ILLUSTRATED KEY TO THE FEMALE *ANOPHELES* OF SOUTHWESTERN ASIA AND EGYPT (DIPTERA: CULICIDAE)[1]

JAYSON I. GLICK[2]

Walter Reed Biosystematics Unit, Department of Entomology, Walter Reed Army Institute of Research, Washington, DC 20307-5100

ABSTRACT. An illustrated key for the identification of the female *Anopheles* mosquitoes of southwestern Asia and Egypt is presented. Thirty-nine species and three subspecies are treated, including 25 species and one subspecies of *Anopheles* (*Cellia*) and 14 species and two subspecies of *Anopheles* (*Anopheles*). A new species from Egypt of the subgenus *Cellia* closely related to *Anopheles stephensi* Liston is left unnamed. *Anopheles* (*Anopheles*) *pseudopictus* Grassi is removed from synonomy with *Anopheles* (*Anopheles*) *hyrcanus* (Pallas), and *Anopheles* (*Anopheles*) *habibi* Mulligan and Puri is recognized as a junior synonym of *Anopheles* (*Anopheles*) *claviger* (Meigen). Tables providing important taxonomic references and the geographic distribution for each species are included.

INTRODUCTION

An identification key for the *Anopheles* mosquitoes of the entire Southwest Asian Region has long been a necessity for entomologists dealing with malaria vectors. Published keys and species descriptions for the region are scattered throughout the literature, and are often limited in scope to the *Anopheles* species of a single country (Salem 1938, Egypt; Pringle 1954, Iraq; Abdel-Malek 1958, Syria; Shahgudian 1960, Iran; Postiglione et al. 1973, Turkey; Danilov 1985, Afghanistan) or limited geographical region such as the Arabian Peninsula (Mattingly and Knight 1956, Shidrawi and Gillies 1987) and the Indian Subregion (Christophers 1933). Many are now of limited value due to numerous nomenclatural changes and additions, and refinements in our ability to differentiate sibling species, and are ineffective for identification of *Anopheles* on a region-wide basis. Available keys for the *Anopheles* of the Palaearctic Region are similarly ineffective (Bates et al. 1949, Senevet and Andarelli 1955a, Russell et al. 1963).

This work began as a study of the *Anopheles* mosquitoes of the Arabian Peninsula, emphasizing the fauna of Saudi Arabia and Kuwait, and was expanded to include all of southwestern Asia as defined by Harbach (1988), and modified to include all land south of the Russian republics between the Mediterranean Sea and the Indus River of Pakistan, including all of Turkey and Egypt. The material examined came largely from the collections of the National Museum of Natural History, Smithsonian Institution, and the British Museum (Natural History). The *Anopheles* fauna of the Southwest Asian Region presently consists of 39 species and three subspecies, representing two subgenera. The majority of the species have Palaearctic affinities, while a smaller number are clearly more Ethiopian or Oriental in their distribution.

Two nomenclatural changes have been made for the *An.* (*Anopheles*) of the Southwest Asian Region. *Anopheles* (*Ano.*) *pseudopictus* Grassi is removed from synonomy with *An.* (*Ano.*) *hyrcanus* (Pallas) based on the apparent absence of evidence for its hybridization with *An. hyrcanus* in any part of its distribution, and the distinctness of material studied of both *An. hyrcanus* and *An. pseudopictus*

[1] The views of the author do not purport to reflect the views of the Department of the Army or the Department of Defense.

[2] Reprint requests: Walter Reed Biosystematics Unit, Museum Support Center, Smithsonian Institution, Washington, DC 20560.

from Turkey, Iran and Afghanistan. Bruce A. Harrison (personal communication) provided characters which clearly show *An.* (*Ano.*) *habibi* Mulligan and Puri to be a synonym of *An.* (*Ano.*) *claviger* (Meigen). In particular, the lower proepisternal setae (PeSL) are found only in *An. habibi* and *An. claviger*, and a closely related western Mediterranean species *An.* (*Ano.*) *petragnani* Del Vecchio. Comparison of the type female of *An. habibi* in the British Museum (Natural History) with *An. claviger* from Iraq and Israel showed no morphological differences between the two; comparison with *An. claviger* from France, Greece, Italy, Spain, Israel and Russia showed no statistical difference in the length of the wing petiole to the anterior forked cell between the two species as was stated in the correction to the original description of *An. habibi* (Mulligan and Puri 1936b); and comparison of the genitalia of *An. habibi* males from Quetta, Baluchistan (BM 1938–663/1413) with *An. claviger* males from Israel, Greece and England showed no salient differences. *Anopheles habibi* is therefore recognized as a junior synonym of *An. claviger* (NEW SYNONOMY).

The scope of this study includes the *Anopheles* fauna from portions of the North Eurasian, Mediterranean, Afro-Arabian (Desert), Afrotropical and Indo-Iranian malarial epidemiological zones as defined by Macdonald (1957). Primary malaria vectors in the Southwest Asian Region include *An.* (*Cellia*) *arabiensis* Patton, *An.* (*Cel.*) *culicifacies* Giles, *An.* (*Cel.*) *fluviatilis* James, *An.* (*Cel.*) *pharoensis* Theobald, *An.* (*Cel.*) *pulcherrimus* Theobald, *An.* (*Ano.*) *sacharovi* Favre, *An.* (*Cel.*) *sergentii* (Theobald), *An.* (*Cel.*) *stephensi* Liston and *An.* (*Cel.*) *superpictus* Grassi. Secondary vectors include *An.* (*Cel.*) *annularis* Van der Wulp, *An.* (*Cel.*) *cinereus* Theobald, *An.* (*Ano.*) *claviger* and *An.* (*Cel.*) *multicolor* Cambouliu (White 1989, Zahar 1974). Although many of the primary vectors are important in malaria transmission over a widespread area of the region, several are of concern in more limited areas, including *An.* (*Cel.*) *arabiensis* in the Arabian Peninsula (Colbourne and Smith 1964, Sebai 1988, Zahar 1985), *An.* (*Cel.*) *pharoensis* in Egypt (Zahar 1974), and *An.* (*Cel.*) *pulcherrimus* in Afghanistan (Zahar 1974).

Indigenous malaria has been eliminated for the most part from Bahrain and Kuwait, where imported malaria is now the primary problem (Amin 1989, Hira et al. 1985). *Anopheles* (*Cel.*) *stephensi* and *An.* (*Cel.*) *pulcherrimus* are present in both countries and are known vectors in neighboring countries. In Iraq, primary malaria vectors presently include *An.* (*Ano.*) *sacharovi*, *An.* (*Cel.*) *stephensi* and *An.* (*Cel.*) *superpictus* (Abul-Hab and Al-Kassal 1986). Malaria eradication programs have reduced transmission in many areas of the Southwest Asian Region, while there has been a resurgence of malaria in others. Ramsdale and Haas (1978) reviewed the problems of resurgent malaria in southern and southeastern Turkey where *An.* (*Ano.*) *sacharovi*, *An.* (*Cel.*) *superpictus* and other species may be playing a role in transmission.

METHODS AND PRESENTATION

Morphological characters used here are based predominantly on previous usage in published literature. Harbach and Knight (1980) are followed for morphological terms and abbreviations, and wing spot characters and abbreviations are taken from the nomenclature used by Wilkerson and Peyton (1990).

In the key, morphological features are written out, followed by their abbreviation, to assist users. Specimens were examined at 20–120× magnification under blue-filtered tungsten light. Pure white was used as a reference for determining other colors according to the method of Peyton and Ramalingam (1988). Taxonomic notes are indicated in the key for certain species and presented in an "Explanation of Notes" section immediately following the key.

Table 1 is a taxonomic index to the *Anopheles* mosquitoes of southwestern Asia and Egypt, including a list of important taxonomic references for each species. Tables 2

Table 1. Taxonomic index and references for the *Anopheles* mosquitoes of southwestern Asia and Egypt.

