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Keys to the adult females and fourth-instar larvae of the mosquitoes of Iran (Diptera: Culicidae)

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Abstract

Taxonomic keys are provided for the identification of the adult females and fourth-instar larvae of Iranian mosquitoes (Diptera: Culicidae), which include 64 species and three subspecies belonging to seven genera. The keys also include 12 species recorded in old literature that have not been collected recently, but are known to occur elsewhere in southwestern Asia. *Aedes albopictus* (Skuse) is not known to occur in Iran, but it is included in the keys because it has been established in many countries in the region during recent decades, and it is medically important. Newly recorded species, new characters, drawings illustrating characters used in the keys, and some notes are included to aid the identification of the species. The keys are based on recently collected specimens and museum collections, as well as taxonomic literature.

Key words: Anophelinae, Culicinae, identification keys, Middle East, Palaearctic Region, southwestern Asia, taxonomy

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Introduction

West Nile and Sindbis viruses, as well as *Dirofilaria* Railliet & Henry (Spirurida: Onchocercidae) (dirofilariasis), which are transmitted by mosquitoes (Diptera: Culicidae), have been reported in Iran (Naficy & Saidi, 1970; Saidi *et al.*, 1976; Azari-Hamidian *et al.*, 2007). Also, mosquito-borne nematodes of genus *Setaria* Viborg (Spirurida: Onchocercidae) (setariasis) have been reported in the country (Eslami, 1997). There is no information about their vectors in Iran. The possibility of some mosquito-borne arboviral outbreaks such as Japanese encephalitis and Rift Valley fever in the WHO Eastern Mediterranean Region, including Iran, is noteworthy (World Health Organization, 2004). There are some doubtful old records of Dengue fever in Iran (Foote & Cook, 1959), but there is no documented recent record of this virus in the country. Seven species of the genus *Anopheles* Meigen (*An. maculipennis* Meigen *s.l.*, *An. sacharovi* Favre, *An. culicifacies* Giles *s.l.*, *An. dthali* Patton, *An. fluviatilis* James *s.l.*, *An. stephensi* Liston, *An. superpictus* Grassi) are known malaria vectors in Iran and *An. pulcherrimus* Theobald is considered a potential vector of malaria in the southeastern area of the country (Edrissian, 2006). Eshghy (1977) observed *Plasmodium* Marchiafava & Celli (Haemosporida: Plasmodiidae) oocysts in *An. multicolor* Combouliu, but sporozoites have not been found in this species and it is not considered a vector in Iran.

Circa 1992, mosquitoes were classified in three subfamilies, 10 tribes, 37 genera and 129 subgenera (Knight & Stone, 1977; Knight, 1978; Ward, 1984; Gaffigan & Ward, 1985; Ward, 1992). Harbach & Kitching (1998) reduced the subfamily Toxorhynchitinae to tribal rank within Culicinae and Reinert (2000) elevated *Ochlerotatus* Lynch Arribálzaga to generic rank. At the turn of the century, the family included two subfamilies, 11 tribes, 39 genera and 135 subgenera (Reinert, 2001). Reinert *et al.* (2004, 2006, 2008) conducted cladistic analyses of the tribe Aedini based on morphological characters of all life stages, described new genera, elevated many subgenera to generic rank and recognized 62 genera and 36 subgenera in the tribe. According to the most recent classification of mosquitoes, the family Culicidae includes two subfamilies, 11 tribes, 95 genera and 3520 species (Harbach, 2007).

There is scattered information about the mosquito fauna in southwestern Asia [for a definition of the region see Harbach (1985, 1988)]. Only two recent comprehensive investigations were carried out in relation to the subgenus *Culex* Linnaeus and female *Anopheles* in the region by Harbach (1985, 1988) and Glick (1992), respectively. There are no complete keys to all mosquito species of the region.

The most recent checklist of Iranian mosquitoes (Azari-Hamidian, 2007) includes 64 species and three subspecies belonging to seven genera. The records of 12 other species need to be verified. Also, the article listed most of the literature that pertains to the records of mosquitoes in Iran. It contains references that are not cited herein.

Shahgudian (1960) provided a checklist and keys to the larvae and adult females of Iranian *Anopheles*, including *An. nigerrimus* Giles and *An. pseudopictus* Grassi as varieties [subspecies] of *An. hyrcanus* (Pallas) and *An. marteri sogdianus* Keshishian. Since then, the most important taxonomic changes in *Anopheles* have been the elevation of many members of the Maculipennis and Hyrcanus Groups to species rank (Knight & Stone, 1977; Knight, 1978; Ward, 1984; Gaffigan & Ward, 1985; Ward, 1992). Also, some new species have been added to the Iranian mosquito fauna, mostly members of species complexes that are defined by DNA sequence data: Culicifacies Complex (species A and B, or probably a new species), Fluviatilis Complex (species T and V) and the Maculipennis Group (*An. atroparvus* van Thiel, *An. labranchiae* Falleroni, *An. messeae* Falleroni, and *An. persiensis* Linton, Sedaghat & Harbach). More recently, *An. peditaeniatus* (Leicester) of the Hyrcanus Group was recorded in Iran based on morphological characters (Azari-Hamidian *et al.*, 2006; Azari-Hamidian, 2007).

Lotfi (1976) provided keys to the larvae of Iranian *Culex*. Zaim (1984) conducted a comprehensive study of the Iranian mosquito fauna, including 55 Afrotropical, Oriental, and principally Palaearctic species of six genera. Zaim & Cranston (1986) provided a checklist and keys to the larvae and adult females of the Culicinae of Iran. After that, *Culiseta morsitans* (Theobald) was recorded as new to the Iranian mosquito fauna and the presence of *Coquillettidia richiardii* (Ficalbi) and *Culiseta annulata* (Schrank) were verified (Azari-

Hamidian, 2007), but the most important taxonomic change was the elevation of *Ochlerotatus* to generic rank (Reinert, 2000, 2001). Also, *Oculeomyia* Theobald was reinstated as a subgenus of *Culex* for the species of the Bitaeniorhynchus Subgroup, including *Cx. bitaeniorhynchus* Giles (Tanaka, 2004).

Reinert *et al.* (2004, 2006, 2008) proposed a new classification of the tribe Aedini based on cladistic analyses of morphological characters of all life stages. Based on this classification, the Iranian aedine mosquitoes include species of five genera: *Aedes* Meigen [*Ae. vexans* (Meigen)]; *Dahliana* Reinert, Harbach & Kitching, including *Da. echinus* (Edwards) [formerly *Ochlerotatus* (*Finlaya*) *echinus*] and *Da. geniculata* (Olivier) [formerly *Oc.* (*Fin.*) *geniculatus*]; *Fredwardsius vittatus* (Bigot) [formerly *Ae.* (*Fredwardsius*) *vittatus*]; *Stegomyia aegypti* (Linnaeus) [formerly *Ae.* (*Stegomyia*) *aegypti*] and *Ochlerotatus*, including: *Oc.* (*Och.*) *berlandi* (Séguy), *Oc.* (*Och.*) *caballus* (Theobald), *Oc.* (*Och.*) *caspius* (Pallas) *s.l.*, *Oc.* (*Och.*) *chelli* (Edwards), *Oc.* (*Och.*) *detritus* (Holiday), *Oc.* (*Och.*) *dorsalis* (Meigen), *Oc.* (*Och.*) *flavescens* (Müller), *Oc.* (*Och.*) *leucomelas* (Meigen), and *Oc.* (*Och.*) *pulcritarsis* (Rondani).

In this article, formally recognized genera and subgenera and their abbreviations follow Knight & Stone (1977) and its supplements (Knight, 1978; Ward, 1984; Gaffigan & Ward, 1985; Ward, 1992), and Reinert (2000, 2001) because Iranian entomologists are more familiar with the earlier system of classification.

Material and methods

All morphological characters used in previously published keys were examined in all available adult and larval specimens from Iran and material deposited in the Natural History Museum, London, including available types (holotypes, paratypes, syntypes, and lectotypes). Characters were checked in at least five specimens of each species from different geographical locations.

Keys based on adult females and fourth-instar larvae are provided to distinguish subfamilies, genera, subgenera, species, and subspecies (where appropriate). The keys include many new characters in addition to those used in the previously published keys of Shahgudian (1960), Lotfi (1976) and Zaim & Cranston (1986). Additional characters that may be useful for identification are indicated in square brackets. Taxonomic notes provide additional information for certain taxa and/or to aid their identification. Characters used in the keys are illustrated in a series of figures to assist users.

Three species, *An. peditaeniatus*, *An. cinereus* Theobald, and *An. rhodesiensis rupicolus* Lewis, are added to Shahgudian's (1960) keys and key characters to the Hyrcanus Group are modified. In general, the couplets in Shahgudian's (1960) keys have not been altered very much, because Iranian entomologists have used them with satisfactory results for many years; they should work very well with the newly added characters. However, morphological variation observed in different species in southwestern Asia and Iran, especially *An. superpictus*, *An. cinereus* and *An. rhodesiensis rupicolus*, complicate identification (see notes). In certain published keys, i.e. Shidrawi & Gillies (1987), Glick (1992) and Amerasinghe *et al.* (2002), these species key out in two or more couplets. This is avoided in the present keys because there are no recent reports of the last two species in Iran, their occurrence in the country has not been verified. Only typical forms are included in the keys and morphological variation is mentioned in the taxonomic notes.

Zaim & Cranston (1986) published the most complete key to the species of the subfamily Culicinae in Iran. *Culiseta morsitans* and *Cs. annulata* are included in the present keys based principally on morphological data provided by Maslov (1967). Keys to the subgenera of *Culex* and species of *Culex* (*Culex*) are based on Harbach (1985, 1988). Three species, *Culex pipiens* Linnaeus, *Cx. torrentium* Martini, and *Cx. vagans* Wiedemann (the occurrence of the last species in Iran should be verified), distinguished in Harbach's (1985, 1988) keys are not separated in Zaim & Cranston's (1986) key to the larvae of *Culex*. *Culex vishnui* Theobald, and *Cx. univittatus* Theobald, based on old and doubtful records in Iran (Azari-Hamidian, 2007), are added to the keys. These species are very similar to *Cx. pseudovishnui* Colless and *Cx. perexiguus* Theobald, respectively. Keys to subgenera, species, and subspecies of the tribe Aedini are based on new characters, and the inclusion of four species, *Ae. aegypti*, *Oc. berlandi*, *Oc. chelli*, and *Oc. dorsalis*, are based on old records

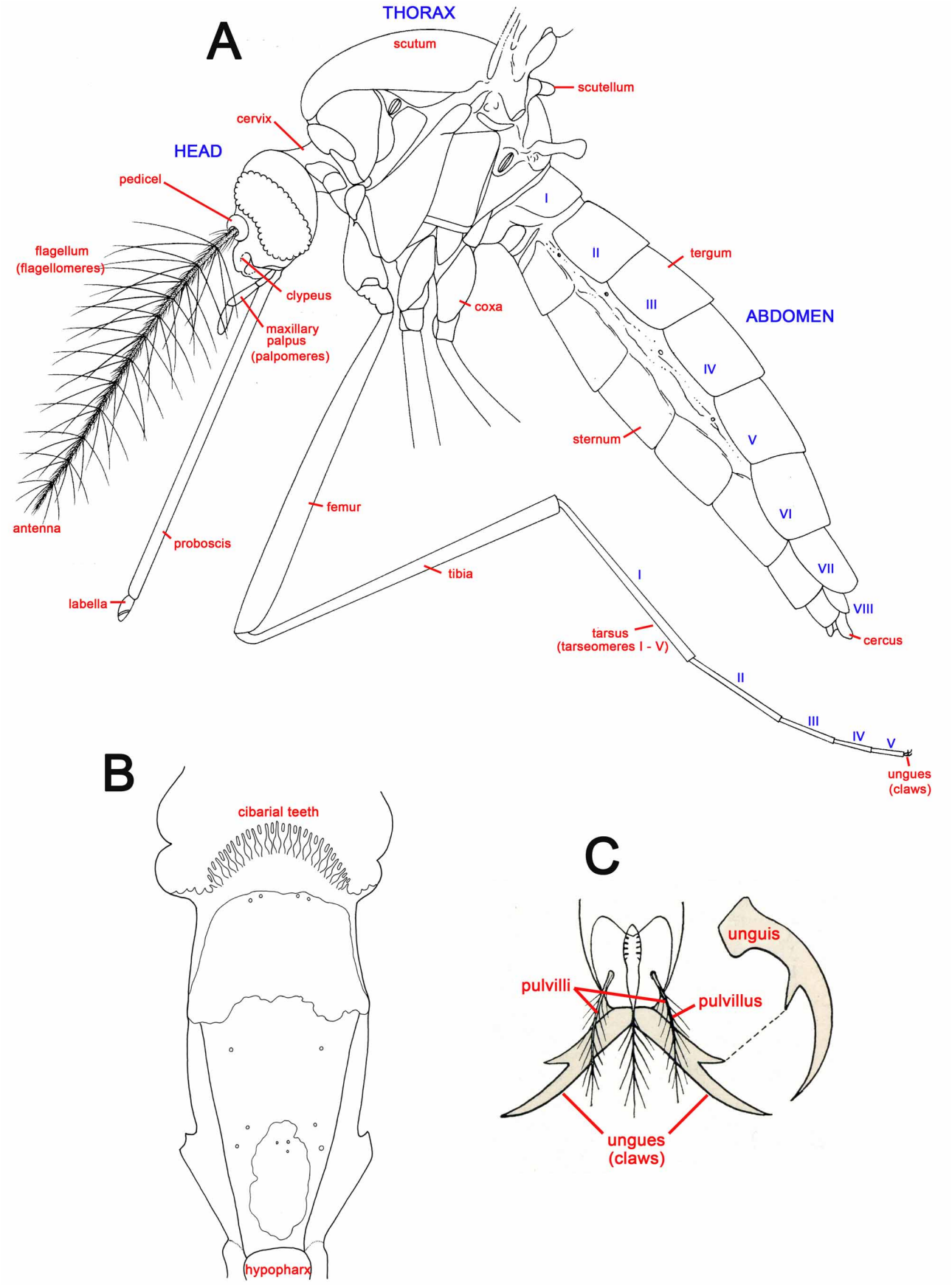

FIGURE 1. Characters of adult mosquitoes used in the keys. A, Lateral aspect (left side) of a culicine female (diagrammatic). B, Dorsal aspect of female anopheline cibarium. C, Ventral aspect of the posttarsis of an aedine female. (A,B Modified from Harbach & Knight, 1980; C modified from Edwards, 1941).

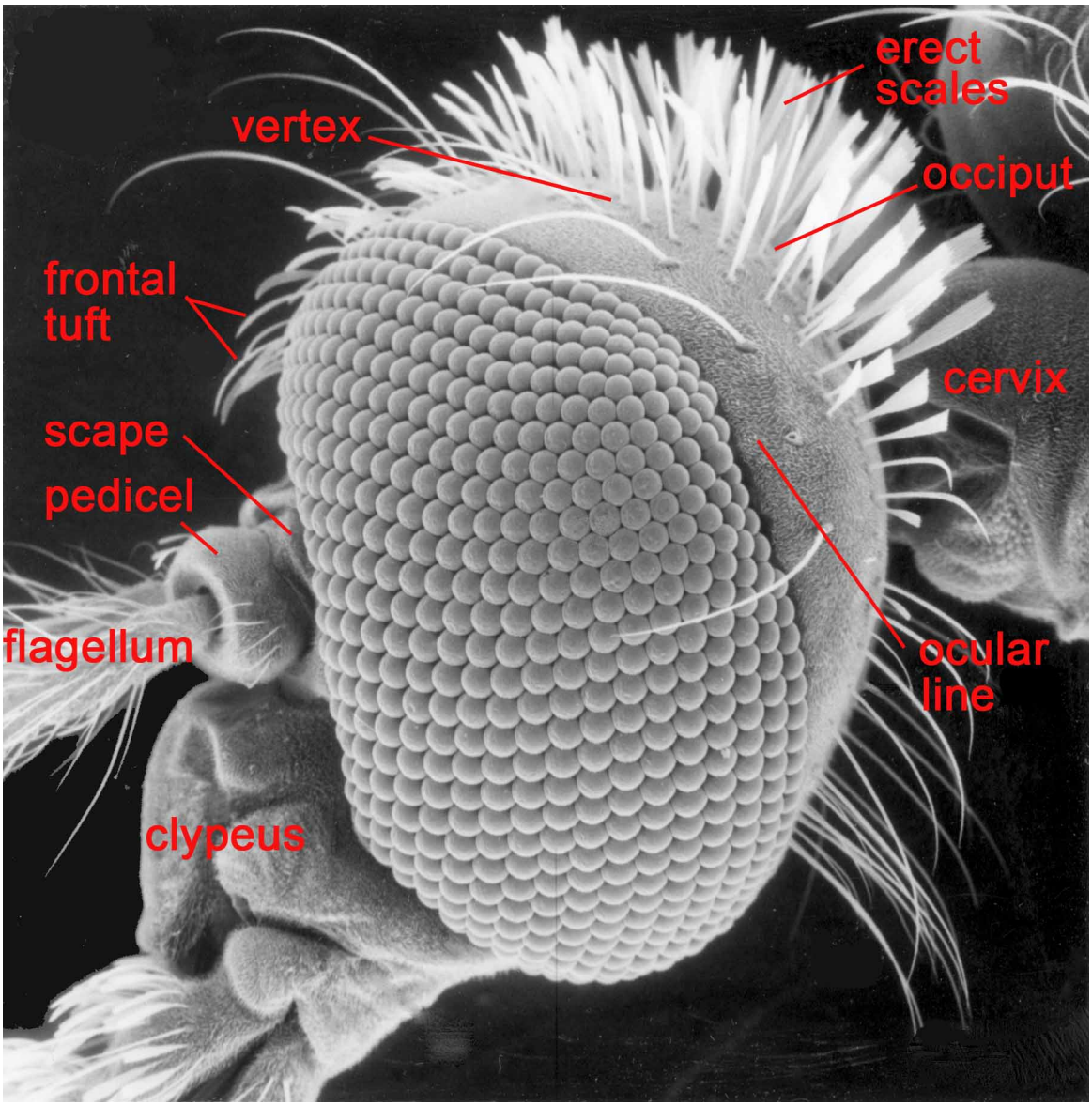

FIGURE 2. Lateral aspect (left side) of the head of an *Anopheles* female showing characters used in the keys. (Modified from Harbach & Knight, 1980).

of their occurrence in Iran (Azari-Hamidian, 2007); however, their presence in the country requires verification. Although *Ae. albopictus* (Skuse) is not recorded from Iran, this species is included in the keys because it is recorded in Pakistan adjoining Iran (Aslamkhan, 1971) and has been established in many countries during recent decades, mainly due to the trade of used tyres (Roiz *et al.*, 2008). *Aedes albopictus* is a vector of Dengue fever virus and many other arboviruses, as well as *Dirofilaria*, and is regarded as a highly medically important species (World Health Organization, 2004; Roiz *et al.*, 2008).

The following references were consulted during the preparation of the keys: Edwards (1941), Hopkins (1952), Mattingly & Knight (1956), Shahgudian (1956, 1960), DuBose & Curtin (1965), Maslov (1967), Gillies & de Meillon (1968), McIntosh (1973), Gutsevich *et al.* (1974), Lotfi (1976), Sirivanakarn (1976), Encinas-Grandes (1982), Zaim & Cranston (1986), Cranston *et al.* (1987), Gillies & Coetzee (1987), Shidrawi & Gillies (1987), Harbach (1985, 1988), Das *et al.* (1990), Glick (1992), Reuben *et al.* (1994), Dahl (1997), Darsie & Samanidou-Voyadjoglou (1997), Ribeiro & Ramos (1999), Samanidou-Voyadjoglou & Harbach (2001), Amerasinghe *et al.* (2002), and Becker *et al.* (2003).

