *cavaticus* Reinert

Aedes (Lorrainea)

- 140. *amesii* (Ludlow)
- 141. *fumidus* Edwards

Aedes (Mucidus)

- 142. *laniger* (Wiedemann)
- 143. *quasiferinus* Mattingly

Aedes (Neomelaniconion)

- 144. *lineatopennis* (Ludlow)

Aedes (Ochlerotatus)

- 145. *vigilax* (Skuse)

Aedes (Paraedes)

- 146. *ostentatio* (Leicester)
- 147. *thailandensis* Reinert

Aedes (Rhinoskusea)

- 148. *longirostris* (Leicester)

Aedes (Scutomyia)

- 149. *albolineatus* (Theobald)

Aedes (Stegomyia)

- 150. *aegypti* (Linnaeus)
- 151. *albopictus* (Skuse)
- 152. *annandalei* (Theobald)
- 153. *craggi* (Barraud)
- 154. *desmotes* (Giles)
- 155. *gardnerii imitator* (Leicester)
- 156. *malayensis* Colless
- 157. *malikuli* Huang
- 158. *novalbopictus* Barraud
- 159. *patriciae* Mattingly
- 160. *perplexus* (Leicester)
- 161. *pseudalbopictus* (Borel)
- 162. *seatoi* Huang
- 163. *w-albus* (Theobald)

Aedes (Verrallina)

- 164. *adustus* Laffoon
- 165. *andamanensis* Edwards
- 166. *atrius* Barraud
- 167. *butleri* Theobald
- 168. *clavatus* Barraud
- 169. *cretatus* Delfinado
- 170. *cyrtolabis* Edwards
- 171. *dux* Dyar and Shannon
- 172. *gibbosus* Delfinado
- 173. *hispidus* Delfinado
- 174. *incertus* Edwards
- 175. *indecorabilis* (Leicester)
- 176. *latipennis* Delfinado
- 177. *lugubris* Barraud
- 178. *notabilis* Delfinado
- 179. *phnomus* Klein
- 180. *protuberans* Delfinado
- 181. *pseudodurum* (Theobald)
- 182. *sohni* Reinert
- 183. *torosus* Delfinado
- 184. *uncus* (Theobald)
- 185. *vallistris* Barraud
- 186. *yusafi* Barraud

Armigeres (Armigeres)

- 187. *aureolineatus* (Leicester)
- 188. *bhayungi* Thurman and Thurman
- 189. *jugraensis* (Leicester)
- 190. *kesseli* Ramalingam
- 191. *kuchingensis* Edwards
- 192. *malayi* (Theobald)
- 193. *maximus* Edwards
- 194. *moultoni* Edwards
- 195. *subalbatus* (Coquillett)
- 196. *theobaldi* Barraud

Armigeres (Leicesteria)

- 197. *annulipalpis* (Theobald)
- 198. *annulitarsis* (Leicester)
- 199. *balteatus* Macdonald
- 200. *dentatus* Barraud
- 201. *digitatus* (Edwards)
- 202. *dolichocephalus* (Leicester)
- 203. *flavus* (Leicester)
- 204. *inchoatus* Barraud
- 205. *longipalpis* (Leicester)
- 206. *magnus* (Theobald)
- 207. *omissus* (Edwards)
- 208. *pectinatus* (Edwards)
- 209. *vimoli* Thurman and Thurman

Heizmannia (Heizmannia)

- 210. *aureochaeta* (Leicester)
- 211. *chengi* Lien
- 212. *communis* (Leicester)
- 213. *complex* (Theobald)
- 214. *covelli* Barraud
- 215. *demeilloni* Mattingly
- 216. *macdonaldi* Mattingly
- 217. *mattinglyi* Thurman
- 218. *persimilis* Mattingly
- 219. *propinqua* Mattingly
- 220. *proxima* Mattingly
- 221. *reidi* Mattingly
- 222. *scanloni* Mattingly
- 223. *scintillans* Ludlow
- 224. *taiwanensis* Lien

Heizmannia (Mattinglyia)

- 225. *achaetae* (Leicester)
- 226. *catesi* Lien
- 227. *thelmae* Mattingly

Udaya

- 228. *argyrurus* (Edwards)

Culex (Culex)

