

**1. Anopheles (Anopheles), Anopheles Series.** Eleven species of this Series are found in Thailand, including seven in the Aitkenii Group, one in the Culiciformis Group, and three in the Lindesayi Group. The known distributions of these 11 species in Thailand are shown in Figs 2 and 3.

**1.1 Aitkenii Group.** The species of the Aitkenii Group in Thailand include *An. aberrans*, *An. bengalensis*, *An. fragilis*, *An. insulaeflorum*, *An. palmatus*, *An. stricklandi*, and *An. tigertti* (Fig 2). The most common species are typically found in ground-water habitats in mountainous areas, including streams and stream margins, seepage areas, rock pools, and elephant footprints. They are occasionally found in swamps, ditches, marshes, and lakes in rural villages and low-lying areas adjacent to or in forested areas. *Anopheles tigertti* is only found in fresh-water crabholes, seepage bogs, and rock pools. Members of the Aitkenii Group are widely distributed throughout Thailand; however, *An. fragilis* and *An. stricklandi* have only been recorded from peninsular and western Thailand (Fig 2).

**1.2 Culiciformis Group.** This Group is represented in Thailand by *An. sintonoides* (Fig 2). Larvae of *An. sintonoides* have been found in a variety of natural containers, including treeholes, holes in stumps, holes between tree roots, bamboo stumps, split bamboo, bamboo internodes, *Pandanus* axils, and banana stumps (Table 4).

**1.3 Lindesayi Group.** This Group in Thailand includes *An. baileyi*, a new species near *An. gigas*, and *An. lindesayi cameronensis* (Fig 3). The species in this group are prevalent at altitudes >1,200 m. Larvae of *An. lindesayi cameronensis*, n. sp. near *An. gigas*, and *An. baileyi* are found in stream pools, stream margins, seepage areas, swamps, and rock pools on the tops of mountains (Table 4).

**2. Anopheles (Anopheles), Lophoscelomyia Series.** Three species of this Series are found in Thailand, including two species in the Asiaticus Group and one species not associated with a specific group. The distribution of these three species in Thailand is shown in Fig 3.

**2.1 Asiaticus Group.** This Group is represented by *An. asiaticus* and *An. interruptus*. *Anopheles interruptus* are known only from tree holes and root holes, whereas the immature stages of *An. asiaticus* are found in bamboo stumps, fallen split bamboo, and bamboo internodes (Table 4).

**2.2 Unassociated Species.** *Anopheles bulkleyi* is the only unassociated species in

this Series. The only specimen (the lost type specimen) of *An. bulkleyi* was a reared male that was collected in 1937 from a tree hole in tropical rain forest in Chanthaburi Province (Fig 3).

**3. *Anopheles* (*Anopheles*), *Myzorhynchus* Series.** Twenty-one species of this Series are found in Thailand, including one in the Albotaeniatus Group, six in the Barbirostris Group, eight in the Hyrcanus Group, and six in the Umbrosus Group. The distributions of the Albotaeniatus and Barbirostris Groups are shown in Fig 4; those of the Hyrcanus and Umbrosus Groups are shown in Figs 5 and 6, respectively.

**3.1 Albotaeniatus Group.** *Anopheles montanus*, the only species in the Albotaeniatus Group that occurs in Thailand, breeds in jungle habitats such as ground and rock pools, swamps, and elephant footprints. It is found only in southern Thailand (Fig 4).

**3.2 Barbirostris Group.** The Barbirostris Group in Thailand includes five species of the Barbirostris Subgroup (*An. barbirostris*, *An. campestris*, *An. donaldi*, *An. hodgkini*, and *An. pollicaris*) and one species of the Vanus Subgroup (*An. barbumbrosus*). The most common species in the Barbirostris Group are *An. barbirostris* and *An. campestris*. Both species are normally closely associated with humans, with immature stages found in rice fields and other ground-water habitats. *Anopheles barbumbrosus*, *An. donaldi*, *An. hodgkini*, and *An. pollicaris* are forest-dwelling species, with larvae found in shaded stream pools, ground pools, and rock pools. The relatively uncommon *An. pollicaris* has been collected from temporary ground pools and from stream pools in the south of Thailand. The distribution of this Group is shown in Fig 4.