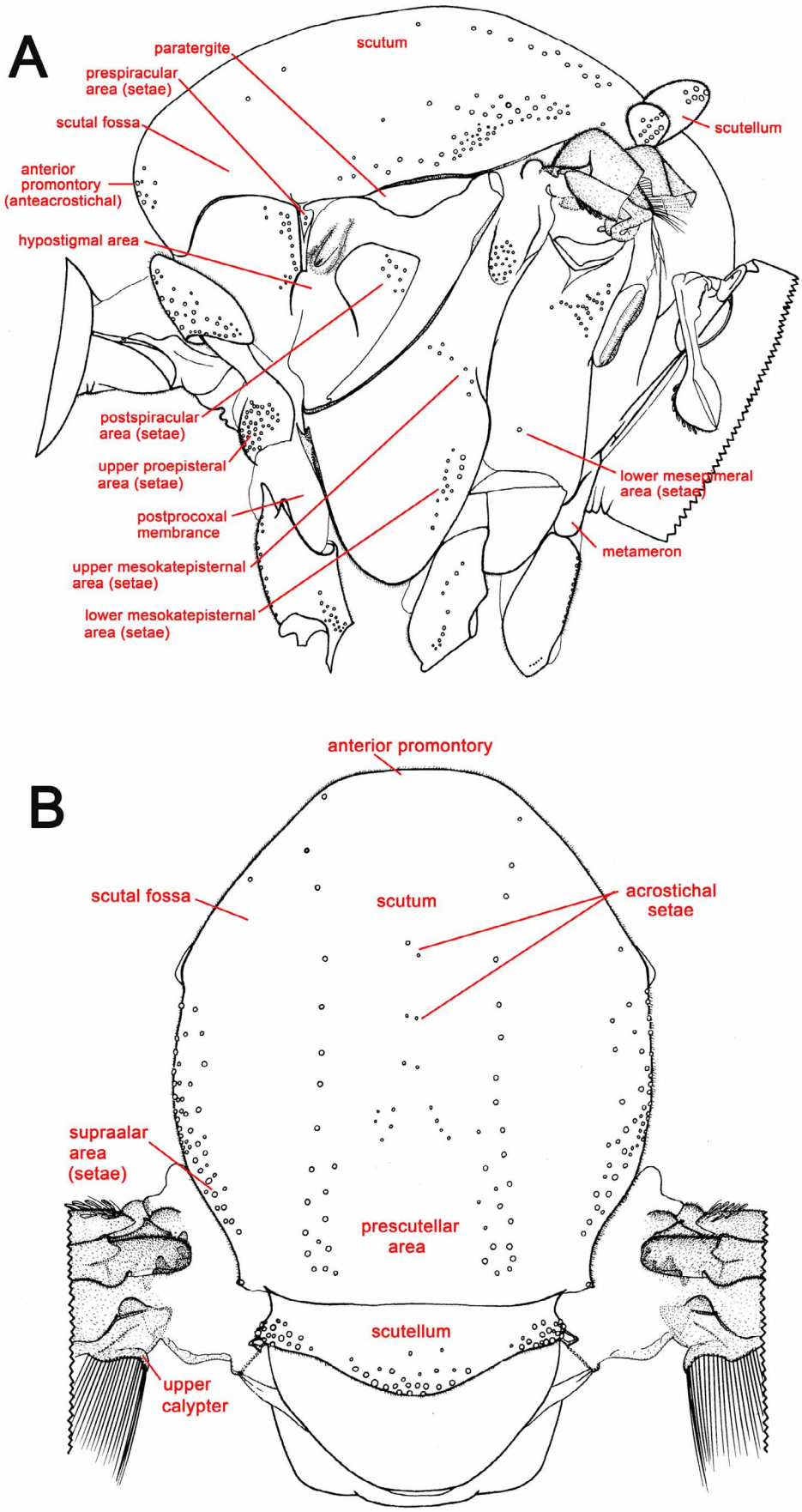

FIGURE 3. Characters of the mosquito thorax used in the keys. A, Lateral aspect (left side) of an aedine male. B, Dorsal aspect of the same. (Modified from Harbach & Knight, 1980).

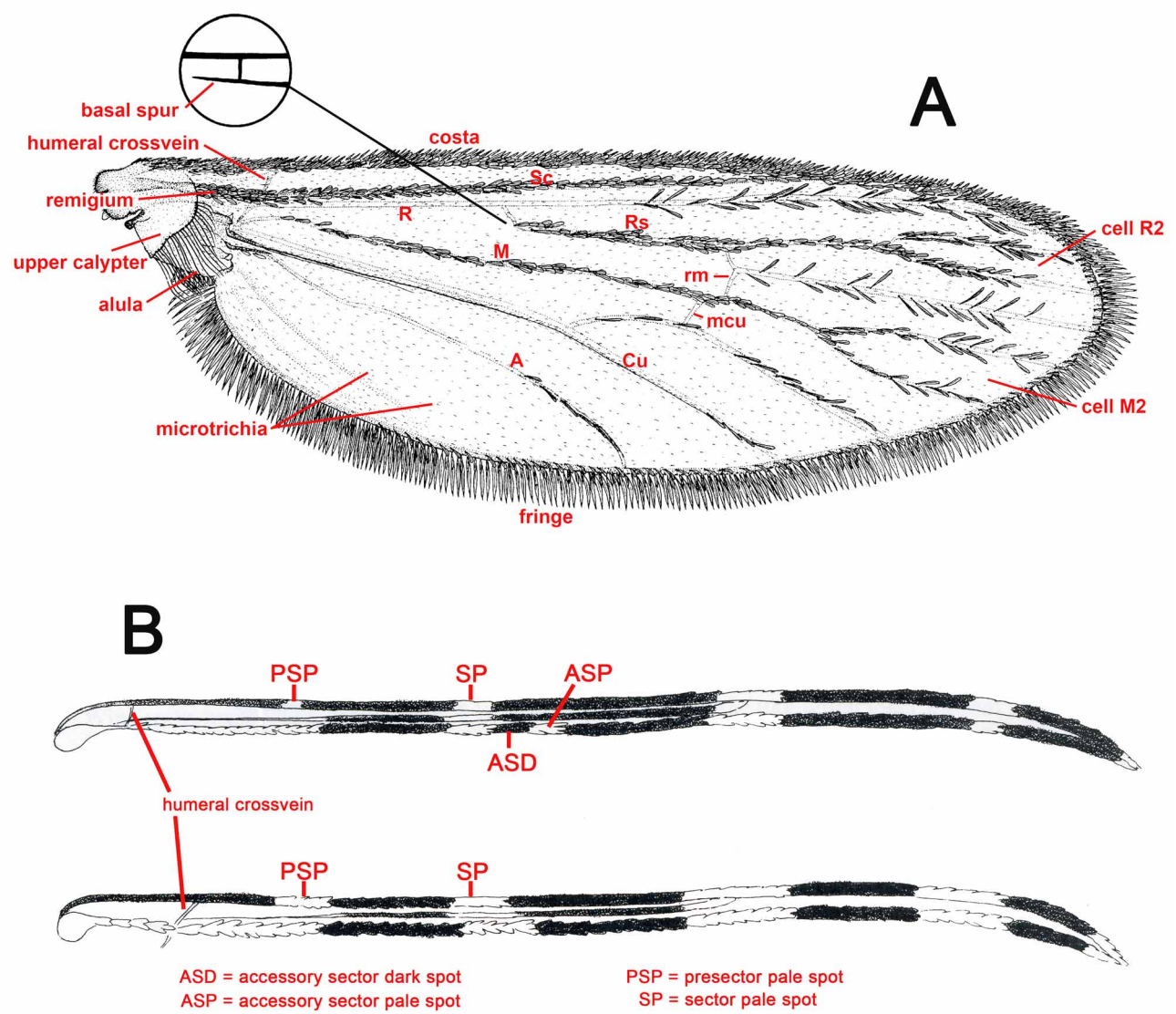

FIGURE 4. Characters of the mosquito wing used in the keys. A, Left wing (ventral aspect) of an aedine female. B, Costal wing spots (dorsal aspect) of anopheline wings. (A Modified from Harbach & Knight, 1980; B modified from Glick, 1992).

The nomenclature of species and subspecies follows *A Catalog of the Mosquitoes of the World* (Knight & Stone, 1977), its supplements (Knight, 1978; Ward, 1984; Gaffigan & Ward, 1985; Ward, 1992), and the online Systematic Catalog of Culicidae (Walter Reed Biosystematics Unit, 2001). Reference to the World Catalog refers collectively to these sources.

The morphological terminology recommended by Harbach & Knight (1980, 1982) is used in the keys, except for the wing venation and wing spot terminology, which is taken from Tanaka *et al.* (1979) and Wilkerson & Peyton (1990), respectively, and older terminology of the former is indicated in parentheses. Generic and subgeneric abbreviations follow Reinert (2000, 2001).

In the keys, the species or subspecies that doubtfully occur in Iran and require verification are marked with an asterisk (*). In the keys to larvae, the prothoracic formula (PTF), as Dahl (1997) mentioned, provides the number of branches on each of prothoracic setae 1–7 (setae 1–7-P). Although many PTF numbers are not constant, and are given as a range, the formula may aid the recognition of subgenera and some species. The Siphon Index (SI), the ratio of siphon length to its basal width, calculated to one decimal place, is expressed as a single entity, a range, and the average of a range.

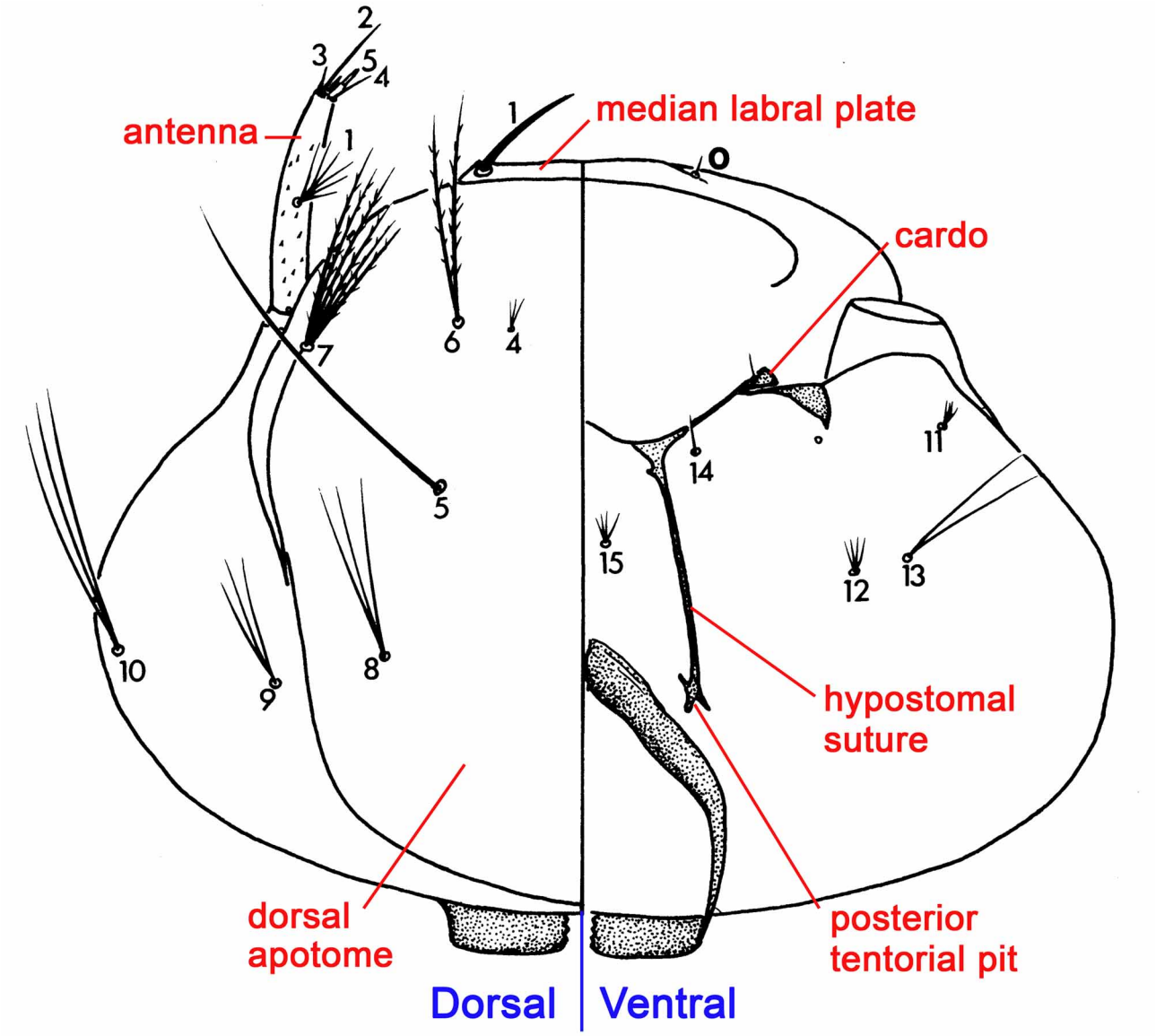

FIGURE 5. Characters of the head of mosquito larvae used in the keys. Dorsal and ventral aspects of a culicine larva. (Modified from Harbach & Knight, 1980).

Four corrections or additions to the checklist of Iranian mosquitoes (Azari-Hamidian 2007) are indicated in taxonomic notes: the spelling of the subgenus to which *Ur. unguiculata* belongs (Note 3), the spelling the subspecific name in the trinomen *An. rhodesiensis rupicolus* (Note 16), the subspecies of *Oc. caspius s.l.* (Note 30), and the removal of the former subspecific taxon of *Cx. modestus* Ficalbi (Note 31).

The keys are regarded as preliminary because collections and specimens are not available for many areas of Iran where additional species may occur, and they are based to some extend on type specimens and material from other countries studied in the NHM, London, and the keys published by Shahgudian (1960), Lotfi (1976), and Zaim & Cranston (1986). Keys to pupae and male genitalia are not provided. There is little published information about the pupae and male genitalia of the mosquito species that occur in Iran.

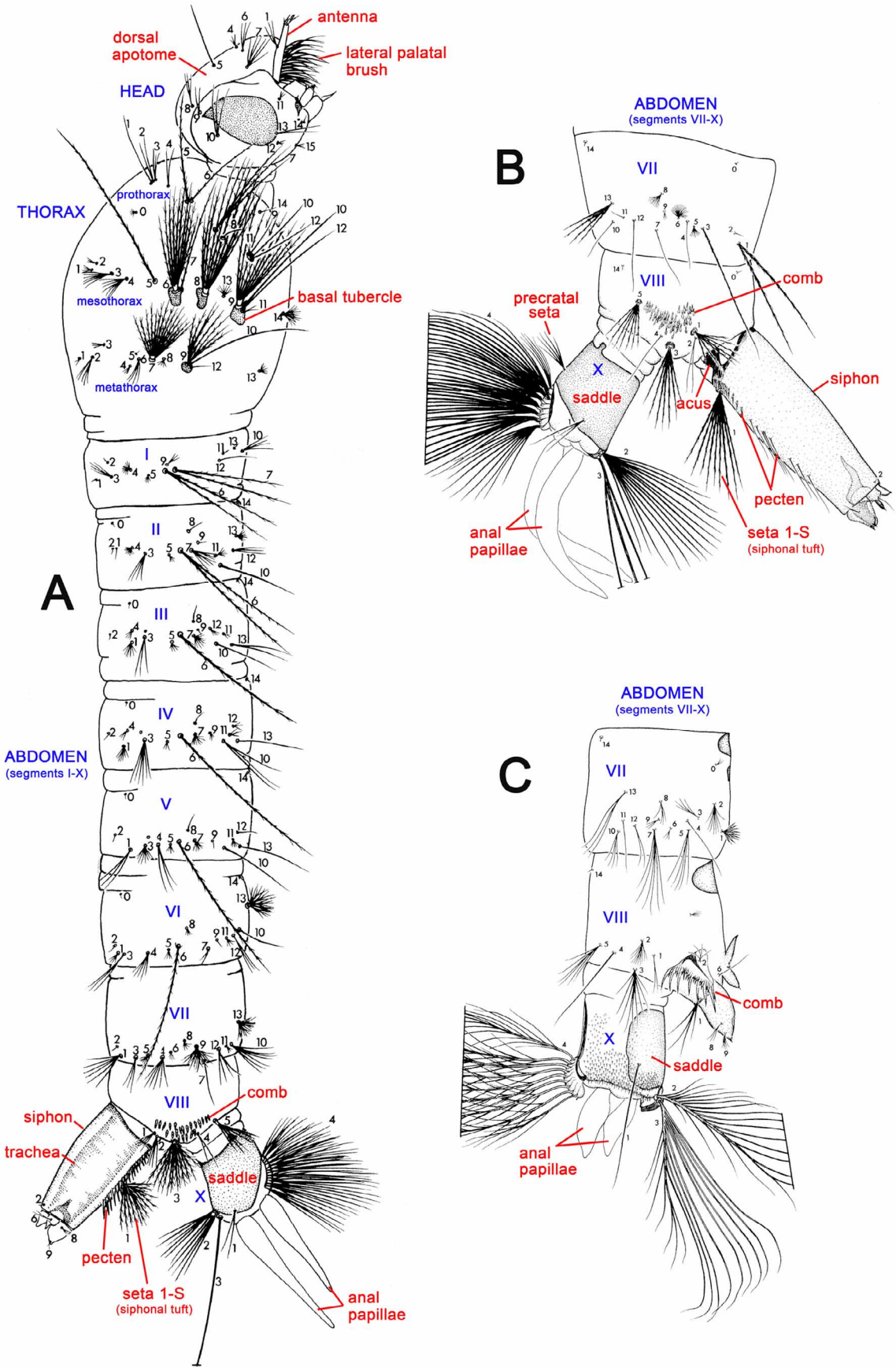

FIGURE 6. Characters of mosquito larvae used in the keys. A, Lateral aspect (right side) of an aedine larva. B,C, Lateral aspects (left sides) of the terminal abdominal segments of a *Culiseta* and an *Anopheles* larva, respectively. (Modified from Harbach & Knight, 1980).

Key to subfamilies and genera: adults
(key characters are illustrated in Figs 1–4)

1. Scutellum evenly rounded with setae evenly distributed along border; maxillary palpus of females with 5 palpomeres and about as long as proboscis (in males, somewhat clubbed, at apex); abdominal sterna (and usually also terga) wholly or largely devoid of scales, except *An. pulcherrimus, An. stephensi*, and the species of the Hyrcanus Group; radial sector (vein Rs) with basal spur [alula bare] (subfamily Anophelinae)..... *Anopheles* (Note 1)
- Scutellum trilobed with setae in 3 distinct groups; maxillary palpus of females with fewer than 5 palpomeres and distinctly shorter than proboscis (usually male palpus longer than proboscis and generally not clubbed at apex, except *Cs. longiareolata* and *Ur. unguiculata*); abdominal sterna and terga covered with scales; vein Rs without basal spur (subfamily Culicinae) (Note 2) 2

2(1). Anal vein (1A) (vein 6) reaching wing margin at about level of fork of cubital vein (Cu) (vein 5); cell R_2 (anterior forked cell of vein 2) shorter than 0.5 length of radius-two-plus-three (R_{2+3}) (petiole or stem); wing membrane apparently without microtrichia, these visible only under high magnification; proboscis somewhat swollen apically; upper calypter bare; lateral surface of thorax with longitudinal stripe of silvery scales; alula bare [paratergite without scales; prespiracular setae present; postspiracular setae absent; lower mesepimeral seta present]..... ..... *Uranotaenia* (*Pseudoficalbia*) *unguiculata* (Note 3)
- Anal vein (1A) reaching wing margin well beyond fork of Cu; cell R_2 more than 0.5 length of vein R_{2+3}; wing microtrichia visible under low magnification; proboscis not swollen apically; upper calypter fringed; lateral surface of thorax without longitudinal stripe of silvery scales; alula with fringes 3

3(2). Prespiracular setae present; wing with setae present ventrally at base of subcosta (Sc) [paratergite with scales] .... *Culiseta*
- Prespiracular setae absent; wing without setae ventrally at base of Sc 4

4(3). Postspiracular setae present; abdomen generally pointed apically; ungues (claws) of foreleg toothed; paratergite with scales (tribe Aedini) ..... *Aedes* and *Ochlerotatus* (Note 4)
- Postspiracular setae absent; abdomen generally rounded and blunt apically; ungues of foreleg simple; paratergite without scales 5

5(4). Pulvilli conspicuous; ungues (claws) of hindleg small and inconspicuous; hindtarsomere 1 as long as or longer than hindtibia, except for subgenus *Barraudius*; scales of wing usually narrow ..... *Culex* (Note 5)
- Pulvilli inconspicuous; ungues of hindleg large and conspicuous; hindtarsomere 1 distinctly shorter than hindtibia; scales of wing usually broad [upper and lower mesepimeral setae present; upper proepisternal setae present; femora, tibia, and abdominal terga covered by broad scales; proboscis largely pale-scaled] .... *Coquillettidia* (*Coquillettidia*) *richiardii* (Note 6)

Key to subgenera, species, and subspecies of genus *Anopheles*: adults
(key characters are illustrated in Figs 1–4)