Taxon	Key couplet	Taxonomic references
Genus *Anopheles*		
Subgenus *Anopheles*	2,27	
algeriensis Theobald	28	Marshall (1938), Senevet and Andarelli (1955a)
claviger (Meigen)	32	Mulligan and Puri (1936a, 1936b), Marshall (1938), Ross and Roberts (1943), Torres Canamares (1945), Senevet and Andarelli (1955a, 1955b)
coustani Laveran	35	Evans (1938), de Meillon (1947), Senevet and Andarelli (1955a), Gillies and de Meillon (1968)
gigas simlensis (James)	39	Christophers (1933), Reid (1968)
hyrcanus (Pallas)	37	Christophers (1933), Ross and Roberts (1943), Reid (1953), Gutsevich (1976)
lindesayi Giles	39	Christophers (1933), Reid (1968)
maculipennis Meigen	30	Hackett and Missiroli (1935), Marshall (1938), Bates (1940), Senevet and Andarelli (1955a), Rioux (1958), Gutsevich et al. (1974), White (1978)
marteri sogdianus Keshishian	31	Keshishian (1938), Shahgudian (1956)
martinius Shingarev	30	Hackett and Missiroli (1935), Bates (1940), White (1978)
nigerrimus Giles	38	Christophers (1933), Reid (1953, 1968), Harrison (1972), Harrison and Scanlon (1975)
peditaeniatus (Leicester)	38	Reid (1953, 1968), Harrison (1972), Harrison and Scanlon (1975)
plumbeus Stephens	32	Marshall (1938), Senevet and Andarelli (1955a)
pseudopictus Grassi	37	Dow (1953), Senevet and Andarelli (1955a)
sacharovi Favre	30	Hackett and Missiroli (1935), Bates (1940), Ross and Roberts (1943), Rioux (1958), White (1978)
subalpinus Hackett and Lewis	30	Hackett and Lewis (1935), Bates (1940), Rioux (1958), White (1978), Cianci et al. (1987)
tenebrosus Doenitz	35	Evans (1938), de Meillon (1947), Gillies and de Meillon (1968)
Subgenus *Cellia*	2,28	
annularis Van der Wulp	5	Christophers (1933), Ross and Roberts (1943), Bonne-Wepster and Swellengrebel (1953), Hara (1959), Reid (1968)
apoci Marsh	26	Marsh (1933)

Table 1 continues.

Table 1. *Continued.*

Taxon	Key couplet	Taxonomic references
arabiensis Patton	22	Evans (1938), de Meillon (1947), Senevet and Andarelli (1955a), Coluzzi (1964), Gillies and de Meillon (1968), Zahar et al. (1970), White (1975, 1985), Mattingly (1977)
azaniae Bailly-Choumara	9	Bailly-Choumara (1960), Gillies and de Meillon (1968)
cinereus Theobald	16	Evans (1938), de Meillon (1947), Senevet and Andarelli (1955a), Gillies and de Meillon (1968)
Culicifacies Complex	23	Christophers (1933), Evans (1938), Ross and Roberts (1943), de Meillon (1947), Bonne-Wepster and Swellengrebel (1953), Gillies and de Meillon (1968), Harrison (1980)
demeilloni Evans	25	Evans (1938), de Meillon (1947), Gillies and de Meillon (1968)
dthali Patton	13	Christophers (1933), Evans (1938), de Meillon (1947), Senevet and Andarelli (1955a), Gillies and de Meillon (1968)
fluviatilis James	25	Christophers (1933), Ross and Roberts (1943), Bonne-Wepster and Swellengrebel (1953)
maculatus Theobald	12	Christophers (1933), Ross and Roberts (1943), Bonne-Wepster and Swellengrebel (1953), Hara (1959), Reid (1968)
moghulensis Christophers	20	Christophers (1933)
multicolor Cambouliu	15	Christophers (1933), Evans (1938), Ross and Roberts (1943), de Meillon (1947), Senevet and Andarelli (1955a), Gillies and de Meillon (1968)
paltrinierii Shidrawi and Gillies	26	Shidrawi and Gillies (1987)
pharoensis Theobald	7	Evans (1938), Ross and Roberts (1943), de Meillon (1947), Senevet and Andarelli (1955a), Gillies and de Meillon (1968)
pretoriensis (Theobald)	11	Evans (1938), de Meillon (1947), Gillies and de Meillon (1968)
pulcherrimus Theobald	4	Christophers (1933), Gutsevich et al. (1974)
rhodesiensis rupicola Lewis	9,28	Evans (1938), de Meillon (1947), Senevet and Andarelli (1955a), Mattingly and Knight (1956), Gillies and de Meillon (1968)
sergentii (Theobald)	24	Christophers (1933), Senevet and Andarelli (1955a), Mattingly and Knight (1956)
splendidus Koidzumi	5	Christophers (1933), Bonne-Wepster and Swellengrebel (1953), Hara (1959)

Table 1 continues.

Table 1. *Continued.*

Taxon	Key couplet	Taxonomic references
squamosus Theobald	7	Evans (1938), de Meillon (1947), Gillies and de Meillon (1968)
stephensi Liston	19	Christophers (1933), Ross and Roberts (1943)
subpictus Grassi	22	Christophers (1933), Ross and Roberts (1943), Bonne-Wepster and Swellengrebel (1953), Hara (1959), Reid (1968)
superpictus Grassi	20	Christophers (1933), Ross and Roberts (1943), Senevet and Andarelli (1955a), Gutsevich et al. (1974)
turkhudi Liston	16	Christophers (1933), Evans (1938), Saliternik and Theodor (1942), de Meillon (1947), Gillies and de Meillon (1968)
willmori (James)	12	Christophers (1933), Reid (1968)
n. sp.	19	B. A. Harrison, personal communication

Table 2. Distribution of *Anopheles* (*Anopheles*) in southwestern Asia and Egypt.

	Afghanistan	Bahrain	Cyprus	Egypt	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Pakistan	Qatar	Saudi Arabia	Syria	Turkey	U.A.E.	Yemen
algeriensis	●		●	●	●	●	●	●		●					●	●		
claviger	●		●		●	●	●	●		●		●			●	●		
coustani											●			●				●
gigas simlensis												●						
hyrcanus	●		●		●	●	●	●		●					●	●		
lindesayi	●											●						
maculipennis					●	●									●	●		
marteri sogdianus			●		●	●	●	●		●					●	●		
martinius	●				●													
nigerrimus												●						
peditaeniatus	●											●						
plumbeus					●										●	●		
pseudopictus	●				●											●		
sacharovi	●		●		●	●	●	●		●					●	●		
subalpinus					●	●									●	●		
tenebrosus				●			●	●			●			●				

Table 3. Distribution of *Anopheles* (*Cellia*) in southwestern Asia and Egypt.

	Afghanistan	Bahrain	Cyprus	Egypt	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Pakistan	Qatar	Saudi Arabia	Syria	Turkey	U.A.E.	Yemen
annularis	●											●						
apoci					●	●												
arabiensis														●				●
azaniae																		●
cinereus				●			●	●			●			●				●
culicifacies	●				●	●					●	●					●	●
demeilloni																		●
dthali	●			●	●	●	●	●		●	●	●		●	●		●	●
fluviatilis	●	●			●	●					●	●		●				●
maculatus	●											●						
moghulensis	●				●							●						
multicolor	●		●	●	●	●	●	●		●	●	●	●	●	●			●
paltrinierii											●						●	
pharoensis				●			●	●						●	●			●
pretoriensis														●				●
pulcherrimus	●	●			●	●	●		●	●		●		●	●	●		
rhodesiensis rupicola				●			●	●		●	●			●	●			●
sergentii				●	●	●	●	●		●	●	●	●	●	●		●	●
splendidus	●											●						
squamosus																		●
stephensi	●	●			●	●			●		●	●		●			●	
subpictus	●				●							●						
superpictus	●		●	●	●	●	●	●		●		●		●	●	●		
turkhudi	●			●	●	●	●	●			●	●		●				●
willmori	●											●						
n. sp.				●														

and 3 include the distribution for each species within the region. Figures 1 and 2 provide a summary of the majority of morphological terms and abbreviations used in the key (taken from Wilkerson and Strickman 1990, with modifications).