**3.3 Hyrcanus Group.** The Hyrcanus Group in Thailand includes three species of the Lesteri Subgroup (*An. crawfordi*, *An. paraliae*, and *An. peditaeniatus*), three species of the Nigerrimus Subgroup (*An. nigerrimus*, *An. nitidus*, and *An. pursati*), and two unassociated species (*An. argyropus* and *An. sinensis*). Immature stages of most species in the Hyrcanus Group are primarily found in rice fields, marshy and swampy areas, ponds, and other similar habitats that contain emergent vegetation. They prefer shaded areas in these habitats. The most abundant and widely distributed mosquitoes of this Group in Thailand are *An. argyropus*, *An. nigerrimus*, *An. peditaeniatus*, and *An. sinensis*. These species occur in valleys and mountainous areas. *Anopheles nitidus* and *An. crawfordi* are primarily found in forested areas. *Anopheles paraliae* larvae are normally found in shaded semi- to permanent brackish water and not in rice fields. *Anopheles paraliae* is confined to coastal areas of peninsular and southeastern Thailand. *Anoph-*

*Anopheles pursati* has a wide distribution in Thailand. The distribution of the Hyrcanus Group is shown in Fig 5.

**3.4 Umbrosus Group.** The Umbrosus Group in Thailand includes members of the Baezai Subgroup (*An. baezai*), the Letifer Subgroup (*An. letifer*, *An. roperi*, and *An. whartoni*), the Separatus Subgroup (*An. separatus*), and the Umbrosus Subgroup (*An. umbrosus*). *Anopheles baezai*, *An. roperi*, and *An. separatus* are generally associated with coastal brackish water habitats such as *Nipa* or mangrove swamps. *Anopheles whartoni* was not recognized as distinct from *An. letifer* until 1963, and the larvae of these two species remain indistinguishable. Thus, their habitats are poorly known. The distribution of the Umbrosus Group is shown in Fig 6.

**4. Anopheles (Baimaia).** This subgenus is based on the nominotypical species, *An. kyondawensis*, which is rarely collected. Until recently, only the larval stage was known and the species was assigned to the Anopheles Series, subgenus *Anopheles*. The first known adults of *An. kyondawensis* were reared from larvae collected in fresh-water crabholes (Table 4). Unique characteristics on the adults, pupa, and male genitalia prompted the recent description of a new subgenus for this species (Harbach *et al.*, 2005). It has been found in three provinces of Thailand (Fig 2). Nothing is known about the behavior of the adults.

**5. Anopheles (Cellia), Myzomyia Series.** Seven species belonging to the Funestus Group of this Series are found in Thailand, including the unassociated *An. jeyporiensis* (Jeyporiensis Complex), three species in the Aconitus Subgroup, one species in the Culicifacies Subgroup (Culicifacies Complex), and two species in the Minimus Subgroup (Minimus Complex) (Garros *et al.*, 2004, 2005). The distribution of these groups is shown in Fig 7.

**5.1 Jeyporiensis Complex.** *Anopheles jeyporiensis*, an unassociated member of the Funestus Group, includes four chromosomal forms in Thailand. These forms are found primarily in marshy depressions with submerged and emergent vegetation.

**5.2 Aconitus Subgroup.** This subgroup is represented in Thailand by *An. aconitus*, *An. pampanai*, and *An. varuna*. Immatures have been collected from ground-water habitats near foothills and forest fringe areas. Typical habitats include ponds, lakes, *Nipa* palm swamps, large pits, streams, river margins, rock pools, stream pools, flood pools, swamps, seepage pools and springs, small ditches, bogs and marshes, ground pools,

and rice fields (including fallow rice fields and pools in dry rice fields). Recently, Junkum *et al.*, (2005), using multiple techniques, determined that *An. aconitus* karyotype Forms B and C are not distinct species, but cytological races of the same species.