1. Wing entirely dark-scaled or with fewer than 4 separate dark areas involving costa (C), radius (R), and radius-one (R_1) (vein 1); cibarial teeth not developed, except *An.* (*Cellia*) *apoci* (subgenus *Anopheles* and *An.* (*Cellia*) *apoci*) (Note 7)..... 2
- Anterior margin of wing with at least 4 separate dark areas involving C, R, and R_1; cibarial teeth well developed (subgenus *Cellia*)..... 13

2(1). Anterior margin of wing with 2 separate pale areas involving costa (C), radius (R), and radius-one (R_1) (vein 1), one about 0.67 from wing base and one near apex; lateral area of clypeus with a patch of projecting dark scales; maxillary palpus with 4 pale bands; tarsi with pale bands; base of forefemur distinctly swollen (Hyrcanus Group) (Note 8)..... 3
- Wing entirely dark-scaled; clypeus without scales; maxillary palpus without pale bands; tarsi without pale bands; base of forefemur not swollen 6

3(2). Hindtarsomere 4 pale at apex or entirely pale; pale spot on subcosta (Sc) relatively large, involving radius-one (R_1) (vein 1) equally with costa (C); hindtarsomere 5 dark [humeral crossvein without scales; remigium mostly pale-scaled]..... 4
- Hindtarsomere 4 usually pale at base and apex; pale spot on Sc smaller, not involving or only incompletely involving R_1; hindtarsomere 5 entirely dark or pale at base only 5

4(3). Hindtarsomere 4 entirely pale; white scales on media (M) (vein 4), cubitus (Cu) (vein 5), and anal vein (1A) (vein 6) ..... *An. pseudopictus*
- Hindtarsomere 4 pale at apex only; yellowish scales on M, Cu, and 1A ..... *An. hyrcanus*

5(3). Humeral crossvein usually without scales, sometimes with 1 or 2 scales; remigium mostly pale-scaled; hindtarsomere 4 and usually 5 with basal pale bands; basal third of costa (C) entirely dark; fringe spot absent at cubitus-two (Cu_2) (vein 5.2); in males, maxillary palpus without a basal pale band on palpomere 3 ..... *An. peditaeniatus*

- Humeral crossvein with patch of dark scales; remigium mostly dark-scaled; pale markings on hindtarsomeres 4 and 5 variable, often without basal pale bands; basal third of C with a few scattered pale scales; fringe spot usually present at Cu_2; in males, maxillary palpus with a basal pale band on palpomere 3 ..... *An. nigerrimus**

6(2). Scales darker and denser at crossveins and furcations, forming dark spots; furcation of radius-two-plus-three (R_{2+3}) (petiole or stem) and media (M) (vein 4) situated at same distance from base of wing (Maculipennis Group) (Note 9)..... 7

- Wing scales uniformly distributed, dark spots not apparent; furcation of R_{2+3} and M not at same distance from base of wing..... 8

7(6). Wing with distinct dark spots; scutum dark brown with a broad pale longitudinal stripe; scutal fossa usually with narrow, piliform pale scales, at least on extreme upper margin; wing fringe with a conspicuous pale spot at apex .. .. *An. maculipennis s.l.*

- Wing spots faint; scutum more or less pale brown without a pale longitudinal stripe; scutal fossa without pale scales; wing fringe entirely dark without a pale spot at apex..... *An. sacharovi*

8(6). Scutum without pale scales on median area; upper surface of scutum unicolourous; frontal tufts of head absent or poorly developed; erect head scales unicolorous 9

- Scutum with narrow to moderately broad pale scales on median area; upper surface of scutum dark at sides with broad paler stripe down the middle; frontal tufts of head well developed, projecting forward between eyes; erect head scales broad and pale on vertex, dark laterally and posteriorly..... 10

9(8). Erect head scales narrow, straw-yellow; furcation of media (M) (vein 4) nearer wing base than furcation of radius-two-plus-three (R_{2+3}) (petiole or stem); setae on thorax and scales on wing very pale .... *An.* (*Cel.*) *apoci* (Note 10)

- Erect head scales broad, dark brown; furcation of M farther from wing base than furcation of R_{2+3}; setae on thorax red-brown or dark brown ..... *An. algeriensis*

10(8). Labella distinctly paler than remainder of proboscis; wing with pale spot at apical fringe; foretarsomere 1 longer than foretarsomeres 2–5 combined (*An. marteri*) (Note 11) 11

- Labella not paler than remainder of proboscis, proboscis entirely dark; wing without pale spot at apical fringe; foretarsomere 1 shorter than or about equal to foretarsomeres 2–5 combined 12

11(10). Scutum with broad median longitudinal pale stripe on anterior half with lateral dark stripe .. *An. marteri marteri**

- Scutum greyish yellow with narrow median longitudinal dark stripe, similar stripes laterally .... *An. marteri sogdianus*

12(10). Scutum with very narrow pale piliform scales on median area; lower proepisternal setae present; palpomere 5 not longer than 0.5 length of palpomere 4; mediocubital (mcu) crossvein distant from radiomedial (rm) crossvein for less than its own length; pale scales on posterior of vertex and anterior promontory (anterior scutal margin) off-white to yellowish; anterior promontory (anteacrostichal) patch weakly developed; antenna with sparse and poorly developed flagellar whorls; scales on wing veins less dense; larger brownish species, wing usually more than 5 mm (5.5–6.0 mm)..... *An. claviger* (Note 12)

- Scutum with narrow to moderately broad pale spatulate scales on median area; lower proepisternal setae absent; palpomere 5 longer than 0.5 length of palpomere 4; mcu distant from rm for about its own length; pale scales on vertex and anterior promontory pure white; anterior promontory patch well developed; antenna with numerous long flagellar whorls; scales on wing veins much more dense; smaller blackish species, wing at most 5.0 mm..... ..... *An. plumbeus*

13(1). Distal 0.5 of hindtarsomere 2 and all of hindtarsomeres 3–5 pale; abdominal terga densely covered with broad pale scales and prominent posterolateral dark scale-tufts; forefemur mostly pale-scaled; mid- and hindfemur with longitudinal white line terminating in an oval spot; maxillary palpus with 4 distinct pale bands [sometimes femora and tibiae slightly spotted] ..... *An. pulcherrimus*

- Distal 0.5 of hindtarsomere 2 and hindtarsomeres 3–5 not entirely pale; abdominal terga without broad pale scales and prominent posterolateral dark scale-tufts; forefemur not pale-scaled, but may have pale spots; mid- and hindfemur without longitudinal white line; maxillary palpus usually with 3 pale bands or entirely dark (Note 13) 14

14(13). Femora and tibiae with pale spots; abdominal terga II–VIII largely covered with pale scales; middle of maxillary palpomere 3 usually with some pale spots other than pale bands [anal vein (1A) (vein 6) with 3 dark spots; upper proepisternal setae absent; scutum with broad pale scales on median area] ..... *An. stephensi* (Note 14)

- Femora and tibiae not spotted; abdominal terga II–VIII without pale scales; maxillary palpomere 3 without pale spots..... 15

15(14). Wing with pale scales confined to costa (C), radius (R), and radius-one (R_1) (vein 1); scutum without scales; maxillary palpus with 2 or 3 indistinct pale bands or entirely dark 16

- Pale spots present on nearly all veins of wing; scutum with obvious pale scales in addition to setae; maxillary pal-

pus with at least 3 distinct pale bands [vertex with broad pale erect scales at center, dark brown laterally and posteriorly] (Note 13) 17

16(15). Erect head scales narrow, straw-yellow throughout; maxillary palpus with pale tip and 2 pale bands which may be so indistinct that the palpus appears entirely dark..... *An. dthali* (Note 15)

- Erect head scales broad and white on vertex and dark brown laterally and posteriorly; maxillary palpus either entirely dark or with apex dark and 2 narrow indistinct pale bands ..... *An. rhodesiensis rupicolus** (Note 16)

17(15). Palpomere 5 dark at apex [radius-four-plus-five (R_{4+5}) (vein 3) usually pale-scaled] 18

- Palpomere 5 pale at apex, or entirely pale 20

18(17). Base of costa (C) pale-scaled; cubitus (Cu) (vein 5) pale-scaled at point of furcation; scutal fossa with scattered pale scales; scutum with broad pale scales on median area; in males, tip of maxillary palpus usually dark [anal vein (1A) (vein 6) with 3 dark spots, or sometimes with outer 2 spots joined to form long distal spot; radius (vein R) without accessory sector dark spot; basal pale band on palpus either much narrower than median band, scarcely overlapping base of palpomere 3, or both basal and median pale bands very narrow]..... *An. multicolor*

- Base of C dark-scaled; Cu dark-scaled at point of furcation; scutal fossa without scales, or at most a few scales present on extreme upper margin; scutum with narrow pale scales on median area; in males, tip of maxillary palpus with distinct pale scales 19

19(18). Wing generally pale, pale and dark areas apart from costa (C), radius (R), and radius-one (R_1) (vein 1) poorly contrasted posterior to R and R_1; anal vein (1A) (vein 6) with at most 2 indistinct dark spots, distal spot long, often appearing mostly dark-scaled; vein R without accessory sector dark spot; anterior promontory without conspicuous scale-tuft; tarsi mainly dark, faintly marked with very narrow pale bands at apexes of tarsomeres; basal and median pale bands of palpus narrow ..... *An. turkhudi* (Note 17)

- Wing with well-defined pale- and dark-scaled areas on all veins; vein 1A with 3 dark spots; vein R with accessory sector dark spot; anterior promontory with conspicuous scale-tuft; fore- and midtarsomeres with faint and obscure apical pale spots, hindtarsomeres 1–4 with distinct apical pale spots, at least in typical form; basal band of palpus about equal to or slightly narrower than median band, broadly overlapping base of palpomere 3 .... *An. cinereus** (Note 18)

20(17). Radius-four-plus-five (R_{4+5}) (vein 3) dark-scaled except at base and apex; scutum unicolourous; frontal tuft poorly developed [upper proepisternal setae present; hindtarsomeres 3 and 4 entirely dark; scutal fossa without scales; scutum with narrow pale scales on median area; anal vein (1A) (vein 6) with 2 dark spots, proximal small and distal long] 21

- Vein R_{4+5} usually pale-scaled or at least pale-scaled in middle; scutum grey on top, darker at sides; frontal tuft well developed 22

21(20). Radius (R) (vein 1) with a dark spot just distal to humeral crossvein; remigium dark-scaled; wing fringe usually with 1 or 2 inconspicuous pale spots on posterior margin, rarely more..... *An. culicifacies s.l.* (Note 19)

- Vein R without a dark spot immediately distal to humeral crossvein; remigium pale-scaled; wing fringe usually with at least 4 pale spots on posterior margin ..... *An. sergentii* (Note 20)

22(20). Tarsi unbanded, with at most indistinct pale markings on joints of 1 or 2 tarsomeres; radius (R) without accessory sector dark spot, or at most with a rudimentary dark spot [anal vein (1A) (vein 6) with 2 dark spots, proximal small and distal long; scutal fossa without scales] 23

- Tarsi with conspicuous pale bands; vein R with accessory sector dark spot, sometimes represented by only a few dark scales in *An. subpictus s.l.* [subapical palpomere about half length of preceding palpomere] 24

23(22). No dark spot at point of furcation of cubitus (Cu) (vein 5); 1 or 2 pale spots at base of costa (C), presector pale spot present; cell R_2 (anterior forked cell of vein 2) short, about same length as radius-two-plus-three (R_{2+3}) (petiole or stem); maxillary palpus unusually long, subapical palpomere about 0.67 length of preceding palpomere; apical palpomere pale, sometimes with dark band; furcation of media (M) (vein 4) nearly equal or closer than furcation of radius-two-plus-three (R_{2+3}) (petiole or stem) to wing base; upper proepisternal setae absent; scutum with broad pale scales on median area; fringe of wing apex mostly pale, except for small dark spot between radius-two (R_2) (vein 2.1) and radius-three (R_3) (vein 2.2); large, pale species [hindtarsomeres at most very faintly pale at apex] ..... *An. superpictus* (Note 21)

- A dark spot at point of furcation of Cu; usually no pale spots at base of C, presector pale spot absent; cell R_2 very long, twice or more length of R_{2+3}; maxillary palpus not unusually long, subapical palpomere about 0.5 length of preceding palpomere; maxillary palpus always with 3 pale bands; furcation of R_{2+3} distinctly closer to wing base than furcation of M; upper proepisternal setae present; scutum with narrow pale scales on median area; fringe of wing apex with dark spots at R_2 and R_3; small, dark species ..... *An. fluviatilis s.l.* (Note 22)

24(22). Tarsi with narrow but distinct apical pale bands; usually no pale spots at base of costa (C), presector pale spot absent; upper proepisternal setae absent; scutum with broad pale scales on median area; anal vein (1A) (vein 6) with 3 dark spots; scutal fossa without scales; fringe of wing apex mostly pale, except a small dark spot between radius-two (R_2) (vein 2.1) and radius-three (R_3) (vein 2.2) ..... *An. moghulensis*

- Tarsi with broad pale bands; pale spots at base of C, presector pale spot present; upper proepisternal setae present; scutum with narrow pale scales on median area; 1A with 2 small dark spots; scutal fossa with scattered pale scales; fringe of wing apex with dark spots between R_2, R_3, and radius-four-plus-five (R_{4+5}) (vein 3) .... *An. subpictus s.l.* (Note 23)

Key to subgenera, species, and subspecies of genera *Aedes* and *Ochlerotatus*: adults
(key characters are illustrated in Figs 1–4)

1. Preapical white bands present on all femora; tibiae with median white bands; scutum with 1–3 pairs of white spots [scutellum with very broad silvery-white scales; clypeus with scales; proboscis about as long as forefemur; cerci long; lower mesepimeral setae present; hindtarsomere 5 entirely pale; lower proepisternal scales absent; hypostigmal area bare; acrostichal setae present; erect head scales on vertex and occiput] (*Aedes* subgenus *Fredwardsius*) ..... *Ae. vittatus*
- Femora without preapical white bands; tibiae without median white bands, may have a white stripe or speckles; scutum without white spots, but may have white lines or scales 2

2(1). Scutum with 1 or more longitudinal white stripes on dark brown or black background; scutellum with broad silvery-white scales; cerci very short, hardly visible from above; proboscis about as long as forefemur; erect scales of head restricted to occiput [lower mesepimeral setae absent; hindtarsomere 5 entirely pale; lower proepisternal scales present; hypostigmal area bare; acrostichal setae absent] (*Aedes* subgenus *Stegomyia*) 3
- Scutum without such white markings but may have scattered pale scales or white stripe on paler background, not dark brown or black; scutellum without broad silvery-white scales; cerci longer, visible from above; proboscis longer than forefemur; erect head scales on vertex and occiput 4

3(2). Scutum with a pair of submedian longitudinal white stripes, but without median (acrostichal) longitudinal white stripe, lateral white stripes broad, continuing over transverse suture to posterior of scutum, with lyre-shaped markings; clypeus with white scale-patches; mesepimeron with 2 well-separated white scale-patches; anterior surface of midfemur with longitudinal white stripe from base to near apex ..... *Ae. aegypti** (Note 24)
- Scutum with a narrow median longitudinal white stripe extending from anterior margin to prescutellar area where it forks to end at anterior margin of scutellum, lateral stripe narrow and short, not reaching middle of scutum and not continued over transverse suture, never lyre-shaped markings; clypeus without white scale-patches; mesepimeron with white scale-patches not separated, forming V-shaped white patch; anterior portion of midfemur without longitudinal white stripe ..... *Ae. albopictus**

4(2). Hindtarsomeres with narrow basal pale rings less than 0.25 length of tarsomere; abdominal terga with basal pale bands indented medially, with slightly bilobed appearance [foretarsomeres 4 and 5 entirely dark; wing and proboscis predominantly dark-scaled; lower mesepimeral setae absent; lower proepisternal scales present; hypostigmal area bare; acrostichal setae present] (*Aedes* subgenus *Aedimorphus*) ..... *Ae. vexans* (Note 25)
- Hindtarsomeres with basal pale rings more than 0.25 length of tarsomere or with both basal and apical pale rings, or without rings; abdominal terga without medially indented basal pale bands, with or without bands or pattern of pale and dark scales (genus *Ochlerotatus*) 5

5(4). Abdomen with prominent silvery-white lateral patches; cerci short, slightly protruding, blunt; sternum VIII not retracted into preceding segment; pedicel of antenna without scales; hindungues simple; without lower mesepimeral setae [tarsi without pale rings; lower proepisternal scales absent; hypostigmal area bare; acrostichal setae present] (*Ochlerotatus* subgenus *Finlaya*) 6
- Abdomen with lateral patches of yellowish or white scales; cerci longer, clearly protruding, tapering; sternum VIII retracted into preceding segment; pedicel of antenna with scales; hindungues toothed; lower mesepimeral setae present (except *Oc. flavescens*, but abdominal terga entirely pale) (*Ochlerotatus* subgenus *Ochlerotatus*) ... 7

6(5). Metameron with patch of scales; at least some abdominal terga with complete basal pale bands; scales of scutellum broad and white ..... *Oc. echinus*
- Metameron bare; abdominal terga with basolateral pale patches only; scutellum with at least a few narrow ochreous scales usually more numerous on lateral lobes ..... *Oc. geniculatus* (Note 26)

7(5). Tarsi without pale rings, some white scaling not forming rings may be present [pale scales scattered on most wing veins; anterior surface of fore- and midtibiae with numerous pale scales; metameron with scales; lower proepisternal scales absent] 8
- Some tarsomeres with rings of pale scales 9

8(7). Abdominal terga with mixture of dark and pale scales posteriorly; first antennal flagellomere without pale scales; hypostigmal area and postprocoxal membrane bare; maxillary palpus with scattered pale scales..... ..... *Oc. detritus* (Note 27)
- Abdominal terga entirely dark-scaled posteriorly or with few pale scales; first antennal flagellomere with white

scales ventrally; hypostigmal area and postprocoxal membrane with pale scales; maxillary palpus with more pale scales and subapical palpomere covered with numerous pale scales ..... *Oc. leucomelas*

9(7). Hindtarsomeres with basal pale rings only; hindtarsomere 5 not entirely pale [lower proepisternal scales absent; hypostigmal area with scales] 10

- Hindtarsomeres with both basal and apical pale rings; hindtarsomere 5 entirely pale 12

10(9). Abdominal terga with pale scales, without dark band, sometimes with a few dark scales; tarsomere 1 of all legs mostly pale except at apex; hindtarsomere 5 with basal pale band; wing mostly pale-scaled; proboscis with pale scales at middle and base; large species [lower mesepimeral seta absent] ..... *Oc. flavescens*

- Abdominal terga with sublateral apical dark patches; tarsomere 1 of all legs mostly dark, but with broad basal pale bands; hindtarsomere 5 entirely dark; wing entirely or mostly dark-scaled; proboscis entirely dark; medium-size species 11

11(10). Metameron with scales; tarsomere 4 of all legs pale basally; wing profusely speckled ..... *Oc. caballus*

- Metameron bare; tarsomere 4 of all legs indistinctly pale basally; wing almost entirely dark-scaled .... *Oc. chelli** (Note 28)

12(9). Abdominal terga with basal pale bands; wing entirely dark-scaled except for small patch at base of costa (C); lower proepisternal scales absent; metameron bare; tarsomere 5 of all legs pale; hypostigmal area bare; proboscis entirely dark (Pulcritarsis Complex) (Note 29) 13

- Abdominal terga with median pale stripes, sometimes entirely pale-scaled; wing with dark and pale scales; lower proepisternal scales present; metameron with scales; only hindtarsomere 5 pale; hypostigmal scales present; proboscis with pale scaling in middle (Caspius Complex) (Note 30) 15

13(12). Femora and tibiae with scattered pale scales; scutum with anteromedian patch of golden scales; erect scales of head entirely or predominantly pale (*Oc. pulcritarsis*) 14

- Femora and tibiae without scattered pale scales; scutum predominantly brown-scaled; erect scales of head entirely or predominantly dark ..... *Oc. berlandi**

14(13). Scutum without longitudinal pale stripe ..... *.Oc. pulcritarsis pulcritarsis*

- Scutum with a narrow longitudinal stripe of white scales ..... *Oc. pulcritarsis asiaticus*

15(12). Scutum golden-scaled with 2 narrow dorsocentral stripes of white scales reaching posterior margin of scutum; wing veins with dark and pale scales more or less evenly mixed; bases of costa (C) and subcosta (Sc) mostly dark-scaled; radius (R) (vein 1) and anal vein (1A) (vein 6) with dark and pale scales; pale scaling of abdominal terga mainly yellowish; acrostichal setae absent ..... *Oc. caspius s.l.*