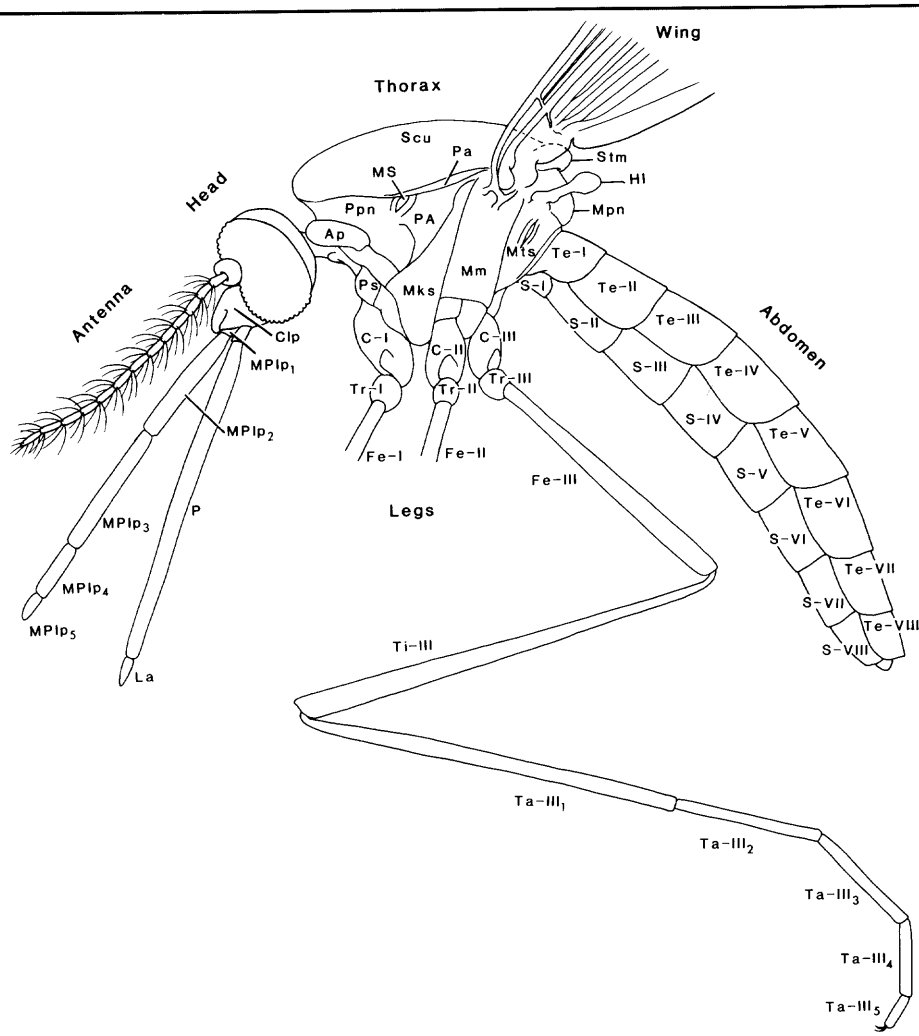
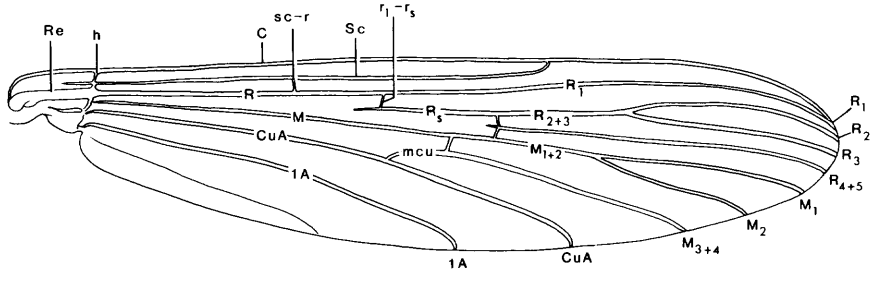


Fig. 1 (above). Female *Anopheles* mosquito, lateral view. Ap, antepronotum; C-I, forecoxa; C-II, midcoxa; C-III, hindcoxa; Clp, clypeus; Fe-I, forefemur; Fe-II, midfemur; Fe-III, hindfemur; Hl, halter; La, labellum; Mks, mesokatepisternum; Mm, mesepimeron; $MPlp_{1-5}$, maxillary palpus, palpomeres 1–5; Mpn, mesopostnotum; MS, mesothoracic spiracle; Mts, metepisternum; P, proboscis; Pa, paratergite; PA, postspiracular area; Ppn, postpronotum; Ps, proepisternum; S-I-VIII, sterna I-VIII; Scu, scutum; Stm, scutellum; $Ta\text{-}III_{1-5}$, hindtarsomeres 1–5; Te-I-VIII, terga I-VIII; Ti-III, hindtibia; Tr-I, foretrochanter; Tr-II, midtrochanter; Tr-III, hindtrochanter.

Fig. 2 (below). Wing veins and crossveins of a female *Anopheles* mosquito. C, costa; CuA, cubitus anterior; h, humeral crossvein; M, media; M_1, media-one; M_{1+2}, media-one-plus-two; M_2, media-two; M_{3+4}, media-three-plus-four; mcu, mediocubital crossvein; R, radius; R_1, radius-one; r_1-r_s, radial crossvein; R_2, radius-two; R_{2+3}, radius-two-plus-three; R_3, radius-three; R_{4+5}, radius-four-plus-five; R_s, radial sector; Re, remigium; Sc, subcosta; sc-r, subcostal crossvein; 1A, anal vein.



KEY TO THE FEMALE *ANOPHELES* OF SOUTHWESTERN ASIA AND EGYPT

1. Wings with contrasting pale and dark spots, at least on costa (C), radius (R) and radius-one (R_1) (Fig. 3) . 2

– Wing entirely dark-scaled (Fig. 4) 26

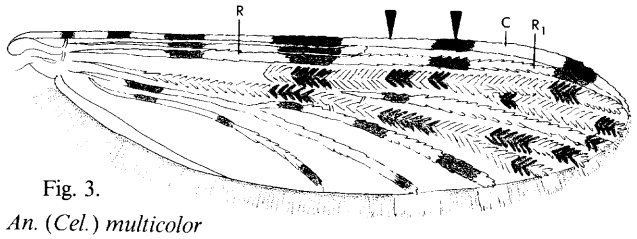


Fig. 3.
An. (Cel.) multicolor

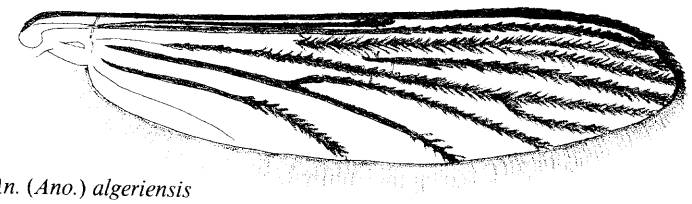


Fig. 4. *An. (Ano.) algeriensis*

2(1). Anterior margin of wing with at least 4 separate dark areas involving the costa (C), radius (R) and radius-one (R_1) (Fig. 5) . . . . . *Anopheles (Cellia)* (in part) 3

– Anterior margin of wing with fewer than 4 separate dark areas involving the costa, radius and radius-one (Fig. 6) . . . . . *Anopheles (Anopheles)* (in part) 33

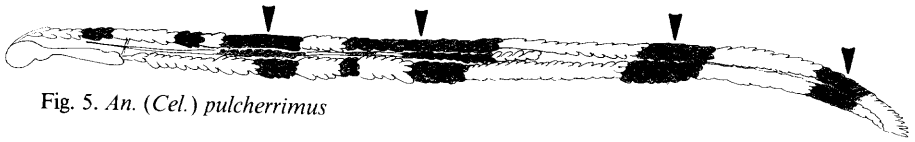


Fig. 5. *An. (Cel.) pulcherrimus*

Fig. 6. *An. (Ano.) hyrcanus*

3(2). Hindtarsomeres 3–5 (Ta-III_{3-5}) pale (Fig. 7) 4

– Hindtarsomeres 3–5 not entirely pale (Fig. 8) 6

Fig. 7. *An. (Cel.) splendidus*

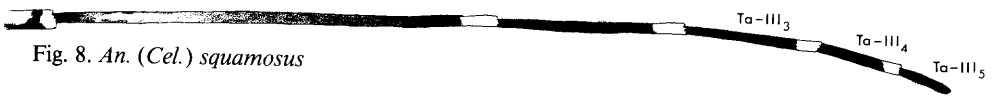


Fig. 8. *An. (Cel.) squamosus*

4(3). Maxillary palpus (MPlp) with 4 pale bands (Fig. 9); abdominal terga densely covered with broad pale scales, and prominent posterolateral dark scale-tufts on all segments (Fig. 10) ..... *pulcherrimus* Theobald