**5.3 Culicifacies Subgroup.** *Anopheles culicifacies* is the only species found in Thailand. Immature stages are found in a variety of habitats, to include stream margins, stream pools, and rice fields. Chromosomal forms A and B of *An. culicifacies* are sympatric in Chiang Mai Province (Baimai *et al.*, 1996a), whereas species B is common in the western subregion and eastern edge of the Korat Plateau subregion.

**5.4 Minimus Subgroup.** This subgroup is represented in Thailand by two species of the Minimus Complex, *An. minimus* [formerly *An. minimus* species A (Harbach *et al.*, 2006)] and the informally designated *An. minimus* C. These species occur principally in stream pools and stream margins. *Anopheles minimus* has also been collected in habitats similar to those of members of the Aconitus Subgroup (Table 4). *Anopheles minimus* is distributed throughout the country, whereas species C occurs only in the western and northern subregions. Previously unpublished collections of *An. minimus* C from Mae Sot in Tak Province and Mae Rim in Chiang Mai Province are reported here for the first time. Integrated molecular and ecological studies are needed to determine the full range of breeding sites occupied by both of these species.

**6. *Anopheles (Cellia), Neocellia Series.*** Fourteen species of the Series are found in Thailand, including three species in the Annularis Group, three in the Jamesii Group, six in the Maculatus Group, and two that are unassociated with a specific group. The distributions of the Annularis and Jamesii Groups are shown in Fig 8. The distribution of the Maculatus Group and the unassociated species is shown in Fig 9.

**6.1 Annularis Group.** The Annularis Group in Thailand includes *An. annularis*, *An. nivipes*, and *An. philippinensis*. These species are abundant throughout much of the country. Larvae are found in clean water with considerable vegetation. They occur in a variety of habitats, including ponds, swamps, marshes, ditches, pits, wells, grassy pools, sand pools, ground pools, flood pools, stream pools, stream margins, seepage springs, and rice fields.

**6.2 Jamesii Group.** The Jamesii Group consists of three species, *An. jamesii*, *An. pseudojamesi*, and *An. splendidus*, all of which occur in Thailand. *Anopheles pseudojamesi* (elevated from synonymy by Nurul Huda and Harrison, 1985) has been found in rice

fields and ground pools, whereas *An. jamesii* and *An. splendidus* occur in a wider range of habitats, including ground pools, stream pools, stream margins, and rice fields. The immature habitats of *An. splendidus* are similar to those of *An. maculatus*.

**6.3 Maculatus Group.** The Maculatus Group in Thailand includes *An. dravidicus*, *An. maculatus*, *An. notanandai*, *An. pseudowillmori*, *An. sawadwongporni*, and *An. willmori*. Members of this Group are found in or near hilly areas, as well as high mountainous areas. Larvae are found in a variety of habitats, including ponds, lakes, swamps, ditches, wells, grassy pools, sand pools, ground pools, flood pools, stream pools, stream margins, seepage springs, rice fields, foot prints, wheel tracks, artificial containers, and occasionally holes in fallen trees and bamboo stumps. *Anopheles maculatus* and *An. sawadwongporni* are widely distributed throughout the country except for the far south, whereas *An. maculatus* (E) is common throughout the peninsular region (Baimai et al., 1993b; Rattanarithikul et al., 1996c; Rongnoparut et al., 1999). *Anopheles willmori*, a primary malaria vector in Nepal (Pradhan et al., 1970), occurs at altitudes between 990–1,475 m in the north of Thailand. Larvae are found only in stream margins. *Anopheles pseudowillmori*, a secondary vector in northwestern Thailand along the Myanmar border (Green et al., 1992), is found primarily in rice fields, stream margins, ponds, pits, and wells (Rattanarithikul et al., 1995). A number of specimens have been collected in sand pools along the Mekong River in northeastern Thailand (Rattanarithikul et al., 1994).