- Scutum with narrow to broad median golden (to dark brown)-scaled stripes, reaching prescutellar dorsocentral area, and white to creamy scales laterally; wing veins predominantly with pale scales; bases of C and Sc and veins R and 1A predominantly white-scaled, occasionally with few dark scales; pale scaling of abdominal terga white; acrostichal setae present ..... *Oc. dorsalis**

Key to subgenera and species of genus *Culex*: adults

(key characters are illustrated in Figs 1–4)

1. Proboscis shorter than forefemur; hindtarsomere 1 shorter than hindtibia, not more than 0.85 length of hindtibia; abdominal terga entirely dark-scaled [in males, maxillary palpus generally with short spinelike setae] (subgenus *Barraudius*) 2

- Proboscis longer than forefemur; hindtarsomere 1 usually as long or longer than hindtibia or only slightly shorter, not less than 0.85 length of hindtibia; abdominal terga with pale bands at least on some segments, except *Cx.* (*Cux.*) *antennatus* 3

2(1). Abdominal terga with lateral pale scales more or less developed as spots; postspiracular scales absent .... *Cx. pusillus*

- Abdominal terga with pale scales arranged in more or less distinct stripes, sometimes forming triangular spots on anterior margins of terga; postspiracular scales present ..... *Cx. modestus* (Note 31)

3(1). Abdominal terga with apical pale bands or apicolateral pale patches [lower mesepimeral setae present except in subgenus *Oculeomyia*] 4

- Abdominal terga with basal pale bands or basolateral pale patches (except *Cx. antennatus*, which has lateral pale patches on terga VI and VII) [lower mesepimeral setae present in Pipiens Group; absent in Sitiens Group] (subgenus *Culex*) 9

4(3). Wing speckled with dark and pale scales, many scales broad ovate; proboscis with ring of pale scales; basal dark area of terga speckled with pale scales; femora and tibiae heavily speckled; tarsi with pale rings; proboscis with pair of dorsolateral pale spots at apex before labella; last palpomere with some pale scales; central part of ocular (orbital) line without scales; anal vein (1A) (vein 6) terminates distal to mediocubital (mcu) crossvein; in males,

proboscis with ventral cluster of setae at false joint; lower mesepimeral seta absent (subgenus *Oculeomyia*) (Note 32) ..... *Cx. bitaeniorhynchus*

– Wing uniformly dark-scaled, scales narrow clavate; proboscis without ring of pale scales; basal dark area of terga not speckled; femora and tibia not speckled, may have a few pale scales or a row of scales; tarsi without pale rings; proboscis without pair of pale spots at apex before labella; last palpomere without pale scales; central part of ocular (orbital) line with broad scales; 1A terminates before crossvein mcu; in males, proboscis without ventral cluster of setae at false joint; lower mesepimeral seta present 5

5(4). Prealar and postspiracular scales absent; pale areas of terga clearly reduced, medially narrowed or interrupted; maxillary palpus dark; end of subcosta (Sc) distinctly proximal to furcation of radius-two-plus-three (R_{2+3}) (petiole or stem) and media (M) (vein 4) (subgenus *Neoculex*) 6

- Prealar and usually postspiracular scales present; terga with broad pale areas of even width or medially extended posteriorly; palpomere 2 usually with pale scales; end of Sc nearly aligned with furcation of R_{2+3} and M or slightly proximal to them (subgenus *Maillotia*) 7

6(5). Apical pale bands of abdominal terga narrow, not interrupted, sometimes represented only by a line of pale scales along border of tergum; in males, last abdominal segment not usually very setose..... *Cx. territans*

- Apical pale bands interrupted at least on some terga, always broader at sides; in males, last abdominal segments with numerous, long setae ..... *Cx. impudicus** (Note 33)

7(5). Sterna entirely pale-scaled; in males, last palpomere with many setae [pale bands of most abdominal terga with projection] ..... *Cx. deserticola*

- Sterna dark with large triangular pale areas at apex of most sterna; in males, last palpomere devoid or nearly devoid of setae 8

8(7). Pale bands of most abdominal terga with projection; upper proepisternal area with many prominent scales; relatively darker species; palpomere 2 usually with prominent pale scales on dark background; in males, gonocoxite of genitalia with unusually broad, sclerotized, flattened process at apex..... *Cx. hortensis* (Note 34)

- Pale bands of abdominal terga of more or less even width, at most a few terga with weak projection; upper proepisternal area with fewer prominent scales; paler species; palpomere 2 with pale scales less prominent; in males, gonocoxite of genitalia otherwise ..... *Cx. arbieeni*

9(3). Proboscis with pale ring in middle; lower mesepimeral setae absent; tarsi with narrow pale rings (Sitiens Group) 10

- Proboscis without pale ring; lower mesepimeral setae present; tarsi without pale rings (Pipiens Group)..... 14

10(9). Wing with 3 conspicuous pale areas on costa (C) and pale markings on other veins; midtibia with anterior pale stripe..... *Cx. mimeticus*

- Wing without pale areas, occasionally with scattered pale scales; midtibia without anterior pale stripe 11

11(10). Anterior surface of fore- and midfemur speckled with pale scales; scutum with indefinite mottled pattern; cell M_2 (posterior forked cell of vein 4) long, furcation of radius-two-plus-three (R_{2+3}) (petiole or stem) distal to furcation of media (M) (vein 4); scutal integument dark ..... *Cx. sitiens*

- Anterior surface of fore- and midfemur not speckled; scutum without mottled pattern; furcation of R_{2+3} proximal to furcation of M; scutal integument pale brown (Vishnui Subgroup) (Note 35)..... 12

12(11). Pale ring of proboscis usually with proximal extension on ventral surface; hindfemur pale with an apical dark ring; erect scales on vertex all dark, dirty yellow to brown in middle; cell R_2 (anterior forked cell of vein 2) more than 3.0 length of radius-two-plus-three (R_{2+3}) (petiole or stem); in males, proboscis with ventral cluster of 10 or more setae at false joint ..... *Cx. tritaeniorhynchus*

- Pale ring of proboscis without proximal extension on ventral surface; hindfemur with dark and pale areas, with or without speckling, without apical dark ring; vertex with mixture of pale (cream, pale yellow, or beige) and dark erect scales, rarely all dark; cell R_2 less than 3.0 length of R_{2+3}; in males, proboscis with at most 10 (usually fewer) setae at false joint..... 13

13(12). Anterior surface of hindfemur with pale stripe contrasting well with dark-scaled area; in males, proboscis usually without ventral cluster of setae at false joint, 1 or 2 setae sometimes present ..... *Cx. pseudovishnui*

- Anterior surface of hindfemur with pale stripe not distinctly contrasting with dark-scaled area; in males, proboscis with ventral cluster of 5–10 setae at false joint ..... *Cx. vishnui**

14(9). At least forefemur with pale stripe on anterior surface, stripe usually present on fore- and midfemur and all tibiae 15

- Fore- and midfemur without anterior pale stripe (*Cx. univittatus* and *Cx. perexiguus* usually have an anterodorsal pale stripe on midtibia) 16

15(14). Basal pale bands of abdominal terga usually produced posteromedially into triangular patches; prealar and postspiracular scales present; hindfemur with a dark ventral stripe in apical third; prealar and upper and lower mesokatepisternal scale-patches confluent ..... *Cx. theileri*

- Basal pale bands of abdominal terga more or less of even width, not produced posteriorly; prealar and

postspiracular scales absent; ventral surface of hindfemur completely pale-scaled; prealar and upper and lower mesokatepisternal scale-patches not confluent ..... *Cx. vagans** (Note 36)

16(14). Postspiracular scales present; hindtibia with pale ring or well-developed and prominent pale spot at apex [prealar scales present] 17

- Postspiracular scales absent; hindtibia without pale ring or spot at apex (except *Cx. laticinctus*, which has a weak apical pale spot) [prealar scales present or absent] 19

17(16). Hindtibia without anterior pale stripe; wing entirely dark-scaled; basal pale bands of terga straight, 0.3–0.4 length of tergum, slightly produced laterally, especially on terga VI and VII; anterior surface of forecoxa pale-scaled or with a few dark scales in middle ..... *Cx. sinaiticus*

- Hindtibia with anterior pale stripe; wing with pale scales at base of costa (C); basal pale bands on terga narrower and convex; anterior surface of forecoxa with numerous dark scales in middle 18

18(17). Anterior surface of midfemur dark-scaled or with incomplete narrow pale stripe; wing seldom with few scales on anal vein 2A ..... *Cx. perexiguus*

- Anterior surface of midfemur with complete narrow pale stripe; wing usually with row of scales on anal vein 2A ..... *Cx. univittatus** (Note 37)

19(16). Abdominal terga unbanded, terga VI and VII with lateral pale stripes; in male, proboscis with ventral cluster of setae at false joint ..... *Cx. antennatus*

- Basal pale bands present on terga of most segments; in male, proboscis without ventral cluster of setae at false joint 20

20(19). Basal pale bands of abdominal terga very broad, 0.50–0.67 length of segment, not narrowed toward sides; scales of forecoxa mostly pale; wing with short line of pale scales at base of costa (C); proboscis all dark or faintly pale beneath; 2–4 lower mesepimeral setae present; hindtibia with apical pale spot [prealar scales present or absent] ... . *Cx. laticinctus*

- Basal pale bands of abdominal terga narrower, less than 0.5 length of segment, often narrower at sides, sometimes reduced to lateral spots or even absent from some terga; forecoxa with some dark scales; wing entirely dark-scaled; proboscis usually distinctly pale beneath in middle; 1, rarely 2, lower mesepimeral setae present; hindtibia without apical pale spot (Note 38) 21

21(20). Scutal scales more or less buff-colored; basal bands of abdominal terga nearly white, usually slightly paler than sternal scaling; tergal bands slightly if at all darker than basolateral white spots; subcosta (Sc) normally intersects costa (C) before furcation of radius-two-plus-three (R_{2+3}) (petiole or stem) [prealar scales absent] .... *Cx. quinquefasciatus*

- Scutal scales golden brown with reddish tint; basal bands of abdominal terga yellowish, usually same colour as sternal scaling; tergal bands distinctly darker than basolateral white spots; Sc normally intersects C at or beyond furcation of R_{2+3} 22

22(21). Cell R_2 (anterior forked cell of vein 2) more than 4.0 length of radius-two-plus-three (R_{2+3}) (petiole or stem); integument and scales between supraalar and posterior dorsocentral setae usually noticeably darker than surrounding integument and scales, evident as pair of ovoid spots [prealar scales normally absent] .... *Cx. pipiens* (including form *molestus*)

- Cell R_2 less than 4.0 length of R_{2+3}; integument and scales between supraalar and posterior dorsocentral setae not appreciably darker than surrounding integument and scales [prealar area normally with 4 scales or more, occasionally absent] ..... *Cx. torrentium*

Key to subgenera, species, and subspecies of genus *Culiseta*: adults

(key characters are illustrated in Figs 1–4)

1. Scutum with distinct longitudinal stripes of white scales, resembling a lyre in shape; femora and tibiae with pattern of pale spots and white stripes; anterior margin of costa (C) almost entirely pale-scaled; lateral margin of antennal scape, posteroventral area of cervix, and lower proepisternum with scales; sternum VIII with 2 broad lobes separated by deep groove; in male, maxillary palpus shorter than proboscis (subgenus *Allotheobaldia*) .... *Cs. longiareolata*

- Scutum with pale scales arranged in a more diffuse pattern; femora and tibiae without pattern of pale spots and white stripes, some scattered pale scales may be present; anterior margin of C mainly dark-scaled or with pale and dark scales intermingled; lateral margin of antennal scape, posteroventral area of cervix, and lower proepisternum without scales; sternum VIII without broad lobes; in male, maxillary palpus at least as long as proboscis 2

2(1). Radiomedial (rm) and mediocubital (mcu) crossveins well separated, mcu closer to wing base, distance between them usually at least as long as mcu; wing without dark clusters of scales; tarsi with narrow pale rings, ring on tar-

somere 3 not more than 0.2 length of tarsomere; hindtarsomere 4 without pale ring; femora and tibiae dark-scaled; postspiracular area and metameron without scales; abdominal tergum II without longitudinal pale band (subgenus *Culicella*)..... *Cs. morsitans* (Note 39)

- Crossveins rm and mcu aligned or slightly separated, if separated distance between them less than length of mcu; wing with dark clusters of scales, especially prominent close to crossveins and at base of cells R_2 (anterior forked cell of vein 2) and M_2 (posterior forked cell of vein 4); rings of pale scales on bases of tarsomeres broad, ring on tarsomere 3 more than 0.3 length of tarsomere; hindtarsomere 4 with pale ring; femora and tibiae speckled or with pale ring; postspiracular area and metameron with scales; abdominal tergum II with longitudinal pale band (subgenus *Culiseta*)..... 3

3(2). Femora without preapical pale rings, dark and pale scales intermixed throughout; hindtarsomere 1 without median pale ring (*Cs. alaskaensis*) (Note 40)..... 4

- Femora with preapical pale rings; hindtarsomere 1 with median white ring (Note 41) 5

4(3). Body dark brown or black; pattern of strongly contrasting dark and pale scales on tarsi and abdominal terga; wing mostly with unicolourous dark scales, only a few scattered pale scales, mostly on costa (C), and also on subcosta (Sc), radius (R), and radius-one (R_1) (vein 1) ..... *Cs. alaskaensis alaskaensis**

- Body pale or ochreous brown; pattern of dark and pale scales on tarsi and abdominal terga not strongly contrasted, diffuse; fairly significant mixture of pale scales on C, Sc, R, and R_1 ..... *Cs. alaskaensis indica*

5(3). Costa (C) usually completely dark-scaled or with isolated pale scales, isolated pale scales on subcosta (Sc) and radius (R) (vein 1); cubitus (Cu) usually entirely dark-scaled (occasionally with a few pale scales); abdominal terga largely with white or yellowish scales, often restricted to basal bands and longitudinal band on tergum II; wing with distinct dark spots; body dark brown or black, relatively dark species; contrasting pattern of dark and pale scales on legs and abdominal terga; radiomedial (rm) and mediocubital (mcu) crossveins aligned ..... *Cs. annulata*

- Veins C, Sc, and R with scattered pale scales; some pale scales always present on Cu; basal bands of abdominal terga always yellowish, yellowish scales scattered over dark areas; wing spots less distinct; body colour pale or ochreous brown, relatively pale species; pattern of dark and pale scales on legs and abdominal terga not distinct, diffuse; crossveins rm and mcu slightly separated, mcu slightly closer to wing apex..... *Cs. subochrea*

Key to subfamilies and genera: fourth-instar larvae

(key characters are illustrated in Figs 5 and 6)

1. Siphon absent; seta 1 palmate on some abdominal segments; comb absent; cardo of maxilla bar-like [posterior spiracles on dorsal sclerotized plate; pecten on plate on segment VIII] (subfamily Anophelinae) ..... *Anopheles*

- Siphon present; abdominal seta 1 never palmate; comb present; cardo of maxilla broad and flat [pecten present or absent on side of siphon] (subfamily Culicinae)..... 2

2(1). Siphon attenuated and pointed, with saw for piercing plant tissues; pecten absent ..... *Coquillettidia* (*Coquillettidia*) *richiardii* (Note 6)

- Siphon subcylindrical with blunt apex, not adapted for piercing plant tissues; pecten present [posterior spiracles on a five-lobed plate] 3

3(2). Abdominal segment VIII with lateral or dorsolateral plates; seta 1-C (preclypeal seta) on small conical projection; hypostomal suture (maxillary suture) incomplete, not reaching posterior tentorial pit (PTP); seta 14-C inserted on anterior margin of head capsule at base of maxilla, adjacent to seta 6-Mx; head longer than wide..... *Uranotaenia* (*Pseudoficalbia*) *unguiculata* (Note 3)

- Abdominal segment VIII without plates; seta 1-C not on projection; hypostomal suture well developed, extending to PTP; seta 14-C far from anterior margin of head capsule and seta 6-Mx; head at least as wide as long 4

4(3). Siphon with 3 or more pairs of seta 1-S (siphonal tufts) [saddle complete, encircling abdominal segment X] ..... *Culex* (Note 5)

- Siphon with only 1 pair of seta 1-S 5

5(4). Seta 1-S (siphonal tufts) inserted at base of siphon..... *Culiseta*

- Seta 1-S inserted well beyond base of siphon, at about 0.33 or beyond [saddle incomplete, not encircling abdominal segment X] (tribe Aedini) (Note 4) 6

6(5). Seta 12-I present..... *Ochlerotatus*

- Seta 12-I absent ..... *Aedes*

Key to subgenera, species, and subspecies of genus *Anopheles*: fourth-instar larvae
(key characters are illustrated in Figs 5 and 6)

1. Seta 2-C (inner clypeal seta) inserted close together, closer than distance between 2-C and 3-C (outer clypeal seta) on one side; seta 1-A (antennal tuft) and setae 5–7-C (frontal setae) branched, if 1-A single then 5–7-C single (*An. plumbeus*); all setae 9,10-P, 9,10-M, and 9,10-T (long pleural setae) single or at most with four branches, never feathered; seta 1-A inserted on inner (mesal) side of antennal shaft, except *An. plumbeus*; leaflets of abdominal seta 1 (palmate seta) usually uniformly tapering to apex, lanceolate, except *An. marteri* (subgenus *Anopheles*) ... 2
- Seta 2-C inserted at least as far apart as distance between 2-C and 3-C on one side; seta 1-A always single; at least one of setae 9,10-P, 9,10-M, and 9,10-T feathered; 1-A inserted on outer (lateral) side of antennal shaft; leaflets of abdominal seta 1 usually abruptly narrowed or shouldered, deeply notched, thus divided into a blade and terminal filament (subgenus *Cellia*) 12

2(1). Antenna smooth, without spicules; seta 6-IV–VI (long lateral setae on abdominal segments IV–VI) distinctly feathered; stellate setae on abdominal sterna present; setae 5–7-C (frontal setae) short and single, sometimes 7-C with 2 or 3 branches; seta 11-C (subantennal seta) very short, with only 2 or 3 branches [tree-hole larva] .... *An. plumbeus*
- Antenna spiculate; setae 6-IV–VI branched but not feathered; abdominal sterna without stellate setae; setae 5–7-C long and branched; seta 11-C nearly as long as antenna, with at least 18 branches 3

3(2). Seta 3-C (outer clypeal seta) simple, aciculate, or very slightly branched at tip 4
- Seta 3-C branched, dendritic 7

4(3). Head with 3 transverse dark bands; setae 2- and 3-C (inner and outer clypeal setae) aciculate; seta 1-P (inner prothoracic or shoulder seta) with 4 or more branches; anterior tergal plates large, 5.0–6.0 times wider than long, larger than distance between setae 1 (palmate setae); seta 8-C (postfrontal seta) with 3 or more branches; seta 0-IV,V well developed; antenna strongly spiculate [leaflets of abdominal seta 1 uniformly tapering to apex; seta 4-C shorter than seta 3-C, branched (2–5) and rarely single; seta 1-X (saddle seta) well within margin of saddle; more than 1 short tooth between longest teeth of pecten] ..... *An. algeriensis*
- Head spotted not banded; setae 2- and 3-C simple or with 2 or 3 apical branches; seta 1-P single or double; anterior tergal plates no more than 3.0 times wider than long, less than distance between setae 1; seta 8-C with at most 2 branches; seta 0-IV,V minute, single, or absent; antenna weakly spiculate 5

5(4). Leaflets of abdominal seta 1 (palmate seta) abruptly narrowed before apex; seta 4-C (posterior clypeal seta) as long as or longer than seta 3-C (outer clypeal seta), single and rarely bifid; seta 1-P (inner prothoracic or shoulder seta) strong, plumose; abdominal seta 2-IV,V (antepalmate setae on abdominal segments IV and V) with 1–3 branches; seta 1-X (saddle seta) well within margin of saddle; more than 1 short tooth between longest teeth of pecten (*An. marteri*) (Note 11) 6
- Leaflets of abdominal seta 1 uniformly tapering to apex; seta 4-C shorter than 3-C, branched (2–5), rarely single; seta 1-P weakly developed, with 3 or 4 branches; abdominal seta 2-IV,V with 3–5 branches; seta 1-X on/or just outside margin of saddle; often one short tooth between longest teeth of pecten..... *An. claviger* (Note 12)