– Maxillary palpus with 3 pale bands (spots of pale scales may also be present) (Fig. 11); abdominal terga with narrow pale scales, and dark posterolateral or apical scales on distal segments only (Fig. 12) 5

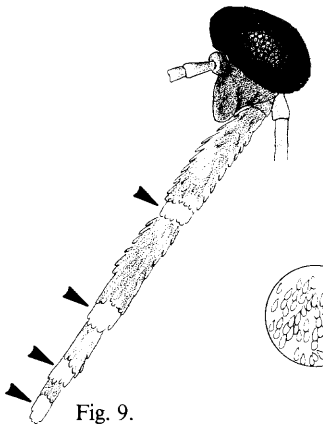


Fig. 9.
An. (Cel.) pulcherrimus

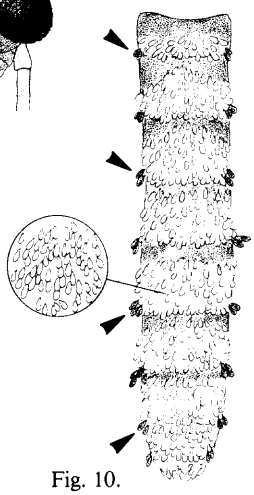


Fig. 10.

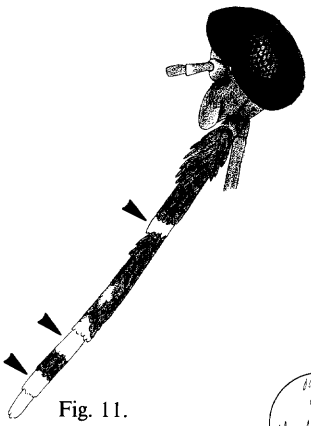


Fig. 11.
An. (Cel.) splendidus

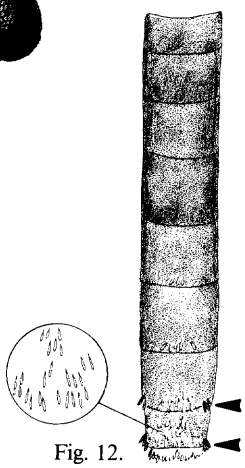


Fig. 12.

5(4). Maxillary palpus (MPlp) with 2 most apical pale bands broad and basal band more narrow (Fig. 13); palpomere 4 ($MPlp_4$) pale at base and apex (Fig. 13); femora (Fe) and tibiae (Ti) with spots of pale scales (Fig. 14) ..... *splendidus* Koidzumi

– Maxillary palpus with apical pale band broad and 2 most basal pale bands narrow (Fig. 15); palpomere 4 usually pale at apex only, occasionally with a few pale scales at base (Fig. 15); femora and tibiae without pale spots (Fig. 16) ..... *annularis* Van der Wulp

Fig. 13.

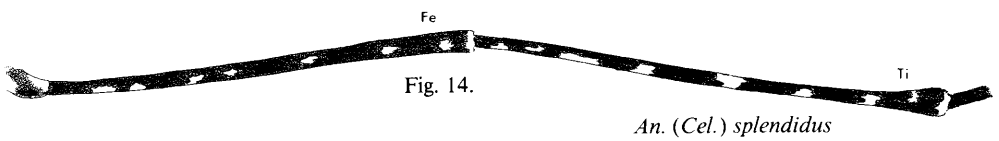


Fig. 14.
An. (Cel.) splendidus

Fig. 15.

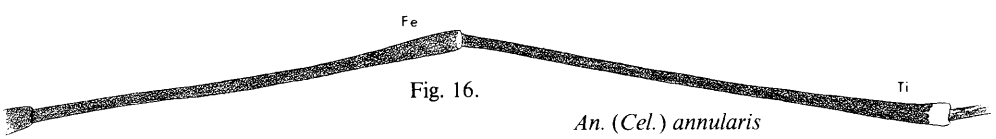
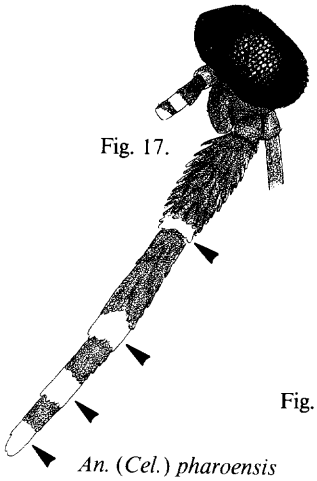


Fig. 16.
An. (Cel.) annularis

6(3). Maxillary palpus (MPlp) with 4 pale bands (Fig. 17); abdominal terga II-VII with posterolateral dark scale tufts (Fig. 18) 7

Maxillary palpus dark, or with at most 3 distinct pale bands (pale spots may also be present) (Fig. 19); abdominal terga II-VII without dark scale-tufts, although some posterolateral dark scales may be present on distal segments (Fig. 20) 8

Fig. 17.



An. (Cel.) pharoensis

Fig. 18.

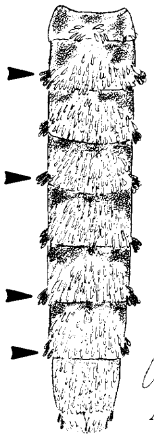


Fig. 19.

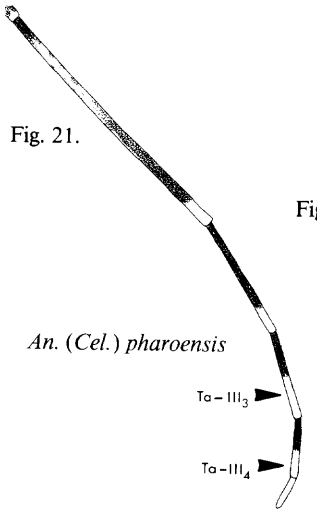
An. (Cel.) pretoriensis

Fig. 20.

7(6). Hindtarsomeres 3 and 4 (Ta-$III_{3,4}$) pale over apical half, hindtarsomere 5 (Ta-III_5) entirely pale (Fig. 21); abdominal terga densely covered with broad pale scales (Fig. 22) ..... *pharoensis* Theobald

– Hindtarsomeres 3 and 4 pale at apex only, hindtarsomere 5 dark (Fig. 23); abdominal terga II-VII covered with moderately narrow dark scales (less dense than in *pharoensis*), and varying amounts of pale scales mesally and posteriorly, pale scales often confined to tergum II and some distal segments (Fig. 24); tergum VIII densely covered with broad pale scales, and with some broad dark scales posterolaterally and mesally (Fig. 24) ..... *squamosus* Theobald

Fig. 21.



An. (Cel.) pharoensis

Fig. 22.

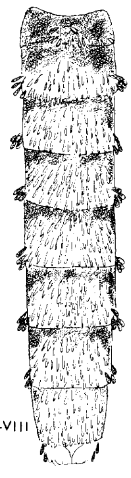
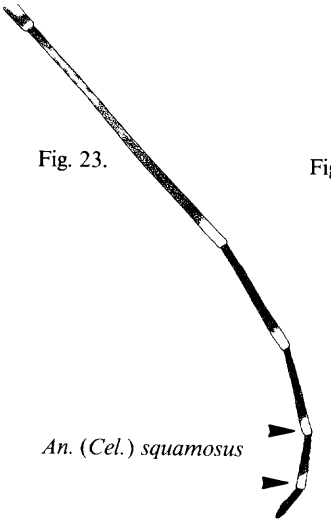


Fig. 23.



An. (Cel.) squamosus

Fig. 24.