**6.4 Unassociated Species.** *Anopheles karwari* and *An. stephensi* are the only members of the Series in Thailand that are not associated with a specific group. The larval habitats of *An. karwari* are similar to those of *An. maculatus*. *Anopheles stephensi*, an important malaria vector in India and the Middle East, is rare in Thailand. Larvae have been found in ground pools, stream pools, and on one occasion in a tree hole. In India, *An. stephensi* larvae have been found in many habitats, including flood pools that covered the concrete floor under a construction site (Dhir, 1969).

**7. *Anopheles (Cellia), Neomyzomyia* Series.** Twelve species of the Series are found in Thailand, including one species in the Kochi Group, 10 in the Leucosphyrus Group, and one in the Tessellatus Group. The distributions of the 12 species are shown in Fig 10.

**7.1 Kochi Group.** *Anopheles kochi* is the only member of this group. It occurs throughout Thailand in a wide variety of larval habitats and preferentially feeds on large animals such as cattle and water buffalo.

**7.2 Leucosphyrus Group.** Ten species of this Group, *An. baimaii*, *An. cracens*, *An. dirus*, *An. hackeri*, *An. introlatus*, *An. latens*, *An. macarthuri*, *An. nemophilous*, *An. pujutensis*, and *An. scanloni*, occur in Thailand. The most favored habitats of the Leucosphyrus Group appear to be footprints (especially elephant footprints), wheel-tracks, temporary ground pools (e.g., stream margins, flood pools, and seepage-springs), and in pits dug for mining with partial to heavily-shaded areas. Larvae have occasionally been collected in water jars, cut tree stumps, bamboo stumps, and root holes. Many species in the Dirus Complex occur in sympatry in Thailand, e.g., *An. baimaii* and *An. dirus* (Rattanarithikul *et al.*, 1995). *Anopheles dirus* is the only species that is widespread throughout Thailand. *Anopheles cracens*, *An. hackeri*, *An. introlatus*, *An. latens*, *An. macarthuri*, *An. nemophilous*, and *An. pujutensis* occur primarily in peninsular Thailand (Fig 10).

**7.3 Tessellatus Group.** *Anopheles tessellatus* is the only member of this Group. The breeding habitats of *An. tessellatus* are similar to species in the Subpictus Group, which include a variety of ground-water habitats such as ponds, swamps, ground pools, stream pools, and stream margins.

**8. *Anopheles (Cellia)*, Pyretophorus Series.** Four species of the Pyretophorus Series are found in Thailand, including one species in the Ludlowae Group and three in the Subpictus Group. The distributions of these mosquitoes are shown in Fig 11.

**8.1 Ludlowae Group.** This Group is represented in Thailand by *An. epiroticus* (=*sundaicus* A), recently described by Linton *et al.* (2005). Larvae of this species are typically found in sunlit brackish pools containing algae; however, *An. epiroticus* has also adapted itself to breeding in freshwater. The major breeding sites of this species include ponds, lakes, marshes, stream pools, stream margins, and rock pools in coastal areas.

**8.2 Subpictus Group.** This Group in Thailand includes *An. indefinitus*, *An. subpictus*, and *An. vagus*. Larvae of *An. indefinitus* are typically found in fresh-water habitats such as grassy pools, ponds, ditches, seepage pools, stream margins, and rice fields. They have also been found in slightly brackish water. *Anopheles vagus* is the most abundant species in this Group, with larvae most commonly found in a wide variety of ground-water habitats. *Anopheles vagus* larvae occasionally have been found in water jars and in holes in logs. Immature stages of *An. subpictus* are found in many habitats similar to those in which *An. epiroticus* is found, but they also occur in ditches, wells, ground pools, rice fields, animal footprints, and artificial containers.