- 229. *alienus* Colless
- 230. *alis* Theobald
- 231. *barraudi* Edwards
- 232. *bitaeniorhynchus* Giles
- 233. *edwardsi* Barraud
- 234. *fuscocephala* Theobald
- 235. *gelidus* Theobald
- 236. *hutchinsoni* Barraud
- 237. *infula* Theobald
- 238. *jacksoni* Edwards
- 239. *longicornis* Sirivanakarn
- 240. *mimeticus* Noe
- 241. *mimulus* Edwards
- 242. *murrelli* Lien
- 243. *perplexus* Leicester
- 244. *pseudosinensis* Colless
- 245. *pseudovishnui* Colless
- 246. *quinquefasciatus* Say
- 247. *sinensis* Theobald
- 248. *sitiens* Wiedemann
- 249. *tritaeniorhynchus* Giles
- 250. *vishnui* Theobald
- 251. *whitei* Barraud
- 252. *whitmorei* (Giles)

Culex (Culiciomyia)

- 253. *bailyi* Barraud
- 254. *barrinus* Bram
- 255. *dispectus* Bram
- 256. *fragilis* Ludlow
- 257. *harrisoni* Sirivanakarn
- 258. *lampangensis* Sirivanakarn
- 259. *nigropunctatus* Edwards
- 260. *pallidothorax* Theobald
- 261. *papuensis* (Taylor)
- 262. *sasai* Kano, Nitahara and Awaya
- 263. *scanloni* Bram
- 264. *spathifurca* (Edwards)
- 265. *spiculothorax* Bram
- 266. *termi* Thurman
- 267. *thurmanorum* Bram
- 268. *viridiventer* Giles

Culex (Eumelanomyia)

- 269. *brevipalpis* (Giles)
- 270. *foliatus* Brug
- 271. *hinglungensis* Chu
- 272. *kiriensis* Klein and Sirivanakarn
- 273. *malayi* (Leicester)
- 274. *oresbius* Harbach and Rattanaarithikul
- 275. *otachati* Klein and Sirivanakarn
- 276. *phangngae* Sirivanakarn
- 277. *richei* Klein
- 278. *tenuipalpis* Barraud

Culex (Lophoceraomyia)

- 279. *aculeatus* Colless
- 280. *alphus* Colless
- 281. *bengalensis* Barraud
- 282. *bicornutus* Theobald
- 283. *cinctellus* Edwards
- 284. *curtipalpis* (Edwards)
- 285. *demissus* Colless
- 286. *eukrines* Bram and Rattanaarithikul
- 287. *ganapathi* Colless
- 288. *gracicornis* Sirivanakarn
- 289. *hirtipalpis* Sirivanakarn
- 290. *incomptus* Bram and Rattanaarithikul
- 291. *infantulus* Edwards
- 292. *lucaris* Colless
- 293. *macdonaldi* Colless
- 294. *mammilifer* (Leicester)
- 295. *minor* (Leicester)
- 296. *minutissimus* (Theobald)
- 297. *pairoji* Sirivanakarn
- 298. *peytoni* Bram and Rattanaarithikul
- 299. *pholeter* Bram and Rattanaarithikul
- 300. *pilifemoralis* Wang and Feng

- 301. *quadripalpis* (Edwards)
- 302. *reidi* Colless
- 303. *rubithoracis* (Leicester)
- 304. *spiculosus* Bram and Rattanaarithikul
- 305. *traubi* Colless
- 306. *tuberis* Bohart
- 307. *variatus* (Leicester)
- 308. *whartoni* Colless
- 309. *wilfredi* Colless

Culex (Lutzia)

- 310. *fuscanus* Wiedemann
- 311. *halifaxii* Theobald

Ficalbia

- 312. *minima* (Theobald)

Mimomyia (Etorleptiomyia)

- 313. *elegans* (Taylor)
- 314. *luzonensis* (Ludlow)

Mimomyia (Ingramia)

- 315. *fusca* (Leicester)

Mimomyia (Mimomyia)

- 316. *aurea* (Leicester)
- 317. *chamberlaini* Ludlow
- 318. *chamberlaini metallica* (Leicester)
- 319. *hybrida* (Leicester)