8(6). Maxillary palpus (MPlp) dark (Fig. 25) 9

– Maxillary palpus with pale bands (pale spots may also be present) (Fig. 26) 10

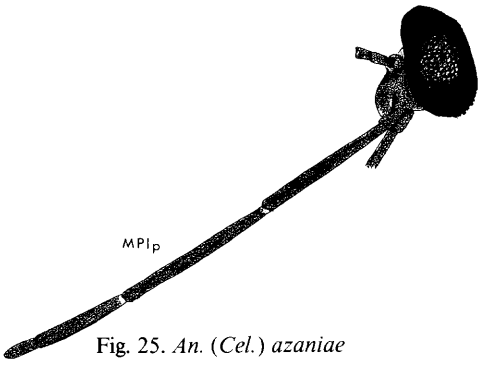


Fig. 25. *An.* (*Cel.*) *azaniae*

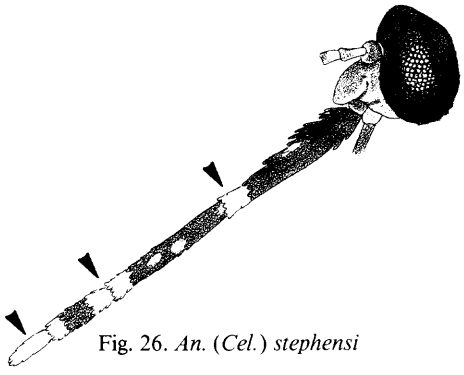


Fig. 26. *An.* (*Cel.*) *stephensi*

9(8). Erect head scales broad, white on vertex (V) and dark brown laterally and posteriorly (Fig. 27) ..... *rhodesiensis rupicola* Lewis (in part) (Note 1)

– Erect head scales narrow, straw-yellow throughout (Fig. 28) ..... *azaniae* Bailly-Choumara

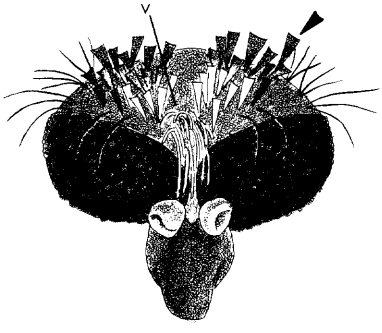


Fig. 27. *An.* (*Cel.*) *rhodesiensis rupicola*

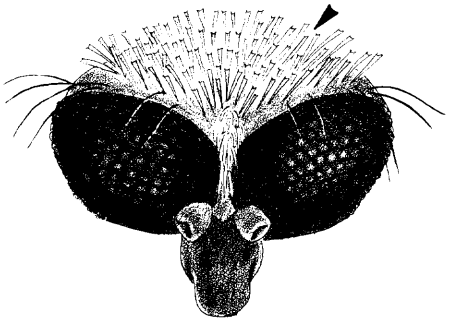


Fig. 28. *An.* (*Cel.*) *azaniae*

10(8). Hindtarsomere 5 (Ta-III_5) pale (Fig. 29) 11

– Hindtarsomere 5 dark (Fig. 30) 13

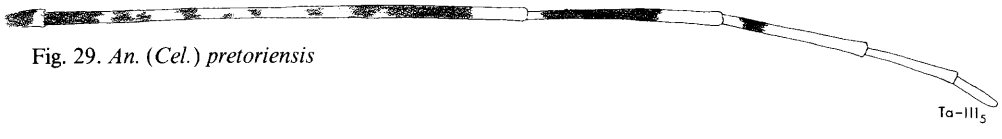


Fig. 29. *An.* (*Cel.*) *pretoriensis*

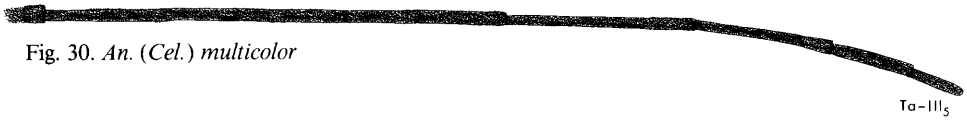


Fig. 30. *An.* (*Cel.*) *multicolor*

11(10). Hindtarsomere 4 (Ta-III$_4$) entirely pale (Fig. 31); abdominal terga without pale scales (Fig. 32) ..... *pretoriensis* (Theobald)

– Hindtarsomere 4 pale only at base and apex (Fig. 33); abdominal terga with pale scales on at least some distal segments (Fig. 34) 12

Fig. 31.

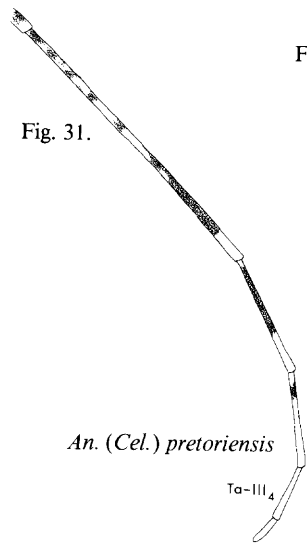


Fig. 32.

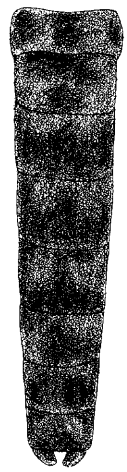


Fig. 33.

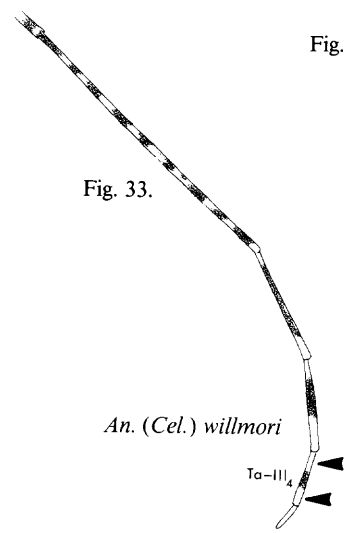


Fig. 34.

12(11). Abdominal terga II-VIII largely covered with pale scales (Fig. 35); dark scales on posterolateral corners of terga VII and VIII, occasionally also on IV-VI (Fig. 35) ..... *willmori* James

– Abdominal terga usually with pale scales at most on segments V-VIII, occasionally tergum IV with a few pale scales posteriorly (Fig. 36); dark scales on posterolateral corners of terga VII and/or VIII, rarely also on VI (Fig. 36) ..... *maculatus* Theobald

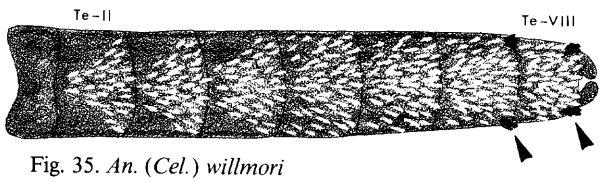


Fig. 35. *An. (Cel.) willmori*

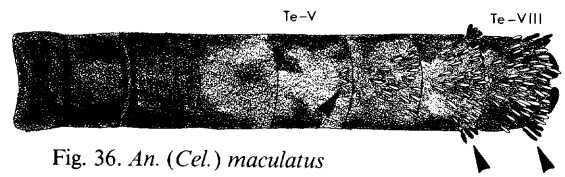


Fig. 36. *An. (Cel.) maculatus*

13(10). Wing with pale spots confined to costa (C), radius (R) and radius-one (R$_1$) (Fig. 37); erect head scales narrow, straw-yellow throughout (Fig. 38); scutum (Scu) with setae only, no scales (Fig. 39) ..... *dthali* Patton

– Wing with pale spots present on nearly all veins (Fig. 40); erect head scales broad, white on vertex (V) and dark brown laterally and posteriorly (Fig. 41); scutum with obvious pale scales in addition to setae (Fig. 42) 14

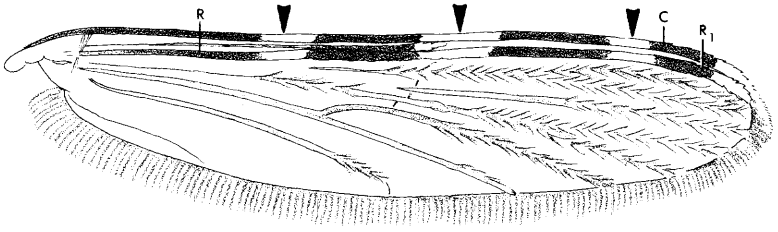


Fig. 37.