6(5). Seta 4-C (posterior clypeal seta) short, usually extended forward just beyond base of seta 2-C (inner clypeal seta) not beyond anterior margin of dorsal apotome (frontoclypeus or clypeus); setae 2,3-P attached to common setal support plate; filaments of palmate setae 0.5 total length of leaflets ..... *An. marteri marteri**
- Seta 4-C much longer, extending well beyond anterior margin of dorsal apotome, approximately 0.25 length of seta 2-C; setae 2,3-P on separate setal support plates; filaments of palmate setae 0.3 total length of leaflets .... *An. marteri sogdianus*

7(3). Seta 1-A (antennal tuft) inserted on basal 0.25 of antenna, usually with 3 or 4 (2–7) branches, length less than 0.5 length of antenna; seta 2-C (inner clypeal seta) well branched at apex (Maculipennis Group) (Note 9) 8
- Seta 1-A inserted near middle of antenna, with 5 or more branches, length more than 0.5 length of antenna; seta 2-C usually simple or weakly branched at apex (Hyrcanus Group) (Note 8) 9

8(7). Seta 2 (antepalmate seta) of abdominal segments IV and V with mean number of branches 36.8, SD 1.9, range 27–45 ..... *An. sacharovi*
- Seta 2 of abdominal segments IV and V with mean number of branches 16.5, SD 5.0, range 9–35 .... *An. maculipennis s.l.*

9(7). Seta 1-X (saddle seta) as long as saddle; abdominal sterna spiculate medially; seta 1-I,II (seta 1 on abdominal segments I and II) more or less flattened and weakly palmate but not pigmented, seta 1-III–VII well developed and pigmented 10
- Seta 1-X longer than saddle; abdominal sterna not spiculate; seta 1-I,II rudimentary, seta 1-III–VII well developed and pigmented 11

10(9). Seta 4-M with sinuate, spreading branches arising close together at base..... *An. peditaeniatus*
- Seta 4-M with stiff, erect branches arising along stem ..... *An. nigerrimus**

11(9). Seta 2-C (inner clypeal seta) simple ..... *An. pseudopictus*
- Seta 2-C branched at apex ..... *An. hyrcanus*
12(1). Seta 3-C (outer clypeal seta) branched (4–12) [dark transverse band behind setae 5-7-C (frontal setae)] ..... *An. pulcherrimus*
- Seta 3-C single, occasionally bifid or slightly branched at apex 13
13(12). Anterior (main) tergal plates of abdominal segments III–VII exceptionally large, their posterior borders usually enclosing posterior tergal plate; width of main plate on segment V at least 0.75 distance between setae 1 (palmate setae) ..... *An. fluviatilis s.l.* (Note 22)
- Anterior tergal plates on terga III–VII narrower, posterior tergal plates always entirely free; width of main plate on segment V not more (usually less) than 0.67 distance between setae 1 (except sometimes in *An. sergentii* and *An. culicifacies s.l.*) 14
14(13). Setae 9,10-M (long mesopleural setae) feathered; seta 1-III or 1-IV (palmate seta on abdominal segments III or IV) well developed; seta 4-C (posterior clypeal seta) exceptionally long, 0.67–1.0 length of seta 2-C (inner clypeal seta) 15
- At least one of seta 9,10-M simple; seta 1-II–VII well developed; seta 4-C less than 0.67 length of seta 2-C, except *An. apoci* 16
15(14). Seta 1-IV–VI (seta 1 on abdominal segments IV–VI) palmate, 1-III weak; filaments of leaflets very short and blunt . ..... *An. turkhudi* (Note 17)
- Seta 1-III–VII palmate; filaments of leaflets sharply pointed and about 0.5 length of blade ..... *An. cinereus** (Note 18)
16(14). Setae 9,10-M (long mesopleural setae) simple, one may be occasionally feathered on one side of the thorax 17
– Seta 9-M feathered and 10-M simple 19
17(16). Setae 9,10-T (long metathoracic pleural setae) feathered; setae 9,10-P (long prothoracic pleural setae) simple ..... *An. subpictus s.l.* (Note 23)
- Seta 9-T feathered and seta 10-T simple; seta 9-P feathered and seta 10-P simple 18
18(17). Setae 2,3-X (inner, outer caudal setae) both with strongly hooked branches; seta 4-C (posterior clypeal seta) about as long as seta 3-C (outer clypeal seta); paired accessory tergal plates usually dash-like and narrow; basal tubercles of setae 1,2-P (inner and median prothoracic or shoulder setae) well separated ..... *An. dthali*
- Branches of seta 2-X straight, their ends not recurved, those of seta 3-X hooked; seta 4-C distinctly shorter than seta 3-C; paired accessory tergal plates usually dot-like and circular; basal tubercles of setae 1,2-P close together . ..... *An. culicifacies s.l.* (Note 19)
19(16). Seta 9-T (long metathoracic pleural seta) feathered and seta 10-T simple; seta 1-I (seta 1 on abdominal segment I) weakly palmate 20
- Setae 9,10-T feathered; seta 1-I not palmate, rudimentary 22
20(19). Abdominal plate wide, 0.8 distance between bases of setae 1 (palmate setae); dark markings on dorsal apotome (frontoclypeal markings) in shape of transverse band behind bases of setae 5–7-C (frontal setae); seta 2-X (inner caudal seta) hooked; seta 2-C (inner clypeal seta) simple ..... *An. sergentii* (Note 20)
- Abdominal plate not more than 0.67 distance between bases of setae 1; dark markings on dorsal apotome, if present, in shape of spots that do not form a continuous band behind bases of setae 5–7-C; seta 2-X straight; seta 2-C usually finely aciculate or branched at apex 21
21(20). Antenna evenly spiculate; both setae 9,10-P (long prothoracic pleural setae) simple; setae 3,4-C (outer and posterior clypeal setae) exceptionally long, as long as seta 2-C (inner clypeal seta) ..... *An. apoci* (Note 10)
- Antenna with a group of markedly longer spicules on basal 0.33 of inner (mesal) side; seta 9-P feathered and seta 10-P simple; seta 3,4-C shorter than seta 2-C ..... *An. rhodesiensis rupicolus** (Note 16)
22(19). Seta 1-II–VII (abdominal palmate setae) well developed; seta 1-T (metathoracic seta 1) differentiated, forming distinct weakly palmate seta with 3–9 long branches [filaments of abdominal palmate setae longer than 0.5 length of blade] 23
- Seta 1-III–VII well developed, 1-II weakly developed; seta 1-T not differentiated, with 2–5 short branches [basal tubercles of setae 1,2-P (inner and median shoulder setae) separate, not fused] 24
23(22). Seta 1-P (prothoracic seta 1 or inner shoulder seta) with small weakly sclerotized tubercle; basal tubercles of 1,2-P (inner and median shoulder setae) not fused; setae 2,3-C not stout and/or finely aciculate; base of dorsal apotome (frontoclypeus) with dark spots ..... *An. superpictus*
- Seta 1-P with strongly sclerotized tubercle; basal tubercles of 1,2-P fused; setae 2,3-C stout, seta 2-C finely aciculate on middle 0.67 and seta 3-C simple; base of dorsal apotome usually wholly dark ..... *An. moghulensis*
24(22). Seta 1-P (prothoracic seta 1 or inner shoulder seta) usually without basal tubercle, or poorly developed tubercle; seta 2-C (inner clypeal seta) always simple; anal papillae (gills) short, stumpy; filaments of abdominal palmate setae poorly defined or undeveloped, however if defined then longer than 0.5 length of blade; well-defined dark spots around bases of setae 5–7-C (frontal setae) that may be fused to form continuous band ..... *An. multicolor*
- Seta 1-P with well-sclerotized tubercle; seta 2-C usually finely aciculate; anal papillae elongate; filaments of

abdominal palmate setae shorter than 0.5 length of blade; dark spots around bases of setae 5–7-C absent or faint . ..... *An. stephensi* (Note 14)

Key to subgenera, species, and subspecies of genera *Aedes* and *Ochlerotatus*: fourth-instar larvae
(larva of *Oc. chelli* is unknown) (key characters are illustrated in Figs 5 and 6)

1. Siphon without acus (auricle) (with indistinct acus in *Ae. vittatus*) [antenna smooth or very sparsely spiculate; seta 1-A (antennal tuft) with at most 4 branches; seta 12-I absent] 2
- Siphon with well-developed acus 4
2(1). Pecten with 1, sometimes 2, apical spines distinctly separated from other spines beyond seta 1-S (siphonal tuft); seta 1-A (antennal tuft) with 2 or 3 branches, inserted slightly before middle of shaft; seta 4-X (ventral brush) with 2 or more precratal setae; seta 4-C (postclypeal seta) and 6-C (median frontal seta) on level with base of antenna; seta 4-C minute, with very few (2–4) fine branches; seta 5-II–V single, rarely double; antenna very sparsely spiculate; anal papillae (gills) wider at base and pointed apically, more than 2.0 length of saddle [SI 2.0 (1.9–3.1); seta 7-C usually with 2 or more branches, rarely single; comb scales with apical spine, without subapical spines; PTF 1:1:2:1:1:1:2–3] (*Aedes* subgenus *Fredwardsius*) ..... *Ae. vittatus*
- Pecten with spines equally spaced, sometimes 1 or 2 apical spines slightly more widely separated but not distinctly and not beyond seta 1-S; seta 1-A single, inserted slightly beyond middle of shaft; seta 4-X without precratal setae; setae 4,6-C inserted far forward on head; seta 4-C well developed, usually with 5 (4–7) branches; seta 5-II–V branched; antenna smooth; anal papillae sausage-shaped with round ends, 2.5–3.0 length of saddle (*Aedes* subgenus *Stegomyia*) 3
3(2). Comb scales with stout subapical spines; basal tubercle(s) of setae 9–12-M,T (meso- and metapleural groups of setae) strongly sclerotized, curved and pointed, spine-like; seta 4-X (ventral brush) with 5 pairs of setae, each usually two-branched (2 or 3); seta 7-C (outer frontal seta) single, rarely double [SI 1.5–2.5; PTF 2–3:1:2:1–2:2:1:2–3] ..... *Ae. aegypti** (Note 24)
- Comb scales without subapical spines; basal tubercle(s) of setae 9–12-M,T with only small denticles; seta 4-X with 4 pairs of setae, each single; seta 7-C usually with 2 or more branches, rarely single [SI 2.0; PTF 3–4:1:2:2–3:1–2:1:2–3] ..... *Ae. albopictus**
4(1). Pecten with 1, sometimes 2, apical spines distinctly separated from other spines, more curved and stouter than others and usually without secondary denticles; seta 1-S (siphonal tufts) small, length about 0.5 width of siphon at point of attachment; seta 12-I absent [antenna spiculate; seta 1-A (antennal tuft) with 5-12 branches; 9–12 comb scales arranged in single or double row; SI 3.0–3.5 (2.1–4.3); lateral palatal brush (LPB) (labral brush) with distally dentate filaments; PTF 1:1:1–3:1–2:1:1:2–3] (*Aedes* subgenus *Aedimorphus*) ..... *Ae. vexans* (Note 25)
- Pecten with spines regularly or irregularly spaced but without apical curved and stout distinctly separated spines; seta 1-S large, length more than 0.5 width of siphon at point of attachment, except *Oc. caballus*; seta 12-I present (genus *Ochlerotatus*) (Note 4) 5
5(4). Thorax and abdomen with stellate setae; antenna smooth, without spicules; pecten spines long, pointed, equally spaced [seta 1-A (antennal tuft) single; comb scales in a single row; tree-hole larva] (*Ochlerotatus* subgenus *Finlaya*) 6
- Thorax and abdomen without stellate setae; antenna spiculate even if only sparsely; pecten spines short, not spine-like, with a broad base (*Ochlerotatus* subgenus *Ochlerotatus*) 7
6(5). Pecten about 0.5 length of siphon, usually with 18–22 (15–27) spines; setae 1,2,5-I (stellate setae of abdominal segment I) obviously longer than segment, some with 5-10 branches; seta 6-III–VI (lateral seta on abdominal segments III–VI) long and stout; dorsal pair of anal papillae (gills) about 2.0 length of ventral pair and distinctly longer than saddle [SI 3.0–3.5; PTF 3–5:1:5–8:6-8:2:1:2] ..... *Oc. echinus*
- Pecten distinctly less than 0.5 length of siphon, usually with 15 (14–20) spines; setae 1,2,5-I about as long as segment, at most 6-branched; setae 6-III–VI shorter and more slender; dorsal pair of anal papillae about 1.5 length ventral pair and slightly longer than saddle [SI 2.0–3.0; PTF 3–4:1:3-6:4–7:2:1:2] ..... *Oc. geniculatus* (Note 26)
7(5). Antenna sparsely spiculate; anal papillae (gills) very long at least 2.0 length of saddle, sausage-shaped with round ends; seta 1-X (saddle seta) at least 2.0 length of saddle; head about as broad as long; median filaments of lateral palatal brush (LPB) (labral brush) not apically serrate; seta 1-S (siphonal tuft) at least 2.0 width of siphon at point of attachment, inserted well below middle of siphon [seta 1-A (antennal tuft) with 2–4 branches; tree-hole larva] (Pulcritarsis Complex) (Note 29) 8
- Antenna well spiculate; anal papillae less than 2.0 length of saddle; seta 1-X less than 2.0 length of saddle; head broader than long; median filaments of LPB apically serrate; seta 1-S less than 2.0 width of siphon at point of attachment, inserted on or beyond middle of siphon (may be slightly below middle in *Oc. dorsalis* and *Oc. leucomelas*) 10

8(7). Seta 1-S (siphonal tuft) at about 0.5 length of siphon, less than 2.0 width of siphon at point of attachment; comb with 6–11 scales in a single row; siphon index (SI) usually under 5.0 (3.0–5.2); anal papillae (gills) equally long; seta 1-A (antennal seta) inserted on or slightly beyond middle of shaft [PTF 3:1–2:2–4:3–4:3–4:1:5] *Oc. pulcritarsis* 9

- Seta 1-S at about 0.33 length of siphon, more than 2.0 width of siphon at point of attachment; comb scales usually more numerous (16–20), often arranged in an irregular triangular patch; SI usually more than 5.0 (3.5–7.8); dorsal pair of anal papillae longer than ventral pair; seta 1-A inserted well beyond middle of shaft [PTF 2–3:1:2:2–3:2-3:1:3–4] ..... *Oc. berlandi**

9(8). Siphon index (SI) 4.0–5.0; siphon slightly but uniformly tapered toward apex; anal papillae (gills) usually as long as siphon ..... *Oc. pulcritarsis pulcritarsis*

- SI 3.0–3.5; siphon strongly tapered toward apex; anal papillae usually twice as long as siphon .... *Oc. pulcritarsis asiaticus*

10(7). Seta 4-X (ventral brush) with 4–7 precratal setae (arising anterior to grid); seta 1-X (saddle seta) about 1.3 length of saddle; siphon index (SI) greater than 3.0 (3.2–4.0) [PTF 1:1:2–3:1:2:1:3–8] ..... *Oc. flavescens*

- Seta 4-X with at most 3 precratal setae; seta 1-X shorter than 1.3 length of saddle, usually at most as long as saddle; SI usually not more than 3.0 11

11(10). Seta 1-A (antennal tuft) single or double; comb with about 10 large scales with secondary denticles confined to base; anal papillae (gills) about 1.5 length of saddle; length of seta 1-S (siphonal tuft) at most 0.5 width of siphon at point of attachment [SI 2.6–2.9; seta 1-X (saddle seta) about half as long as saddle; PTF 1:1:1-4:1:1:1-2:3 .... *Oc. caballus* (Note 28)

- Seta 1-A with more than 3 branches; comb with more than 10 (usually more than 20) scales or spines; anal papillae no longer than saddle, usually shorter; seta 1-S more than 0.5 width of siphon at point of attachment..... 12

12(11). Comb with more than 25 (usually more than 35) scales, scales without main spine; anal papillae (gills) spherical and very short; setae 2–6-P (prothoracic setae 2–6) usually single; seta 5-C (inner frontal seta) with 2–5 branches; seta 6-C (median frontal seta) usually with 2 or 3 branches, rarely single [SI 3.0 (1.8–3.5); seta 1-X (saddle seta) nearly as long as saddle; PTF 2:1:1:1:1:1:3] ..... *Oc. detritus*

- Comb with fewer than 25 scales, at least some scales with long main spine; anal papillae not spherical; at least one of setae 2–6-P branched; seta 5-C usually single, rarely with 2 branches; seta 6-C usually single, rarely with 2 or 3 branches 13

13(12). Seta 4-X (ventral brush) with long main basal stem, at least 1.5–2.0 length of transverse grid bar at base of central cratal seta; anal papillae (gills) tapering; seta 1-X (saddle seta) nearly as long as saddle [SI 2.6 (2.2–4.2); PTF 1–2:1:1:1:2:1:3] ..... *Oc. leucomelas*

- Seta 4-X branched from near base, main stem subequal to length of transverse grid bar at base of central cratal seta; anal papillae rounded; seta 1-X short, about 0.5 length of saddle (Caspius Complex) (Note 30) 14

14(13). Seta 1-S (siphonal tuft) inserted beyond middle of siphon, usually with more than 5 (5–10) branches; seta 1-III–VI short with more than 2 simple branches; seta 3-VIII usually with more than 8 branches; seta 1-P (prothoracic seta 1) usually single [SI 2.9 (1.4–3.2); PTF 1:1:2:1:1–2:1:3] ..... *Oc. caspius s.l.*

- Seta 1-S inserted about midlength of siphon, usually with fewer than 5 (3-6) branches; seta 1-III–VI long with 2 aciculate branches; seta 3-VIII usually with fewer than 8 branches; seta 1-P usually double [SI 2.3 (1.4–3.0); PTF 2:1:2:1:2:1:3] ..... *Oc. dorsalis**

Key to subgenera and species of genus *Culex*: fourth-instar larvae

(key characters are illustrated in Figs 5 and 6)

1. Seta 4-X (ventral brush) with 1 or more precratal setae; thorax and abdomen spiculate [siphonal trachea narrow, less than 0.5 width of siphon] 2

- Seta 4-X without precratal setae; thorax and abdomen not spiculate, except *Cx.* (*Cux.*) *vishnui* (with thorax spiculate) 6

2(1). Seta 3-P more than 0.5 length of setae 1,2-P; siphon with 2 or more (usually more) anterolateral setae on each side; seta 1-S (siphonal tufts) unpaired, occurring in single median posterior row; seta 2-S (apicodorsal seta of siphon) large and hooked; siphon not expanded at apex; seta 6-C (median frontal seta) with at least 2 branches; seta 1-C (preclypeal seta) pale, more or less stout, never strongly tapered or filamentous (subgenus *Maillotia*) ... 3

- Seta 3-P about 0.5 or less length of setae 1,2-P; siphon without anterolateral setae; seta 1-S more or less paired, occurring in 2 posterolateral rows; seta 2-S small and straight, not hooked; siphon slightly expanded at apex; seta 6-C single; seta 1-C dark, otherwise same as above (subgenus *Neoculex*) 5

3(2). Siphon with numerous strong setae on subdorsal part of distal 0.67; siphon index (SI) less than 5.0 (4.4); seta 1-S (siphonal tuft) inserted beyond pecten [PTF 3–4:1:2:3:1:1:3] ..... *Cx. arbieeni*

- Siphon without such setae; SI more than 5.0; usually at least 1 pair of seta 1-S (siphonal tufts) inserted within pecten 4

4(3). Seta 3-P (prothoracic seta 3) bifid; seta 8-P (prothoracic seta 8) usually single; seta 1-S (siphonal tuft) often less than 0.3 length of siphon; anal papillae (gills) longer than saddle; siphon more than 4.0 length of saddle; siphon index (SI) 6.5 or greater (6.5–8.0) [PTF 1:1:2–3:4:1:1:3] ..... *Cx. hortensis*

- Seta 3-P single; seta 8-P usually with 2 or 3 branches; seta 1-S often more than 0.3 length of siphon; anal papillae shorter than saddle; siphon less than 4.0 length of saddle; SI less than 6.5 (6.0–6.4) [PTF 1:1:1:3:1:1:4] .... *Cx. deserticola*

5(2). Length of seta 1-S (siphonal tuft) usually more than 2.0 (1.5–3.0) width of siphon at point of attachment; more distal pecten spines evenly spaced, each with 3 long ventral denticles; anal papillae (gills) about 0.5 length of saddle, blunt tipped [SI 6.1–8.5; PTF 1:1:3:2:1:1:3] ..... *Cx. impudicus** (Note 33)