Hodgesia

- 320. *lampangensis* Thurman
- 321. *malayi* Leicester

Coquillettidia (Coquillettidia)

- 322. *crassipes* (Van der Wulp)
- 323. *nigrosignata* (Edwards)
- 324. *novochracea* (Barraud)
- 325. *ochracea* (Theobald)

Mansonia (Mansonoides)

- 326. *annulata* Leicester
- 327. *annulifera* (Theobald)
- 328. *bonneae* Edwards
- 329. *dives* (Schiner)
- 330. *indiana* Edwards
- 331. *uniformis* (Theobald)

Orthopodomyia

- 332. *albipes* Leicester
- 333. *andamanensis* Barraud
- 334. *anopheloides* (Giles)
- 335. *siamensis* Zavortink
- 336. *wilsoni* Macdonald

Malaya

- 337. *genurostris* Leicester
- 338. *jacobsoni* (Edwards)

Topomyia (Suaymyia)

- 339. *apsarae* Klein
- 340. *cristata* Thurman
- 341. *houghtoni* Feng
- 342. *leucotarsis* Thurman
- 343. *suchariti* Miyagi and Toma
- 344. *yanbarensis* Miyagi

Topomyia (Topomyia)

- 345. *aenea* Thurman
- 346. *angkoris* Klein
- 347. *inclinata* Thurman
- 348. *lindsayi* Thurman
- 349. *svastii* Thurman

Tripteroides (Rachionotomyia)

- 350. *affinis* (Edwards)
- 351. *aranoides* (Theobald)
- 352. *serratus* (Barraud)
- 353. *tenax* (De Meijere)

Tripteroides (Tripteroides)

- 354. *aeneus* (Edwards)
- 355. *caeruleocephalus* (Leicester)
- 356. *denticulatus* Delfinado and Hodges
- 357. *hybridus* (Leicester)
- 358. *indicus* (Barraud)
- 359. *powelli* (Ludlow)
- 360. *proximus* (Edwards)
- 361. *similis* (Leicester)
- 362. *tarsalis* Delfinado and Hodges

Uranotaenia (Pseudoficalbia)

- 363. *abditata* Peyton
- 364. *albipes* Peyton
- 365. *approximata* Peyton

- 366. *bicolor* Leicester
- 367. *bimaculata* Leicester
- 368. *demeilloni* Peyton and Rattanaarithikul
- 369. *enigmatica* Peyton
- 370. *gouldi* Peyton and Klein
- 371. *hirsutifemora* Peters
- 372. *koli* Peyton and Klein
- 373. *lutescens* Leicester
- 374. *maxima* Leicester
- 375. *modesta* Leicester
- 376. *nivipleura* Leicester
- 377. *nocticola* Peyton
- 378. *novobscura* Barraud
- 379. *obscura* Edwards
- 380. *patriciae* Peyton
- 381. *pseudomaculipleura* Peyton and Rattanaarithikul
- 382. *spiculosa* Peyton and Rattanaarithikul
- 383. *stricklandi* Barraud
- 384. *sumethi* Peyton and Rattanaarithikul

Uranotaenia (Uranotaenia)

- 385. *annandalei* Barraud
- 386. *bimaculiala* Leicester
- 387. *campestris* Leicester
- 388. *diraphati* Peyton and Klein
- 389. *edwardsi* Barraud
- 390. *hebes* Barraud
- 391. *lateralis* Ludlow
- 392. *longirostris* Leicester
- 393. *macfarlanei* Edwards
- 394. *metatarsata* Edwards
- 395. *micans* Leicester
- 396. *orientalis* Barraud
- 397. *prajimi* Peyton and Rattanaarithikul
- 398. *rampae* Peyton and Klein
- 399. *sombooni* Peyton and Klein
- 400. *subnormalis* Martini
- 401. *testacea* Theobald
- 402. *trilineata* Leicester

Toxorhynchites (Toxorhynchites)

- 403. *albipes* (Edwards)
- 404. *bickleyi* Thurman
- 405. *gravelyi* (Edwards)
- 406. *leicesteri* Theobald
- 407. *magnificus* (Leicester)
- 408. *manopi* Thurman
- 409. *splendens* (Wiedemann)
- 410. *sunthorni* Thurman