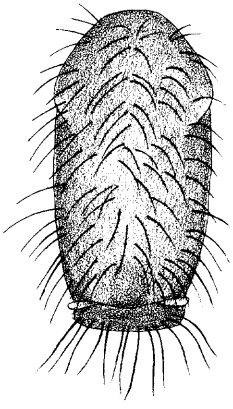
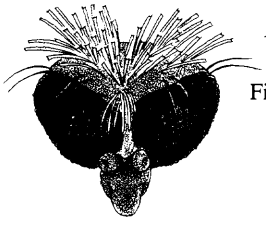


Fig. 39.



An. (Cel.) dthali

Fig. 38.

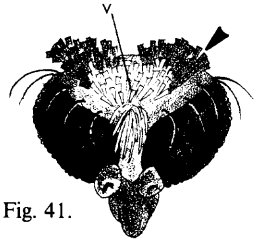
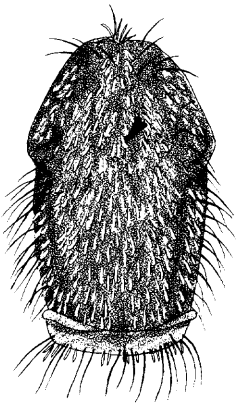


Fig. 41.



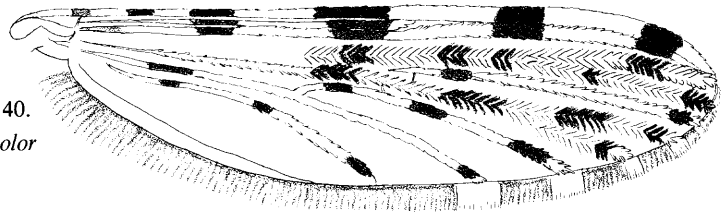


Fig. 40.
An. (Cel.) multicolor

14(13). Palpomere 5 ($MPlp_5$) dark at apex (Fig. 43) 15

– Palpomere 5 entirely pale (Fig. 44) 17

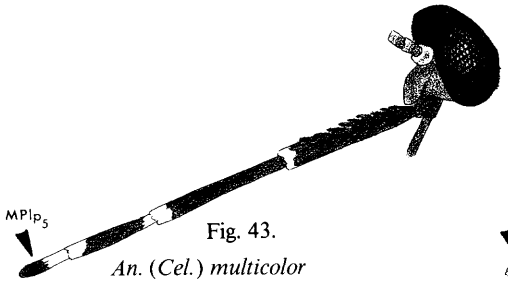


Fig. 43.
An. (Cel.) multicolor

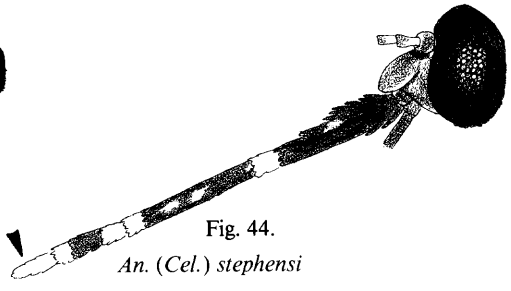


Fig. 44.
An. (Cel.) stephensi

15(14). Scutal fossa (SF) covered with scattered pale scales (Fig. 45); base of costa (C) pale-scaled (Fig. 46) ..... *multicolor* Cambouliu

Scutal fossa without scales, or at most a few scales present at extreme upper margin (Fig. 47); base of costa dark (Fig. 48) 16

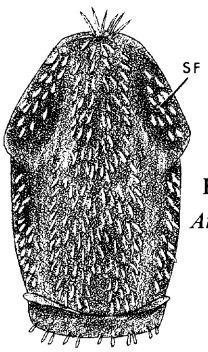


Fig. 45.
An. (Cel.) multicolor

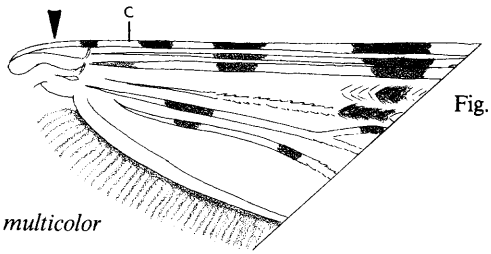


Fig. 46.

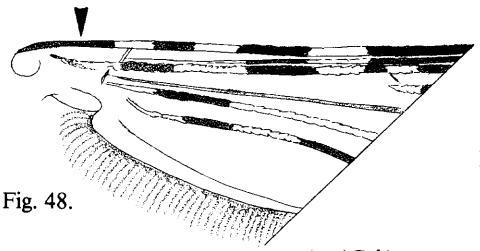


Fig. 48.

An. (Cel.) cinereus

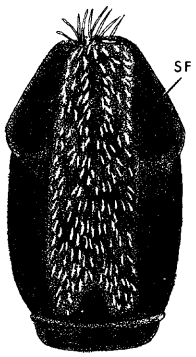


Fig. 47.

16(15). Wing with well defined pale- and dark-scaled areas on all veins (Fig. 49); anal vein (1A) with 3 dark spots (Fig. 49) ..... *cinereus* Theobald

Wing spots indistinct posterior to radius (R) and radius-one (R_1) (Fig. 50); anal vein with at most 2 indistinct dark spots, often appearing mostly dark-scaled (Fig. 50) ..... *turkhudi* Liston (Note 2)

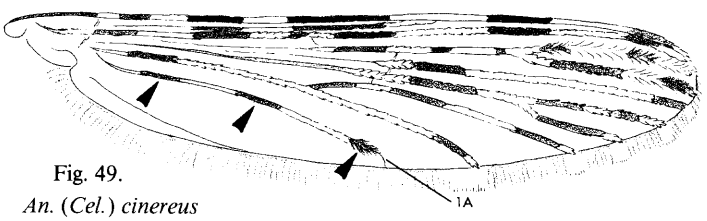


Fig. 49.
An. (Cel.) cinereus

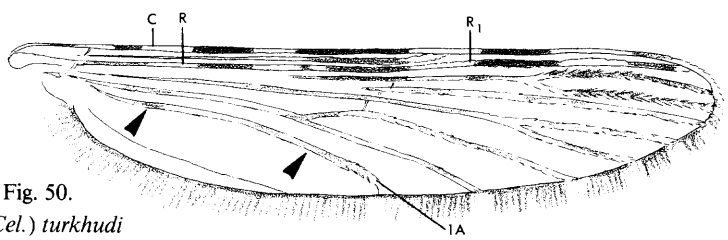


Fig. 50.
An. (Cel.) turkhudi

17(14). Scutum (Scu) with broad pale scales on median area (Fig. 51); upper proepisternal setae (PeSU) (Note 3) absent (Fig. 52) 18

– Scutum with narrow pale scales on median area (Fig. 53); upper proepisternal setae present (Fig. 54) ... 21

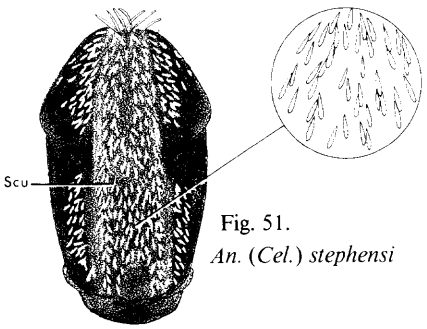


Fig. 51.
An. (Cel.) stephensi

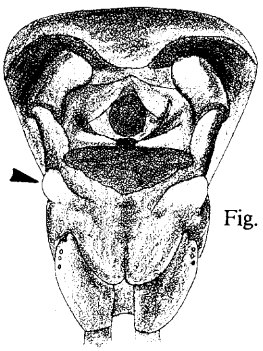


Fig. 52.