- Seta 1-S at most 2.0 (usually less than 1.5) width of siphon at point of attachment; more distal pecten spines often more widely spaced and somewhat irregularly inserted, each with 1 or 2 ventral denticles; anal papillae nearly as long or longer than saddle, pointed [SI 6.0–7.0; PTF 1:1:3:2:1:1:3] ..... *Cx. territans*

6(1). Seta 1-S (siphonal tufts) in single row, with all elements arranged in more or less straight line; seta 3-C absent [siphonal trachea broad, more than 0.5 width of siphon; at least one pair of seta 1-S inserted within pecten; seta 1-C (preclypeal seta) pale, very slender and distally strongly tapered or filamentous] (subgenus *Barraudius*) 7

- Seta 1-S in 1 or 2 rows, with 1-3 elements distinctly out of line with the others (inserted laterally); seta 3-C usually present (may be absent in some species, such as *Cx.* (*Cux.*) *pipiens* and *Cx.* (*Cux.*) *vishnui*) 8

7(6). Siphon index (SI) about 3.0 (2.6–3.2); pecten at least 0.5 length of siphon; 2 apical seta 1-S (siphonal tufts) at least as long as width of siphon at point of attachment; 2 pairs of seta 1-S inserted within pecten; anal papillae (gills) about 0.5 length of saddle, scarcely longer than diameter, dorsal pair slightly longer than ventral pair; seta 8-P (prothoracic seta 8) usually single [PTF 1:1:1:2:1:1:3] ..... *Cx. pusillus*

- SI about 4.0 or more (3.8–5.0); pecten less than 0.5 length of siphon; 2 apical seta 1-S shorter than width of siphon at point of attachment; 1 pair of seta 1-S inserted within pecten; anal papillae slightly shorter than saddle, slender and tapering, same length; seta 8-P with 2 or 3 branches [PTF 1:1:1:1–2:1:1:3]..... *Cx. modestus*

8(6). Dorsomentum of head a straight-sided triangle with minutely serrate margins; pecten very short, with 7–9 spines grouped at base of siphon, less than 0.1 length of siphon; seta 1-A (antennal tuft) inserted near mid-length of antenna; median labral plate (preclypeus or labrum) indistinguishably fused to dorsal apotome (frontoclypeus) [comb with 4–8 large scales, each with distinct main spine; distal pecten spines with 7 or more ventral denticles; seta 1-C (preclypeal seta) stout, distinctly thicker than branches of setae 5,6-C; SI 6.8 (5.0–8.4); PTF 1:1:1:1–2:1:1:3] (subgenus *Oculeomyia*) (Note 32)..... *Cx. bitaeniorhynchus*

- Dorsomentum an imperfect triangle with large teeth; pecten much longer, about 0.33 length of siphon; seta 1-A inserted near apex of antenna; median labral plate distinct, separated by suture from dorsal apotome (subgenus *Culex*) 9

9(8). Some or all comb scales spiniform, with pointed apex and fringe at sides 10

- All comb scales evenly fringed at sides and apex 14

10(9). Comb with fewer than 25 spiniform scales (usually fewer than 20), each with distinct main spine [seta 1-C (preclypeal seta) pigmented, stout, distinctly thicker than branches of setae 5,6-C] (Note 33) 11

- Comb with more than 25 spiniform scales, without distinct main spine..... 12

11(10). Comb with 4–8 (rarely up to 19) large spiniform scales in single row; thorax not spiculate; seta 1-S (siphonal tufts) with 5 or fewer branches; distal pecten spines with 7 or more ventral denticles of similar size arising along entire length [SI 5.4 (4.4–6.9); PTF 1:1:1:1–3:1:1:3] ..... *Cx. pseudovishnui*

- Comb with 16–22 small spiniform scales in 3 or 4 rows; thorax spiculate; seta 1-S with 6 or more branches; distal pecten spines with 2–5 ventral denticles of different size arising proximally [PTF 1:1:1:2:1:1:3] .... *Cx. vishnui**

12(10). Seta 2-S long and curved; antenna with setae 2,3-A (subapical setae) arising at 0.3–0.5 distance between apical setae and seta 1-A (antennal tuft); seta 7-I about as long as 6-I, usually single; seta 14-C single; distal pecten spines with 7 or more ventral denticles; seta 1-C (preclypeal seta) stout, distinctly thicker than branches of setae 5,6-C (inner and median frontal setae), dark [siphonal trachea narrow, less than 0.5 width of siphon; SI 6.0 (4.5–7.4); PTF 1:1:1:1:1:1:2–3] ..... *Cx. mimeticus*

- Seta 2-S always straight; setae 2,3-A arising adjacent to apical setae; seta 7-I distinctly shorter than 6-I, usually double; seta 14-C with 2 or more branches, rarely single; distal pecten spines with 2–5 ventral denticles of different size arising proximally; seta 1-C slender, usually not thicker than branches of setae 5,6-C, dark or pale..... 13

13(12). Siphon with all elements of seta 1-S (siphonal tufts) arising laterally and posterolaterally, with 1–4 branches; siphonal trachea narrow, less than 0.5 width of siphon; pecten spines not large and curved; some anterior scales of comb evenly fringed at sides and apex; seta 5-C (inner frontal seta) with 1 or 2 branches (usually single), shorter than seta 6-C (median frontal seta); seta 14-P double on at least one side; siphon index (SI) more than 5.5 (6.9; 5.9–8.1); seta 1-C (preclypeal seta) pale, very slender and strongly tapered or filamentous [PTF 1:1:1:1–4:1:1:3]. ..... *Cx. sinaiticus*

- Siphon with most elements of seta 1-S arising relatively close to posterior midline, with 4–11 branches; siphonal trachea broad, more than 0.5 width of siphon; more distal pecten spines very large and curved; all scales of comb spiniform; seta 5-C with 3 or 4 branches, about as long as seta 6-C; seta 14-P single; SI less than 5.5 (4.7; 4.1–5.4); seta 1-C dark, more or less stout, never strongly tapered or filamentous [PTF 1:1:1:2:1:1:3–4]..... ..... *Cx. theileri*

14(9). Distal pecten spines with 7 or more ventral denticles of similar size arising along entire length; seta 1-C (preclypeal seta) dark, stout, spiniform or foliform, abruptly pointed or blunt apically, distinctly thicker than branches of setae 5,6-C (inner and median frontal setae) 15

- Distal pecten spines with 2–5 ventral denticles of different size arising proximally; seta 1-C usually pale or pigmented, never dark, slender, scarcely if at all thicker than branches of setae 5,6-C 16

15(14). Seta 1-S (siphonal tufts) mostly inserted in irregular row on posterior margin of siphon; anal papillae (gills) very small and globular, about 0.5 length of saddle or less; siphon index (SI) less than 5.0 (3.8, 3.6–4.6); seta 5-C (inner frontal seta) with at least 6 (6–8) branches; seta 6-C (median frontal seta) with at least 4 (4–7) branches; seta 1-X (saddle seta) usually single; seta 1-C (preclypeal seta) markedly flattened, or somewhat foliform, with blunt apex [PTF 1:1:1:2:1:1:2–3] ..... *Cx. sitiens*

- Seta 1-S in posterolateral pairs; anal papillae elongate, never globular; SI more than 5.0 (6.3, 5.7–7.0); seta 5-C with 4 or fewer branches; seta 6-C with 3 or fewer branches; seta 1-X usually triple (2–4); seta 1-C slender and spiniform, with acuminate apex [PTF 1:1:1:1–2:1:1:2–3] ..... *Cx. tritaeniorhynchus*

16(14). Siphon with 6–8 pairs of seta 1-S (siphonal tufts), with one pair arising laterally and 5–7 irregular pairs arising relatively close to posterior midline; seta 1-S with 2 pairs arising within pecten [seta 1-C (preclypeal seta) pale, more or less stout, never strongly tapered or filamentous; SI 3.5 (2.8–4.6); PTF 1:1:1:2:1:1:3–4] ... *Cx. laticinctus*

- Siphon with 3–6 pairs of seta 1-S, with 1-3 pairs arising laterally and 2–4 pairs arising posterolaterally; seta 1-S at most with 1 pair arising within pecten 17

17(16). Seta 1-S (siphonal tufts) no longer than width of siphon at point of attachment, usually in 5 pairs; all seta 1-S subequal in length; seta 6-VI normally single; seta 5-C (inner frontal seta) usually double or triple (occasionally with 4 branches); seta 6-C (median frontal seta) at most with 3 (2 or 3) branches; seta 1-C (preclypeal seta) more or less stout, never strongly tapered or filamentous 18

- Seta 1-S longer than width of siphon at point of attachment, usually in 4 pairs; at least basal 2 pairs of seta 1-S distinctly longer than apical setae; seta 6-VI normally double; seta 5-C with 4 or 5 branches; seta 6-C usually with more than 3 branches; seta 1-C pale, very slender and distally strongly tapered or filamentous 20

18(17). Siphon with 3 lateral pairs of seta 1-S (siphonal tufts); seta 1-M usually double or triple, sometimes single; seta 5-C (inner frontal seta) usually with 2 branches; distal pecten spines usually with 2 ventral denticles; seta 1-C (preclypeal seta) long, thin and pale [SI 6.8 (5.4–8.2); PTF 1:1:1:2:1:1:3]..... *Cx. antennatus*

- Siphon with 2 lateral pairs of seta 1-S (siphonal tuft); seta 1-M usually single, sometimes double; seta 5-C usually with 3 branches; distal pecten spines usually with 3 or more ventral denticles; seta 1-C not as long, slightly stouter and pigmented 19

19(18). Seta 1-S (siphonal tufts) as long as width of siphon at point of attachment [SI 6.8 (5.4–7.9); PTF 1:1:1:2:1:1:3–4] *Cx. perexiguus*

- Seta 1-S distinctly shorter than width of siphon at point of attachment [SI 5.7 (4.9–7.2); PTF 1:1:1:2:1:1:2–3] .... *Cx. univittatus** (Note 37)

20(17). Seta 1-III–V with 3–6 branches (usually 4 or 5), sum of their branches on one side of abdomen 10 or more (usually more); seta 1-M normally double or triple; seta 1-X (saddle seta) usually double [SI 5.2 (4.4–5.7); PTF 1:1:1:2:1:1:2–3] ..... *Cx. torrentium* (Note 38)

- Seta 1-III–V with 1–4 branches (usually 1 or 2), sum of their branches on one side of abdomen not exceeding 10 (usually 6 or fewer); seta 1-M normally single; seta 1-X usually single..... 21

21(20). Integument of thorax and abdomen with rows of minute vesicles; seta 13-T as long as 12-T; seta 1-C (preclypeal seta) pigmented, usually spiculate in middle [SI 5.4 (3.9–6.7); 1:1:1:2:1:1:2–4] ..... *Cx. vagans** (Note 36)

- Integument of thorax and abdomen without vesicles; seta 13-T distinctly shorter than 12-T; seta 1-C usually not pigmented, sides smooth 22

22(21). Siphon usually widest in middle, tapering more strongly apically than basally; width of siphon at apex more than 0.5 width at base; siphon index (SI) never more than 4.6 usually about 4.0 (3.7; 2.8–4.6); siphonal saddle index less than 3.45; seta 1-III, IV usually single [PTF 1:1:1:2:1:1:2]..... *Cx. quinquefasciatus*

- Siphon widest at base, tapering towards apex, slightly sigmoid in lateral view; SI usually about 5.0 (4.6; 3.0–5.8); siphonal saddle index greater than 3.45; seta 1-III, IV usually double [PTF 1:1:1:2–3:1:1:2–3]..... ..... *Cx. pipiens* (including form *molestus*)

Key to subgenera, species, and subspecies of genus *Culiseta*: fourth-instar larvae
(key characters are illustrated in Figs 5 and 6)

1. Siphon index (SI) usually less than 2.5 (1.4–2.4); antenna very short, with antennal index (ratio of length of antenna, without apical setae and appendages, to length of head) 0.3–0.4; saddle (dorsal plate) incomplete, covers abdominal segment X (anal segment) only dorsolaterally; antenna smooth; seta 1-A (antennal tuft) with 1–4 simple branches, not longer than 2.0 width of antenna; pecten spines large, distal spine near apex of siphon (pecten about 0.75 length of siphon); dorsal pair of anal papillae (gills) slightly longer than ventral pair; at least some scales of comb spiniform; setae 5,6-C (inner and median frontal setae) single [siphonal trachea broad, ribbon-like; PTF 3:1:3:6:3:1:6] (subgenus *Allotheobaldia*) ..... *Cs. longiareolata*
- SI usually more than 2.5; antennal index usually more than 0.4; saddle complete, encircling segment X; antenna spiculate; seta 1-A with more than 4 branches, longer than 2.0 width of antenna; pecten spines fine, distal spine never near apex of siphon; anal papillae of more or less equal length; all comb scales evenly fringed at sides and apex, not spine-like; setae 5,6-C multiple branched 2

2(1). Siphon index (SI) more than 4.0 (4.3–7.0); antenna very long with index 1.0 or more; seta 1-A with more than 15 (16–30) long branches, extending well beyond apex of antenna; pecten without distal filamentous spines; pecten not extending beyond basal 0.3 of siphon; antenna with distinct thick proximal and narrow distal sections; seta 5-C (inner frontal seta) with 1–4 branches; siphonal trachea narrow, rounded; seta 1-X (saddle seta) more than 0.5 length of saddle, single; 5–9 precratal setae present [PTF 1:1:2:1-2:1:1:2–3] (subgenus *Culicella*) .... *Cs. morsitans* (Note 39)
- SI at most 4.0; antenna short with index less than 0.7 (usually less than 0.5); seta 1-A with no more than 15 short branches, not reaching or extending only slightly beyond apex of antenna; pecten with distal filamentous spines; pecten extending beyond basal 0.3 of siphon; antenna without 2 distinct sections; seta 5-C usually with more than 4 branches; siphonal trachea broad, ribbon-like; seta 1-X about 0.5 or less length of saddle, with 2 or 3 branches; 2–5 precratal setae present (subgenus *Culiseta*) (Note 38)..... 3

3(2). Seta 4-X (ventral brush) usually with 4 (3–5) precratal setae, at least 2 perforating saddle; comb scales narrow, elongate with parallel margins; pecten extends to 0.75 length of siphon; siphon index (SI) at most 3.0 (2.7; 2.4–3.0), siphon slightly tapered apically; anal papillae (gills) bluntly rounded at apex [PTF 1:1:2–3:3–4:1:1:4–6] (*Cs. alaskaensis*) (Note 40)..... 4
- Seta 4-X usually with 2 (2 or 3) precratal setae, 1, rarely 2, perforating saddle; comb scales short, distinctly broader at base, narrowed medially; pecten extends to 0.67 length of siphon; SI usually more than 3.0 (2.4–4.0), siphon markedly tapered apically; anal papillae tapered [PTF 1:1:3–6:3–6:1:1:3–5] (Note 41) 5

4(3). Seta 4-C (postclypeal seta) with 3, very rarely 4, branches; head and siphon very dark, often almost black..... ..... *Cs. alaskaensis alaskaensis**
- Seta 4-C with 3–7 (usually 5 or 6) branches; head and siphon pale-brown, sometimes yellowish brown .... *Cs. alaskaensis indica*

5(3). Seta 4-C (postclypeal seta) inserted in line with (directly anterior) to seta 5-C (inner frontal seta) (index 0.8–1.2, average 1); head and siphon dark brown [SI 3.6–4.0] ..... *Cs. annulata*
- Seta 4-C inserted anteromesad of seta 5-C, i.e. closer to midline than in *Cx. annulata* (index 1.2–1.6, average 1.5); head and siphon pale-brown or dark ochreous [SI 3.3–3.6] ..... *Cs. subochrea*

Notes

1. Among Iranian *Anopheles*, only two species, *An. pulcherrimus* and *An. stephensi*, have abdominal terga covered in scales, and the abdominal sterna also in *An. pulcherrimus* (Glick, 1992). Some scales are present on the posterior sterna of *An. stephensi* and the species of the Hyrcanus Group.

2. Males of *Cs. longiareolata* (Macquart) have the maxillary palpus about three-fourths the length of the proboscis. Also, in the species of the genus *Culiseta* Felt, the last segment of the maxillary palpus is to some extent clubbed (Maslov, 1967). In *Ur. unguiculata* males, the palpus is very short, as in females.

3. *Uranotaenia unguiculata* includes two subspecies: *Ur. unguiculata unguiculata* and *Ur. unguiculata pefflyi* Stone [Saudi Arabia (type locality)]. Zaim & Cranston (1986) noted the presence of *Ur. unguiculata unguiculata* in Iran. The adults from northern Iran show the nominotypical characteristics described by Stone (1960). The occurrence of the second subspecies seems to be possible in southern Iran. To distinguish the females and males, not male genitalia, of the subspecies, consult Stone (1960). The larva and pupa of *Ur.*

unguiculata pefflyi have not been described. The alula is not scaled in *Ur. unguiculata*, however, it is covered by broad scales in some other species of *Uranotaenia* in other zoogeographical regions. *Uranotaenia* includes two species in the Palaearctic Region, *Ur. unguiculata* and *Ur. mashonaensis* Theobald. The latter, which is an Afrotropical species, was recently recorded from Israel (Harbach & Schnur, 2007). The alula has a few broad scales in *Ur. mashonaensis*. Both species belong to the subgenus *Pseudoficalbia* Theobald, which was incorrectly spelled as *Pseudopictus* in the checklist of Iranian mosquitoes (Azari-Hamidian, 2007).

4. Reinert (2000, 2001) elevated *Ochlerotatus* to generic rank. However, females of *Aedes* are separated from *Ochlerotatus* only by characters of the female genitalia, which need to be dissected, and only seta 12-I can be used for distinguishing the larvae of these genera in Iran, which is used in the key to subfamilies and genera. The saddle is incomplete in Iranian species, but some species that do not occur in Iran have a complete saddle, so this character is reliable only for Iranian species. Sometimes one distal pecten spine in *Oc. detritus* and 1–3 in *Oc. flavescens* are more widely separated (Gutsevich *et al.*, 1974). However the separation is less apparent than in *Ae. vexans* where the distal spines are more strongly curved and stouter than the proximal spines. Also, one of five specimens of *Oc. leucomelas* borrowed from the Laboratoire de Taxonomie des Vecteurs, Centre IRD de Montpellier, Montpellier, France, have one distal pecten spine on one side of the siphon more widely separated than the other spines.

5. In the subgenus *Barraudius* Edwards of the genus *Culex*, which includes two species in Iran, hindtarsomere 1 is shorter than the hindtibia, as indicated in the keys to the subgenera and species of the genus. The two species are easily separated from *Cq. richiardii* using other characters mentioned in the key, especially broad scales on the wing veins, and the proboscis at least as long as or longer than the forefemur in *Cq. richiardii*. Also, *Cx. bitaeniorhynchus* has broad scales on the wing veins, but it is easily separated from *Cq. richiardii* using the key to genera. Some species that do not occur in Iran have an incomplete saddle, so this character is reliable only for Iranian species.

6. Zaim & Cranston (1986) noted a possible new species of *Coquillettidia* from Marivan in Kurdistan Province of western Iran. There is a *Coquillettidia* female in the Medical Arthropod Museum in the School of Public Health, Tehran University of Medical Sciences, from Marivan without any other information on its label. Examination of this specimen revealed that it resembles specimens of *Cq. richiardii* from northern Iran. This species has been recorded in Iran based only on adult females. The genus includes two species in the western Palaearctic Region, *Cq. richiardii* and *Cq. buxtoni* (Edwards). Gutsevich *et al.* (1974), Darsie & Samanidou-Voyadjoglou (1997), Samanidou-Voyadjoglou & Harbach (2001), and Becker *et al.* (2003) can be consulted for characters to distinguish the two species.

7. *Anopheles* (*Cellia*) *apoci* Marsh and some specimens of *An.* (*Cel.*) *rhodesiensis rupicolus*, have entirely dark-scaled wings (Glick, 1992). In general, in *An.* (*Cel.*) *rhodesiensis rupicolus* the pale spots on C, R, and R_1 are generally ill-defined, small and inconspicuous, with 2 to 3 pale spots, which are sometimes partly or completely absent (Gillies & de Meillon, 1968). So, the wing may be entirely dark or has fewer than 4 dark spots on C, R, and R_1.

8. Three species of the Hyrcanus Group occur in Iran. The old records of *An. nigerrimus* need to be verified (Azari-Hamidian *et al.*, 2006). The characters mentioned by Shahgudian (1960) for *An. nigerrimus*, as a variety of *An. hyrcanus*, are not reliable for distinguishing the females of this species from those of *An. peditaeniatus*. The key to the females of the Hyrcanus Group is based on Glick (1992), Amerasinghe *et al.* (2002), and examination of available Iranian specimens and specimens in the NHM, London. Also, for the first time, a key is provided for the identification of the larvae of the western Palaearctic and Oriental species of the group that occur in Iran. Darsie & Samanidou-Voyadjoglou (1997) mentioned just one character to distinguish the larvae of *An. hyrcanus* from those of *An. pseudopictus*. Recently, Ponçon *et al.* (2008) suggested that *An. hyrcanus* and *An. pseudopictus* may belong to a single species in southeastern France based on molecular evidence. The systematics of the western Palaearctic species of the Hyrcanus Group needs to be reviewed completely, especially using specimens from type localities.

9. The Maculipennis Group includes 12 species in the Palaearctic Region (Trari *et al.*, 2004; Gordeyev *et*

al., 2005), eight of which have been reported in Iran (Doosti *et al.*, 2006; Azari-Hamidian, 2007). *Anopheles maculipennis*, *An. messeae*, and *An. sacharovi* have been recorded based on DNA sequence data and morphological characters, *An. atroparvus*, *An. labranchiae*, and *An. persiensis* based on DNA sequence data, and *An. melanoon* Hackett based on egg pattern. Glick (1992) is the only reference to *An. martinius* (Shingarev) in Iran, but there is no formal record of this species in the country. DuBose & Curtin (1965) mentioned the presence of entirely dark apical wing fringes in *An. labranchiae*. This character should be carefully studied in the Maculipennis Group. There are no reliable morphological characters for distinguishing all species of the group. Indeed, in the keys provided here only *An. sacharovi* is separated from other species in Iran. It seems the use of DNA is the only way to distinguish other species of the group. *Anopheles sacharovi* and *An. martinius* can be distinguished only by the fixed paracentric inversions of their polytene chromosomes or molecular data (Glick, 1992; Trari *et al.*, 2004; Gordeyev *et al.*, 2005). Doosti *et al.* (2006) was consulted for characters that distinguish the larvae.

10. The adult females of *An. apoci* and *An. paltrinierii* Shidrawi & Gillies cannot be distinguished morphologically except by features of the cibarial armature; however, their larvae and pupae can be distinguished (Shidrawi & Gillies, 1987).

11. *Anopheles marteri* Senevet & Prunnelle includes two subspecies: *An. marteri marteri* and *An. marteri sogdianus* [Tajikistan (type locality)]. Only *An. marteri sogdianus* has been recorded in Iran (Shahgudian, 1956, 1960). It seems that the validity of this subspecies is doubtful. Ribeiro *et al.* (1987) considered it as a synonym of *An. marteri*, but Glick (1992) treated it as a valid taxon. Shahgudian (1956) did not find any reliable characters to distinguish the adults. The present keys to adults and larvae of the subspecies are based on Shahgudian (1956), Darsie & Samanidou-Voyadjoglou (1997), Samanidou-Voyadjoglou & Harbach (2001), and the examination of specimens in the NHM, London, including some specimens from Iran.

12. The Claviger Complex includes two species: *An. claviger* (Meigen), and *An. petragnani* del Vecchio (Coluzzi, 1962). The adult females and the male genitalia of these species cannot be distinguished, but their larvae and pupae can be distinguished using the keys provided by Ribeiro & Ramos (1999), Darsie & Samanidou-Voyadjoglou (1997) and Becker *et al.* (2003). *Anopheles petragnani* has not been recorded in Iran.

13. In some females of *An. dthali* and *An. rhodesiensis rupicolus* and all specimens of *An. apoci*, the maxillary palpi are entirely dark. Also, some specimens of *An. superpictus* and *An. cinereus* have four pale bands on the maxillary palpi. *Anopheles superpictus* sometimes has a dark band in the middle of apical palpomere, which generally is entirely pale. Also, sometimes there is a pale spot at the apex of the apical palpomere in *An. cinereus*, which is generally entirely dark (Shidrawi & Gillies, 1987). In these cases, other characters need to be studied to prevent misidentification of these species. All of the other species of subgenus *Cellia* Theobald in Iran have three pale bands on the palpi.

14. *Anopheles stephensi* includes three egg phenotypes: *mysorensis* Sweet & Rao, typical and intermediate, based on egg dimensions and the numbers of ridges on the egg float (Rao *et al.*, 1938). They are natural variations and taxonomically considered infrasubspecific forms of *An. stephensi*. All of them are recorded in Iran (Azari-Hamidian, 2007). Glick (1992) mentioned a new species similar to *An. stephensi* that has two small dark spots on the anal vein (1A), the scutal fossa with scales only on the upper margin, and abdominal sterna, except for sternum VIII, usually without scales. This species was later formally named and described as *An. ainshamsi* Gad, Harbach & Harrison (Gad *et al.*, 2006). Examination of colony specimens of *An. stephensi* from Bandar Abbas, Hormozgan Province of southern Iran in the Insectary of the Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, confirmed all characters used by Glick (1992) to distinguish *An. stephensi* except a few scales on sternum VIII. Also, two small dark spots, the first one rudimentary, were observed on the anal vein (1A) of one wing of one specimen of *An. stephensi*.

15. Some females of *An. dthali* and *An. rhodesiensis rupicolus* have an entirely dark maxillary palpus, but they can be distinguished by the character of the erect head scales (Gillies & deMeillon, 1968; Gillies & Coetzee, 1987; Glick, 1992).

16. Shahgudian (1960) mentioned that the old records of *An. rhodesiensis rupicolus* [Sudan (type locality)] in Iran might be based on misidentifications. This subspecies is recorded in some other countries in southwestern Asia (Glick 1992). Gillies & de Meillon (1968) and Gillies & Coetzee (1987) should be consulted for characters that distinguish this subspecies from the nominotypical subspecies, which occurs only in the Afrotropical Region. Some specimens of *An. rhodesiensis rupicolus* have an entirely dark maxillary palpus and wing, very similar to *An. algeriensis* and *An. apoci*. Such specimens can be distinguished from these two species by the well-developed frontal tuft and the character of the erect head scales mentioned in the key. These characters should be carefully checked in specimens from southern Iran. The subspecific name *rupicolus* is spelled as Lewis (1937) intended to it be spelled. It was correctly spelled in *A Synoptic Catalog of the Mosquitoes of the World* (Stone *et al.*, 1959); however, the spelling was changed to *rupicola* in the second edition of the catalog (Knight & Stone, 1977) and used by many authors, including Glick (1992), and in the checklist of Iranian mosquitoes (Azari-Hamidian, 2007). As Gillies & Coetzee (1987) explained, the correct spelling is *rupicolus*, which is used in this article.

17. *Anopheles turkhudi* Liston includes two subspecies: *An. turkhudi turkhudi* and *An. turkhudi telamali* Saliternik & Theodor [Israel (type locality)]. The validity of the subspecies is in doubt (Glick 1992).

18. Foote & Cook (1959) provided only one record of *An. cinereus* in Iran. This species is recorded from other countries in southwestern Asia (Glick, 1992). The status of the name *hispaniola* Theobald is not clear. It has been regarded as a species and a subspecies of *An. cinereus*, but is now considered as a junior primary synonym of *An. cinereus* until further evidence becomes available. The *hispaniola* form was reported from the Mediterranean Region, northern Africa, and French Equatorial Africa, and *An. cinereus* from the Ethiopian Region and Arabian Peninsula (Ramsdale, 1998; Becker *et al.*, 2003). Mattingly & Knight (1956) mentioned that *hispaniola* is the Mediterranean 'analogue' of *An. cinereus*.

19. The Culicifacies Complex includes five sibling species informally designated A, B, C, D, and E in the Oriental Region (Kar *et al.*, 1999). *Anopheles culicifacies* A and B (or probably a new species) have been recorded in Iran based on cytotaxonomy and molecular data (Azari-Hamidian, 2007). The letter-designated species cannot be distinguished morphologically.

20. *Anopheles sergentii* (Theobald) includes two subspecies: *An. sergentii sergentii* and *An. sergentii macmahoni* Evans [Kenya (type locality)]. Vein R_{4+5} is mostly pale-scaled in the latter subspecies, which occurs in the Afrotropical Region and northern Africa (Algeria). Gillies & de Meillon (1968) and Gillies & Coetzee (1987) should be consulted for characters that distinguish the two subspecies.

21. Oshaghi *et al.* (2007) suggested that *An. superpictus* is a complex of species in Iran based on sequence analysis of the mtDNA COI and rDNA ITS2.

22. The *An. fluviatilis* complex probably includes four species (S, T, U, and V) in southern Asia. The former species Y is one of the ITS2 haplotypes of species T (with haplotypes T1 and T2) and the former species X is synonymous with species S. Also, species U may hybridize with T in some regions (Chen *et al.*, 2006; Singh *et al.*, 2006). There are at least two sibling species (T and V) in Iran (Chen *et al.*, 2006). They cannot be distinguished morphologically. The sector pale spot on the radius of the holotype of *An. fluviatilis* in the NHM, London, has a few dark scales near the middle (= accessory sector dark spot), which are absent in many other specimens.

23. The Subpictus Complex includes four sibling species in India, informally designated species A, B, C, and D, (Suguna *et al.*, 1994). They cannot be reliably separated using morphological characters (Amerasinghe *et al.*, 2002). It is not known which species of the complex are present in Iran.

24. There are some old records of *Ae. aegypti* in southern Iran (Azari-Hamidian, 2007). It has not been reported in Iran for more than 50 years, but it may possibly occur in southern Iran, especially in view of its recent record in Saudi Arabia (Miller *et al.*, 2002). *Aedes aegypti* has two subspecies: *Ae. aegypti aegypti* and *Ae. aegypti formosus* (Walker) [Sierra Leone (type locality)]. Huang (2004) can be consulted for characters to distinguish the subspecies.

25. *Aedes vexans* includes three subspecies: *Ae. vexans vexans*, *Ae. vexans arabiensis* (Patton) [Yemen (type locality)], and *Ae. vexans nipponii* (Theobald) [Japan (type locality)]. The specimens from northern Iran

show the nominotypical characteristics. The occurrence of the second subspecies in southern Iran seems possible. Muspratt (1955), Gutsevich *et al.* (1974), and Reinert (1973) should be consulted for characters that distinguish the subspecies. The character mentioned for abdominal terga in the key is for the nominotypical subspecies; the pale bands of terga are broader and without a bilobed appearance in *Ae. vexans arabiensis*.

26. Gutsevich *et al.* (1974) described a form or subspecies of *Oc. geniculatus* (as *Ae. geniculatus*), without a name from northern Iran based on larval characters. Minar (1981) believed that *Oc. geniculatus* found in Guilan Province, northern Iran, belongs to this form or subspecies (Azari-Hamidian, 2007).

27. The *Ochlerotatus detritus* complex includes two species: *Oc. detritus* and *Oc. coluzzii* (Rioux, Guilvard & Pasteur) (Rioux *et al.*, 1998). The second species is not recorded from Iran.

28. McIntosh (1973) reported the presence of *Oc. chelli* (as *Ae. chelli*) in Jask, Hormozgan Province of southern Iran, and illustrated its male genitalia based on Iranian specimens. Its larva and pupa have not been described. No specimen of this species from Iran is available. McIntosh's (1973) key and the specimens of *Oc. chelli* in the NHM, London, were used to construct this part of the key.

29. *Ochlerotatus pulcritarsis* includes two subspecies: *Oc. pulcritarsis pulcritarsis* and *Oc. pulcritarsis asiaticus* (Edwards) [Pakistan (type locality)], both are recorded in Iran (Azari-Hamidian, 2007). Also, *Oc. pulcritarsis* is a member of a species complex that includes *Oc. berlandi*. Only Gutsevich *et al.* (1974) noted the occurrence of *Oc. berlandi* (as a variety of *Oc. pulcritarsis*) in Iran. There is no other information about this species in the country. Becker *et al.* (2003) did not separate these two species in the adult female stage in their key. The inclusion of these forms in the present keys is based on Gutsevich *et al.* (1974) and the examination of the specimens in the NHM, London.

30. *Ochlerotatus caspius* includes three subspecies: *Oc. caspius caspius*, *Oc. caspius meirai* Ribeiro, da Cunha Ramos, Capela & Pires [Portugal (type locality)], and *Oc. caspius hargreavesi* (Edwards) [Italy (type locality)]. The last subspecies was regarded as a variety in the checklist of Iranian mosquitoes (Azari-Hamidian, 2007), however it is considered a subspecies based on provisions of the *International Code of Zoological Nomenclature* (Harbach & Howard, 2007). Also, two sibling species, A and B, comprise the *Oc. caspius* complex (Cianchi *et al.*, 1980). Minar (1981) noted that the specimens that he studied from Iran showed typical characters. There are some old records of *Oc. dorsalis* (as *Ae. caspius dorsalis*) in Ashar, Khuzistan Province of southwestern Iran, and in different locations of East and West Azerbaijan Provinces, northwestern Iran (Azari-Hamidian, 2007). There is no recent report of *Oc. dorsalis* in Iran. Dahl (1997) noted that the larvae of these two species are indistinguishable and Cranston *et al.* (1987) stated that the larvae of *Oc. caspius*, *Oc. dorsalis*, and *Oc. leucomelas* are inseparable. Distinguishing characters of the present keys are based on information provided by Gutsevich *et al.* (1974), Lambert *et al.* (1990), and Darsie & Samanidou-Voyadjoglou (1997), as well as the examination of specimens in the NHM, London.

31. *Culex inatomii* Kamimura & Wada [Japan (type locality)] was included as a subspecies of *Cx. modestus* Ficalbi in the checklist of Iranian mosquitoes (Azari-Hamidian, 2007). However, Tanaka *et al.* (1979) elevated it to species rank. So, *Cx. modestus* is without subspecies.

32. *Oculeomyia* Theobald was recently reinstated as a subgenus of *Culex* for the species belonging to the Bitaeniorhynchus Subgroup based on pupal characters (Tanaka, 2004).

33. *Culex impudicus* Ficalbi was recorded in Iran only by Lotfi (1976). Zaim & Cranston (1986) did not mention it in their checklist.

34. *Culex hortensis* Ficalbi includes two subspecies: *Cx. hortensis hortensis* and *Cx. hortensis maderensis* Mattingly [Portugal (type locality)]. Keys for separating the females and fourth-instar larvae of the subspecies were provided by Ribeiro & Ramos (1999). Specimens from northern Iran bear the nominotypical characteristics.

35. The old records of *Cx. vishnui* in southwestern Asia and Iran are considered to refer to *Cx. pseudovishnui* (Harbach, 1988). However, based on the record of the first species in Pakistan, it seems that *Cx. vishnui* may occur in southern and southeastern Iran. Two specimens collected in Qeshm Island, the Persian Gulf, show the characters of *Cx. pseudovishnui*, i.e. wing mostly dark-scaled with few pale scales, pale ring on the proboscis without a ventral extension, erect scales on the vertex that are pale centrally and dark

laterally, hindfemur with a pale stripe on anterior surface that contrasts well with the dark scaling, and scutum pale-scaled. However, the specimen has five prominent lower proepisternal setae. This character was not cited as a feature of this species in previous studies (Colless, 1957; Sirivanakarn, 1976; Harbach, 1985, 1988; Reuben *et al.*, 1994). A study of specimens in the NHM, London, revealed that the specimens of *Cx. vishnui* from different localities, as well as the syntypes of this species and the holotype of *Cx. pseudovishnui*, lack lower proepisternal setae. However, less prominent setae were observed in some specimens identified as *Cx. pseudovishnui*. Also, the fore- and midfemur in the type specimens of both species are entirely dark-scaled, whereas they have a row of a few pale scales on the anterior side in Iranian specimens. This character was observed in some specimens, identified as *Cx. vishnui*, other than type specimens, from different localities. The Vishnui Subgroup needs to be studied extensively to include specimens from Iran, the westernmost part of its distribution. *Culex pseudovishnui* was previously recorded in Iran only from Sistan and Baluchistan Province in the southeastern area of the country (Zaim, 1987).

36. Lotfi (1976) recorded *Cx. vagans* in Iran based on unreliable characters of the larval stage, including siphon index, siphon-saddle index, and the number of seta 1-S (subventral tufts) on the siphon. This species cannot be distinguished from members of the *Cx. pipiens* complex and *Cx. torrentium* with certainty based on those characters. Zaim & Cranston (1986) listed only *Cx. torrentium* in their checklist and Harbach (1988) mentioned that the records of this species in Iran are doubtful.

37. The old records of *Cx. univittatus* in southwestern Asia, and in Iran (Azari-Hamidian, 2007), are considered to refer to *Cx. perexiguus*. The former species is an Afrotropical species that occurs only at high altitudes in the Yemen Republic in southwestern Asia (Harbach, 1988). Recently, Mahmoud-Asl (1989) mentioned some specimens from Hormozgan Province, southern Iran, that show morphological characters of *Cx. univittatus*, but they are probably specimens of *Cx. perexiguus*. Further study of the Univittatus Assemblage in Africa and Asia, perhaps including molecular analyses, is needed.

38. Lotfi (1976) recorded *Cx. torrentium* in Iran based on unreliable characters in the larval stage, including siphon index, siphon-saddle index, and the number of seta 1-S (subventral tufts) on the siphon. This species cannot be distinguished from members of the *Cx. pipiens* complex and *Cx. vagans* with certainty based on those characters. Zaim & Cranston (1986) listed only *Cx. torrentium* in their checklist and Harbach (1988) mentioned that the records of *Cx. torrentium* and *Cx. vagans* in Iran are doubtful. Danilov (1975) reported *Cx. torrentium* from Rasht in northern Iran. Both physiological and behavioral forms of *Cx. pipiens*, the nominotypical and *molestus* forms, are recorded from Iran (Zaim & Cranston, 1986; Azari-Hamidian, 2007). Using characters provided by Harbach (1985, 1988) for larvae, *Cx. torrentium* was identified among specimens collected from Ardebil and Guilan Provinces of northwestern and northern Iran, respectively.

39. *Culiseta morsitans* was recorded in Iran based on larvae (Azari-Hamidian, 2007). Key characters for adults are based on Maslov (1967) and the examination of specimens in the NHM, London.

40. *Culiseta alaskaensis* Ludlow includes two subspecies: *Cs. alaskaensis alaskaensis* and *Cs. alaskaensis indica* (Edwards) [India (type locality)]. Maslov (1967) recorded *Cs. alaskaensis indica* from Iran. Zaim & Cranston (1986) mentioned *Cs. alaskaensis* as a new record for Iran based on larvae without consideration of subspecies. Cranston *et al.* (1987) did not distinguish the larva of *Cs. alaskaensis* from those of *Cs. annulata* and *Cs. subochrea*. Unfortunately, there are no available specimens of *Cs. alaskaensis* from Iran to examine and the keys to subgenus *Culiseta* and the subspecies of *Cs. alaskaensis* are based mostly on Maslov (1967) and the examination of specimens from other countries in the collection of the NHM, London.

41. Maslov (1967) reported the occurrence of *Cs. subochrea* (as subspecies of *Cs. annulata*) in Iran. Zaim & Cranston (1986) mentioned *Cs. annulata* in their checklist and *Cs. subochrea* in their keys. Adults of both species were collected recently in Ardebil Province of northwestern Iran; however, it seems that *Cs. annulata* is more prevalent, at least in northern Iran (Azari-Hamidian, 2007). The character of the bases of setae 4- and 5-C is not very reliable for distinguishing larvae of these species because this character is variable (Cranston *et al.*, 1987; Dahl, 1997). Also, the character of the length of the seta 1-S compared to the width of the siphon at the point of attachment, which was used to distinguish larvae of these species in Portugal (Ribeiro *et al.*, 1997), has not been verified for specimens from other locations (Becker *et al.*, 2003).

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References

Amerasinghe, F.P., Mukhtar, M. & Herrel, N. (2002) Keys to the anopheline mosquitoes (Diptera: Culicidae) of Pakistan. *Journal of Medical Entomology*, 39(1), 28–35.

Aslamkhan, M. (1971) The mosquitoes of Pakistan I. A checklist. *Mosquito Systematics*, 3, 147–159.

Azari-Hamidian, S. (2007) Checklist of Iranian mosquitoes (Diptera: Culicidae). *Journal of Vector Ecology*, 32, 235–242.

Azari-Hamidian, S., Abai, M.R., Ladonni, H., Vatandoost, H. & Akbarzadeh, K. (2006) *Anopheles peditaeniatus* (Leicester) new to the Iranian mosquito fauna with notes on *Anopheles hyrcanus* group in Iran. *Journal of the American Mosquito Control Association*, 22, 144–146.