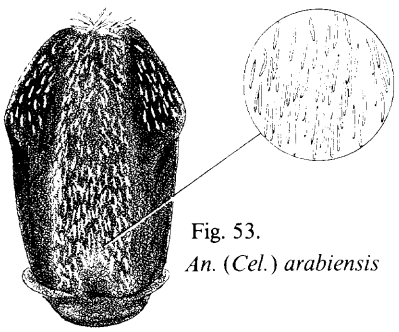


Fig. 53.
An. (Cel.) arabiensis

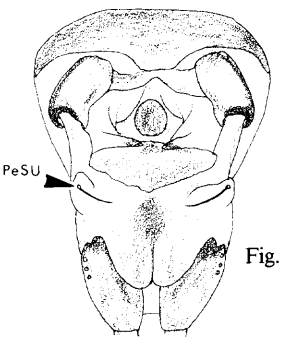


Fig. 54.

18(17). Femora (Fe) and tibiae (Ti) spotted with pale scales (Fig. 55); abdominal terga II-VIII largely covered with pale scales (Fig. 56) 19

– Femora and tibiae not spotted (Fig. 57); abdominal terga without pale scales (Fig. 58) 20

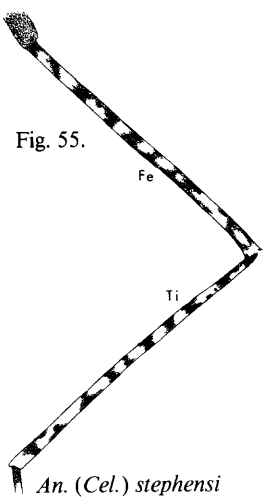


Fig. 55.
An. (Cel.) stephensi

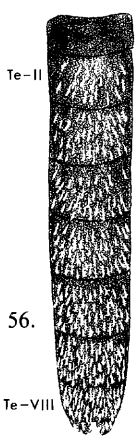


Fig. 56.

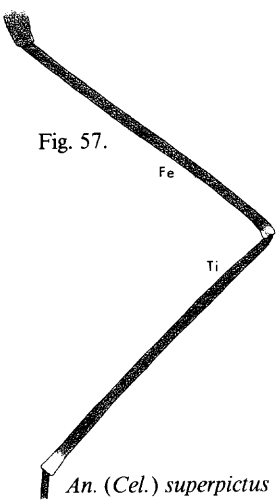


Fig. 57.
An. (Cel.) superpictus

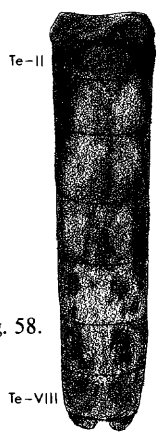


Fig. 58.

19(18). Anal vein (1A) with 3 dark spots (Fig. 59); scutal fossa (SF) covered with scattered pale scales (Fig. 60); abdominal sterna V-VIII usually with pale scales (Fig. 61) ..... *stephensi* Liston

– Anal vein with at most 2 small poorly defined dark spots, one just past midlength and the other near apex, or appearing entirely pale-scaled (Fig. 62); scutal fossa with pale scales only at upper margin (Fig. 63); abdominal sterna usually without pale scales, or at most with pale scales on sternum VIII, rarely a few scales on VII (Fig. 64) ..... n. sp. (Note 4)

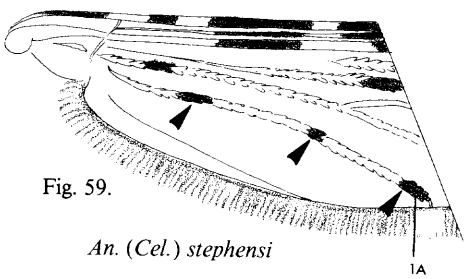


Fig. 59.

An. (Cel.) stephensi

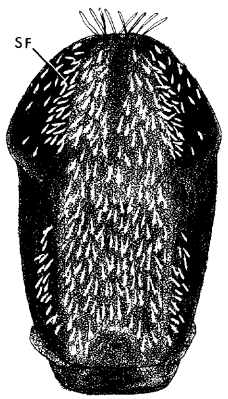


Fig. 60.

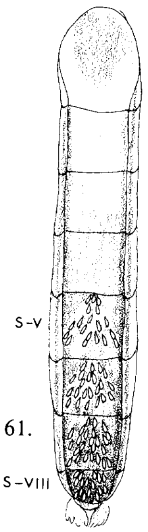


Fig. 61.

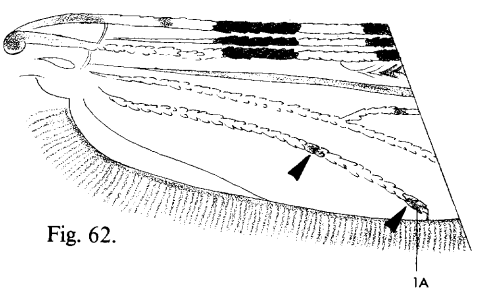


Fig. 62.

An. (Cel.) n. sp.

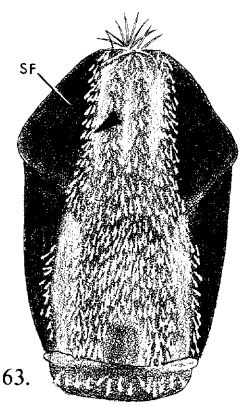


Fig. 63.

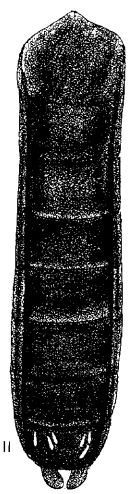


Fig. 64.

20(18). Anal vein (1A) with 3 dark spots (Fig. 65) ..... *moghulensis* Christophers

– Anal vein with 2 dark spots, distal spot long (Fig. 66) ..... *superpictus* Grassi

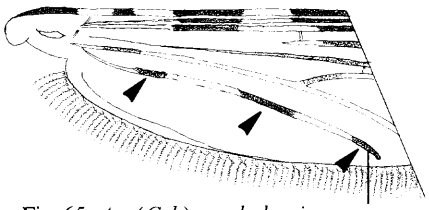


Fig. 65. *An. (Cel.) moghulensis*

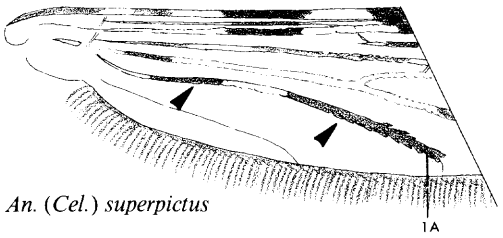


Fig. 66. *An. (Cel.) superpictus*

21(17). Scutal fossa (SF) covered with scattered pale scales (Fig. 67); hindtarsomeres 3 and 4 (Ta-$III_{3,4}$) pale at apex (Fig. 68) 22

\- Scutal fossa without scales (Fig. 69); hindtarsomeres 3 and 4 entirely dark (Fig. 70) 23

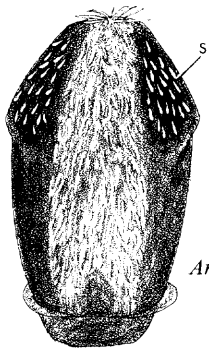


Fig. 67. *An. (Cel.) arabiensis*

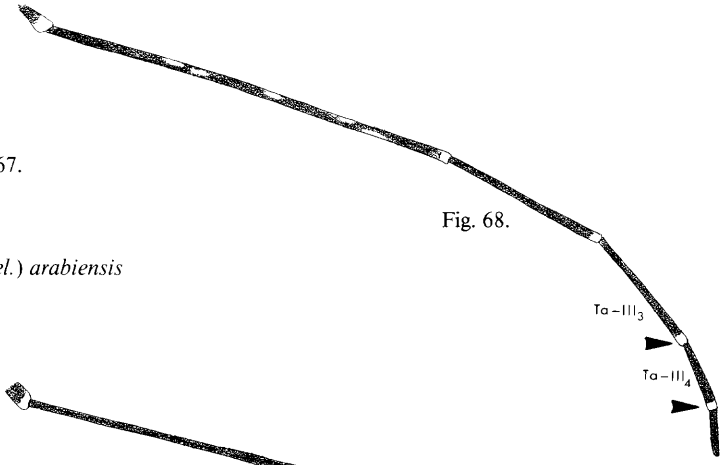


Fig. 68.