Azari-Hamidian, S., Yaghoobi-Ershadi, M.R., Javadian, E., Mobedi, I. & Abai, M.R. (2007) Review of dirofilariasis in Iran. *Journal of Medical Faculty Guilan University of Medical Sciences*, 15(60), 102–113 [in Persian with English abstract].

Becker, N., Petric, D., Zgomba, M., Boase, C., Dahl, C., Lane, J. & Kaiser, A. (2003) *Mosquitoes and Their Control*. Kluwer Academic/ Plenum Publishers, New York, 498 pp.

Chen, B., Butlin, R.K., Pedro, P.M., Wang, X.Z. & Harbach, R.E. (2006) Molecular variation, systematics and distribution of the *Anopheles fluviatilis* complex in southern Asia. *Medical and Veterinary Entomology*, 20, 33–43.

Cianchi, R., Sabatini, A., Boccolini, D., Bullini, L. & Coluzzi, M. (1980) Due entita riproduttivamente isolate sotto il nome di *Aedes caspius* (Diptera, Culicidae). Atti XII Congreso Nazionale Italiano Entomologia, Roma, 2, pp. 269–272.

Colless, D.H. (1957) Notes on the culicine mosquitoes of Singapore II.- The *Culex vishnui* group (Diptera, Culicidae), with description of two new species. *Annals of Tropical Medicine and Parasitology*, 51, 87–101.

Coluzzi, M. (1962) Le forme di *Anopheles claviger* Meigen indicate con i nomi *missirolii* e *petragnanii*, sono due specie riproduttivamente isolate. *Atti della Accademia Nazionale dei Lincei. Rendiconti della Classe di Scienze Fisiche, Matematiche e Naturali*, 32, 1025–1030.

Cranston, P.S., Ramsdale, C.D., Snow, K.R. & White, G.B. (1987) *Keys to the Adults, Male Hypopygia, Fourth-Instar Larvae and Pupae of the British Mosquitoes (Culicidae) with Notes on their Ecology and Medical Importance*. Fresh Water Biological Association Scientific Publication, No.48, Cumbria, 152 pp.

Dahl, C. (1997) Diptera Culicidae, Mosquitoes. *In*: Nilsson, A.N. (Ed.) *Aquatic Insects of North Europe - A Taxonomic Handbook. Volume 2*. Apollo Books, Denmark, pp. 163–186.

Danilov, V.N. (1975) Mosquito fauna of northwestern Iran. *Medical Parasitology and Parasitic Diseases*, 44, 732 [in Russian with English abstract].

Darsie, R.F. & Samanidou-Voyadjoglou, A. (1997) Keys for the identification of the mosquitoes of Greece. *Journal of the American Mosquito Control Association*, 13, 247–254.

Das, B.P., Rajagopal, R. & Akiyama, J. (1990) Pictorial key to the species of Indian anopheline mosquitoes. *Zoology* (*Journal of Pure and Applied Zoology*), 2, 131–162.

Doosti, S., Azari-Hamidian, S., Vatandoost, H., Oshaghi, M.A. & Hosseini, M. (2006) Taxonomic differentiation of *Anopheles sacharovi* and *An. maculipennis s.l.* (Diptera: Culicidae) larvae by seta 2 (antepalmate hair). *Acta Medica Iranica*, 44, 21–27.

DuBose, W.P. & Curtin, T.J. (1965) Identification keys to the adult and larval mosquitoes of the Mediterranean area. *Journal of Medical Entomology*, 1, 349–355.

Edrissian, G.H. (2006) Malaria in Iran: Past and present situation. *Iranian Journal of Parasitology*, 1, 1–14.

Edwards, F.W. (1941) *Mosquitoes of the Ethiopian Region III. – Culicine Adults and Pupae*. British Museum (Natural History), London. 499 pp.

Encinas-Grandes, A. (1982) *Taxonomia y Biologia de los Mosquitos del Area Salamantina (Diptera, Culicidae)*. Universidad de Salamanca, Salamanca, 437 pp.
Eshghy, N. (1977) *Anopheles multicolor* Cambouliu and its role in the transmission of malaria in Iran. *Journal of the Entomological Society of Iran*, 4, 87–88 [in Persian with English abstract].
Eslami, A. (1997) *Veterinary Helminthology. Vol. 3. Nematoda and Acanthocephala*. Tehran University Publications, Tehran, 892 pp [in Persian].
Foote, R.H. & Cook, D.R. (1959) *Mosquitoes of Medical Importance*. Agriculture Handbook No. 152, Agricultural Research Service, U.S. Department of Agriculture, Washington, DC, 158 pp.
Gad, A.M., Harbach, R.E. & Harrison, B.A. (2006) *Anopheles* (*Cellia*) *ainshamsi*, n. sp. (Diptera: Culicidae), a saltwater species from the Red Sea coast of Egypt. *Proceedings of the Entomological Society of Washington*, 108, 366–380.
Gaffigan, T.V. & Ward, R.A. (1985) Index to the second supplement to "A Catalog of the Mosquitoes of the World", with corrections and additions (Diptera: Culicidae). *Mosquito Systematics*, 17, 51–63.
Gillies, M.T. & Coetzee, M. (1987) *A Supplement to the Anophelinae of Africa South of the Sahara*. Publications of the South African Institute for Medical Research, No. 55, Johannesburg, 143 pp.
Gillies, M.T. & de Meillon, B. (1968) *The Anophelinae of Africa South of the Sahara* (*Ethiopian Zoogeographical Region*). 2nd ed. Publication of the South African Institute for Medical Research, No. 54, Johannesburg, 343 pp.
Glick, J.I. (1992) Illustrated key to the female *Anopheles* of southwestern Asia and Egypt (Diptera: Culicidae). *Mosquito Systematics*, 24, 125–153.
Gordeyev, M.I., Zvantsov, A.B., Goryacheva, I.I., Shaikevich, Ye.V. & Yezhov, M.N. (2005) Description of the new species *Anopheles artemievi* sp.n. (Diptera, Culicidae). *Medical Parasitology and Parasitic Diseases*, 74, 4–5 [in Russian with English abstract].
Gutsevich, A.V., Monchadskii, A.S. & Shtakelberg, A.A. (1974) *Fauna of the USSR Diptera Volume III No4 Mosquitoes Family Culicidae*. Akad Nauk SSSR Zool Inst NS No 100, Leningrad, 408 pp [in Russian, English translation by Lavoott, R. ed. by Theodor, O., Israel Program for Scientific Translations, Jerusalem].
Harbach, R.E. (1985) Pictorial keys to the genera of mosquitoes, subgenera of *Culex* and the species of *Culex* (*Culex*) occurring in southwestern Asia and Egypt, with a note on the subgeneric placement of *Culex deserticola* (Diptera: Culicidae). *Mosquito Systematics*, 17, 83–107.
Harbach, R.E. (1988) The mosquitoes of the subgenus *Culex* in southwestern Asia and Egypt (Diptera: Culicidae). *Contributions of the American Entomological Institute*, 24(1), vi + 1–236.
Harbach (2007 onwards) Mosquito Taxonomic Inventory. http://mosquito-taxonomic-inventory.info/ (accessed 11 February 2009).
Harbach, R.E. & Howard, T.M. (2007) Correction in the status and rank of names used to denote varietal forms of mosquitoes (Diptera: Culicidae). *Zootaxa*, 1542, 35–48.
Harbach, R.E. & Kitching, I.J. (1998) Phylogeny and classification of the Culicidae (Diptera). *Systematic Entomology*, 23, 327–370.
Harbach, R.E. & Knight, K.L. (1980) *Taxonomists' Glossary of Mosquito Anatomy.* Plexus Publishing, Marlton, New Jersey, 415 pp.
Harbach, R.E. & Knight, K.L. (1982) Corrections and additions to Taxonomists' Glossary of Mosquito Anatomy. *Mosquito Systematics* (for 1981) 13, 201–217.
Harbach, R.E. & Schnur, H.J. (2007) *Uranotaenia* (*Pseudoficalbia*) *mashonaensis*, an Afrotropical species found in northern Israel. *Journal of the American Mosquito Control Association*, 23, 224–225.
Hopkins, G.H.E. (1952) *Mosquitoes of the Ethiopian Region. I. – Larval Bionomics of Mosquitoes and Taxonomy of Culicine Larvae*. British Museum (Natural History), London, 355 pp.
Huang, Y.-M. (2004) The subgenus *Stegomyia* of *Aedes* in the Afrotropical Region with keys to the species (Diptera; Culicidae). *Zootaxa*, 700, 1–120.
Kar, I., Subbarao, S.K., Eapen, A., Ravindran, J., Satyanarayana, T.S., Raghavendra, K., Nanda, N. & Sharma, V.P. (1999) Evidence for a new malaria vector species, species E, within the *Anopheles culicifacies* complex (Diptera: Culicidae). *Journal of Medical Entomology*, 36, 595–600.
Knight, K.L. (1978) *Supplement to a Catalog of the Mosquitoes of the World (Diptera: Culicidae)*. Thomas Say Foundation and Entomological Society of America, Maryland, College Park, 107 pp.
Knight, K.L. & Stone, A. (1977) *A Catalog of the Mosquitoes of the World (Diptera: Culicidae)*. 2nd ed. Thomas Say Foundation and Entomological Society of America, Maryland, College Park, 611 pp.
Lambert, M., Pasteur, N., Rioux, J.-A., Delalbre-Belmonte, A. & Balard, Y. (1990) *Aedes caspius* (Pallas, 1771) et *A. dorsalis* (Meigen, 1830) (Diptera: Culicidae) analyses morphologique et genetique de deux populations sympatriques. Preuves de l'isolement reproductif. *Annales de la Societe Entomologique de France*, 26, 381–398.
Lewis, D.J. (1937) A new species of *Anopheles* from the Anglo-Egyptian Sudan. *Proceedings of the Royal Entomological Society of London. Series B. Taxonomy*, 6, 181–183.
Lotfi, M.D. (1976) Key to Culicinae of Iran, genus *Culex* and their biology (Diptera: Culicidae). *Iranian Journal of*

Public Health, 5, 71–84.
Mahmoud-Asl, F. (1989) *The Spatial Distribution of the Culicine Mosquitoes in Hormozgan Province (Southern Iran) with Notes on Certain Aspects of their Behavior (Diptera: Culicidae)*. M.S.P.H. Thesis, Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, 230 pp [in Persian].
Maslov, A.V. (1967) *Blood-Sucking Mosquitoes of Subtribe Culisetina (Diptera: Culicidae) in the World Fauna*. Opredeliteli po Faune SSSR, No. 93, Moscow, 248 pp [in Russian, English translation by Rao, P.M. with a forward by Ward, R.A. (1989) Washington DC, Smithsonian Institution Libraries and the National Science Foundation].
Mattingly, P.F. & Knight, K.L. (1956) The mosquitoes of Arabia. I. *Bulletin of the British Museum (Natural History). Entomology*, 4, 91–141.
McIntosh, B.M. (1973) A taxonomic re-assessment of *Aedes* (*Ochlerotatus*) *caballus* (Theobald) (Diptera: Culicidae) including a description of a new species of *Ochlerotatus*. *Journal of the Entomological Society of Southern Africa*, 36, 261–269.
Miller, B.R., Godsey, M.S., Crabtree, M.B., Savage, H.M., Al-Mazrao, Y., Al-Jeffri, M.H., Abdoon, A.M.M., Al-Seghayer, S.M., Al-Shahrani, A.M. & Ksiazek, T.G. (2002) Isolation and genetic characterization of Rift Valley fever virus from *Aedes vexans arabiensis*, Kingdom of Saudi Arabia. *Emerging Infectious Diseases*, 8, 1492–1494.
Minar, J. (1981) Result of Czechoslovak-Iranian entomological expeditions to Iran (Diptera: Culicidae, Oestridae). *Acta Entomologica Musei Nationalis Pragae*, 40, 83–84.
Muspratt, J. (1955) Research on South African Culicini (Diptera, Culicidae). III. – A checklist of the species and their distribution, with notes on taxonomy, bionomics and identification. *Journal of the Entomological Society of Southern Africa*, 18, 149–207.
Naficy, K. & Saidi, S. (1970) Serological survey on viral antibodies in Iran. *Tropical and Geographical Medicine*, 2, 183–188.
Oshaghi, M.A., Shemshad, Kh., Yaghobi-Ershadi, M.R., Pedram, M., Vatandoost, H., Abaie, M.R., Akbarzadeh, K. & Mohtarami, F. (2007) Genetic structure of the malaria vector *Anopheles superpictus* in Iran using mitochondrial cytochrome oxidase (COI and COII) and morphologic markers: A new species complex? *Acta Tropica*, 101, 241–248.
Ponçon, N., Toty, C., Kengne, P., Alten, B. & Fontenille, D. (2008) Molecular evidence for similarity between *Anopheles hyrcanus* (Diptera: Culicidae) and *Anopheles pseudopictus* (Diptera: Culicidae), sympatric potential vectors of malaria in France. *Journal of Medical Entomology*, 45, 576–580.
Ramsdale, C.D. (1998) *Anopheles cinereus* Theobald 1901 and its synonym *hispaniola* Theobald 1903. *European Mosquito Bulletin*, 2, 18–19.
Rao, B.A., Sweet, W.C. & Subba Rao, A.M. (1938) Ova measurements of *A. stephensi* type and *A. stephensi* var. *mysorensis*. *Journal of the Malaria Institute of India*, 1, 261–266.
Reinert, J.F. (1973) Contributions to the mosquito fauna of Southeast Asia. – XVI. Genus *Aedes* Meigen, Subgenus *Aedimorphus* Theobald in Southeast Asia. *Contributions of the American Entomological Institute*, 9(5), 1–218.
Reinert, J.F. (2000) New classification for the composite genus *Aedes* (Diptera: Culicidae: Aedini), elevation of subgenus *Ochlerotatus* to generic rank, reclassification of the other subgenera, and notes on certain subgenera and species. *Journal of the American Mosquito Control Association*, 16, 175–188.
Reinert, J.F. (2001) Revised list of abbreviation for genera and subgenera of Culicidae (Diptera) and the notes on generic and subgeneric changes. *Journal of the American Mosquito Control Association*, 17, 51–55.
Reinert, J.F., Harbach, R.H. & Kitching, I.J. (2004) Phylogeny and classification of Aedini (Diptera: Culicidae), based on morphological characters of all life stages. *Zoological Journal of the Linnean Society*, 142, 289–368.
Reinert, J.F., Harbach, R.H. & Kitching, I.J. (2006) Phylogeny and classification of *Finlaya* and allied taxa (Diptera: Culicidae: Aedini) based on morphological data from all life stages. *Zoological Journal of the Linnean Society*, 148, 1–101.
Reinert, J.F., Harbach, R.H. & Kitching, I.J. (2008) Phylogeny and classification of *Ochlerotatus* and allied taxa (Diptera: Culicidae: Aedini) based on morphological data from all life stages. *Zoological Journal of the Linnean Society*, 153, 29–114.
Reuben, R., Tewari, S.C., Hiriyan, J. & Akiyama, J. (1994) Illustrated keys to species of *Culex* (*Culex*) associated with Japanese encephalitis in Southeast Asia (Diptera: Culicidae). *Mosquito Systematics*, 26, 75–96.
Ribeiro, H., da Cunha Ramos, H., Peres, C.A. & Capela, R.A. (1987) Research of the mosquitoes of Portugal (Diptera, Culicidae) IX- A new anopheline record. *Garcia de Orta. Serie de Zoologia*, 12, 105–112.
Ribeiro, H. & Ramos, H.C. (1999) Identification keys of the mosquitoes (Diptera: Culicidae) of Continental Portugal, Acores and Madeira. *European Mosquito Bulletin*, 3, 1–11.
Rioux, J.A., Guivard, E. & Pasteur, N. (1998) Description d'*Aedes* (*Ochlerotatus*) *coluzzii* n. sp. (Diptera, Culicidae), espéce jumelle A du complexe *detritus*. *Parassitologia*, 40, 353–360.
Roiz, D., Eritja, R., Molina, R., Melero-Alcibar, R. & Lucientes, J. (2008) Initial distribution assessment of *Aedes albopictus* (Diptera : Culicidae) in the Barcelona, Spain, area. *Journal of Medical Entomology*, 45, 347–352.

Saidi, S., Tesh, R., Javadian, E. & Nadim, A. (1976) The prevalence of human infection of West Nile in Iran. *Iranian Journal of Public Health*, 5, 8–14.
Samanidou-Voyadjoglou, A. & Harbach, R.E. (2001) Keys to the adult female mosquitoes (Culicidae) of Greece. *European Mosquito Bulletin*, 10, 13–20.
Shahgudian, E.R. (1956) Notes on *Anopheles marteri* Senevet and Prunnelle, 1927. *Proceedings of the Royal Entomological Society of London. Series A. General Entomology*, 31, 71–75.
Shahgudian, E.R. (1960) A key to the anophelines of Iran. *Acta Medica Iranica*, 3, 38–48.
Shidrawi, G.R. & Gillies, M.T. (1987) *Anopheles paltrinierii*, n. sp., (Culicidae: Diptera) from the Sultanate of Oman. *Mosquito Systematics*, 19, 201–211.
Singh, O.P., Chandra, D., Nanda, N., Sharma, S.K., Htun, P.T., Adak, T., Subbarao, S.K. & Dash, A.P. (2006) On the conspecificity of *Anopheles fluviatilis* species S with *Anopheles minimus* species C. *Journal of Bioscience*, 31, 671–677.
Sirivanakarn, S. (1976) Medical entomology studies – III. A revision of the subgenus *Culex* in the Oriental Region (Diptera: Culicidae). *Contributions of the American Entomological Institute*, 12(2), iii + 1–272.
Stone, A. (1960) A new subspecies of *Uranotaenia unguiculata* Edwards from Arabia (Diptera: Culicidae). *Proceedings of the Entomological Society of Washington*, 62, 249.
Stone, A., Knight, K.L. & Starcke, H. (1959) *A Synoptic Catalog of the Mosquitoes of the World (Diptera, Culicidae)*. Thomas Say Foundation and Entomological Society of America, Maryland, College Park, 358 pp.
Suguna, S.G., Gopala Rathinam, K., Rajaval, A.R. & Dhanda, V. (1994) Morphological and chromosomal descriptions of new species in the *Anopheles subpictus* complex. *Medical and Veterinary Entomology*, 18, 88–94.
Tanaka, K. (2004) Studies on the pupal mosquitoes of Japan (11) subgenera *Oculeomyia* (stat. nov.) and *Sirivanakarnius* (nov.) of the genus *Culex*, with a key of pupal mosquitoes from Ogasawara-gunto (Diptera; Culicidae). *Medical Entomology and Zoology*, 55, 217–231.
Tanaka, K., Mizusawa, K. & Saugstad, E.S. (1979) A revision of the adult and larval mosquitoes of Japan (including the Ryuku Archipelago and the Ogasawara Islands) and Korea (Diptera: Culicidae). *Contributions of the American Entomological Institute*, 16, vii + 1–987.
Trari, B., Harbach, R.E., Himmi, O., Dakki, M.A. & Agoumi, A. (2004) An inventory of the mosquitoes of Morocco. I. Genus *Anopheles* (Diptera: Culicidae). *European Mosquito Bulletin*, 18, 1–19.
Walter Reed Biosystematics Unit (2001) Systematic Catalog of Culicidae. http://www.mosquitocatalog.org/ (accessed 18 August 2008).
Ward, R.A. (1984) Second supplement to "A Catalog of the Mosquitoes of the World" (Diptera: Culicidae). *Mosquito Systematics*, 16, 227–270.
Ward, R.A. (1992) Third supplement to "A Catalog of the Mosquitoes of the World" (Diptera: Culicidae). *Mosquito Systematics*, 24, 177–230.
Wilkerson, R.C. & Peyton, E.L. (1990) Standardized nomenclature for the costal wing spots of the genus *Anopheles* and other spotted-wing mosquitoes (Diptera: Culicidae). *Journal of Medical Entomology*, 27, 207–224.
World Health Organization (2004) *Integrated Vector Management*. WHO Regional Officer for Eastern Mediterranean, Cairo, 27 pp.
Zaim, M. (1984) Mosquito fauna of Iran. XVII International Congress of Entomology, Hamburg, p. 29.
Zaim, M. (1987) The distribution and larval habitat characteristics of Iranian Culicinae. *Journal of the American Mosquito Control Association*, 3, 568–573.
Zaim, M. & Cranston, P.S. (1986) Checklist and keys to the Culicinae of Iran (Diptera; Culicidae). *Mosquito Systematics*, 18, 233–245.