Fig. 69. *An. (Cel.) culicifacies*

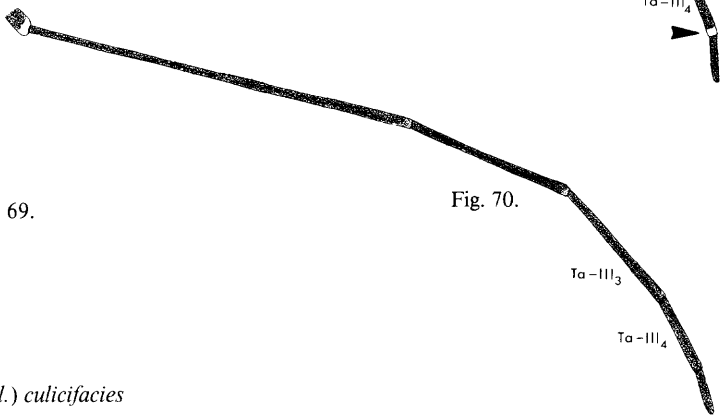


Fig. 70.

22(21). Femora (Fe) and tibiae (Ti) with spots of pale scales (Fig. 71); anal vein (1A) usually with 3 dark spots (Fig. 72); radius (R) usually with distinct preaccessory sector dark (PASD) spot (Note 5) (Fig. 72) ..... *arabiensis* Patton

– Femora and tibiae not spotted (Fig. 73); anal vein with 2 dark spots (Fig. 74); radius usually without preaccessory sector dark spot (Fig. 74) ..... *subpictus* Grassi

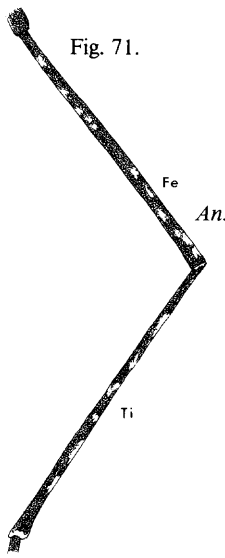


Fig. 71.

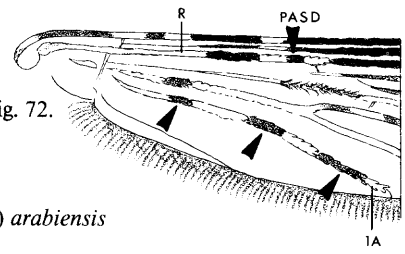


Fig. 72.
An. (Cel.) arabiensis

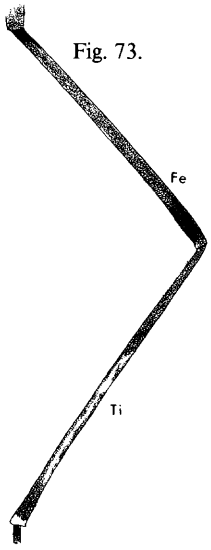


Fig. 73.

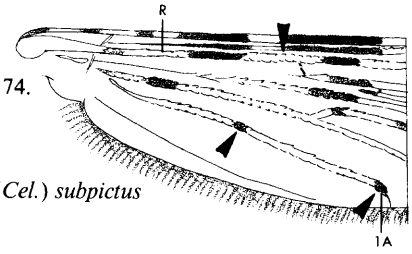


Fig. 74.
An. (Cel.) subpictus

23(21). Radius (R) with a dark spot just distal to humeral crossvein (h) (Fig. 75); wing fringe usually with 1–2 inconspicuous pale spots on posterior margin, rarely more (Fig. 75) ..... Culicifacies Complex (Note 6)

– Radius without basal dark spot just distal to humeral crossvein (Fig. 76); wing fringe usually with at least 4 pale spots on posterior margin (Fig. 76) 24

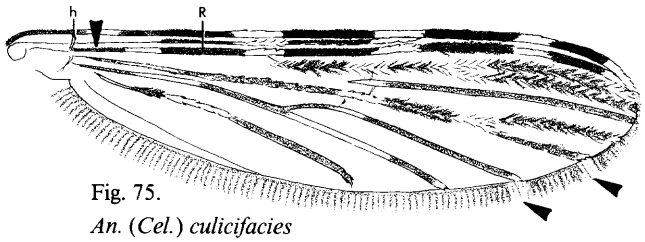


Fig. 75.
An. (Cel.) culicifacies

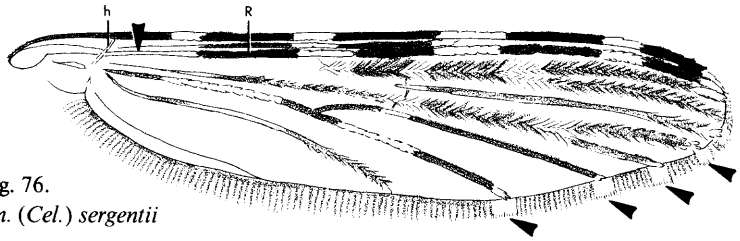


Fig. 76.
An. (Cel.) sergentii

24(23). Radius-four-plus-five (R_{4+5}) dark-scaled except at base and apex, occasionally with some pale scales in distal area (Fig.77) ..... *sergentii* (Theobald)

– Radius-four-plus-five with a distinct, large median pale area (Fig. 78) 25

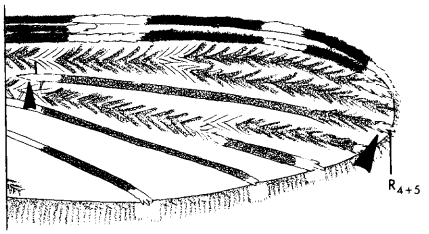


Fig. 77. *An.* (*Cel.*) *sergentii*

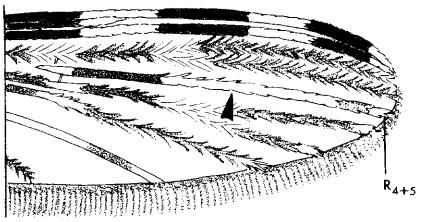


Fig. 78. *An.* (*Cel.*) *fluviatilis*

25(24). Radius (R) with preaccessory sector dark (PASD) spot (Fig. 79) ..... *demeilloni* Evans

– Radius without preaccessory sector dark spot (Fig. 80)..... *fluviatilis* James

Fig. 79. *An.* (*Cel.*) *demeilloni*

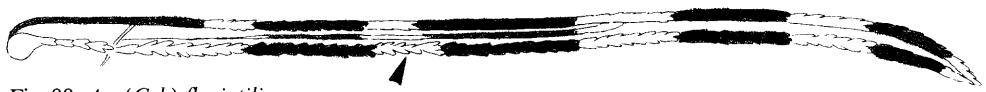


Fig. 80. *An.* (*Cel.*) *fluviatilis*

26(1). Erect head scales narrow, straw-yellow throughout (Fig.81) ..... *Anopheles* (*Cellia*) (in part)

..... *apoci* Marsh and *paltrinierii* Shidrawi and Gillies (Note 7)

Erect head scales broad, white on vertex (V) and dark brown laterally and posteriorly (Fig. 82), or dark brown throughout (Fig. 83)..... 27

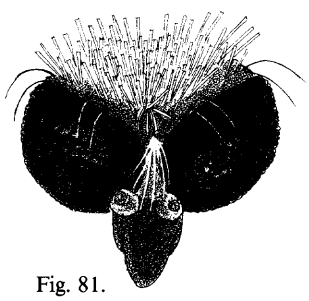


Fig. 81.
An. (*Cel.*) *paltrinierii*

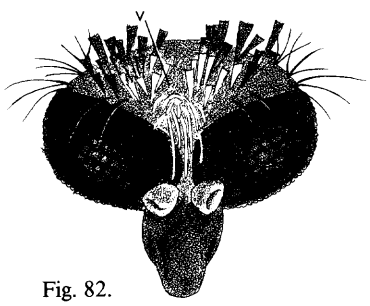


Fig. 82.
An. (*Cel.*) *rhodesiensis rupicola*

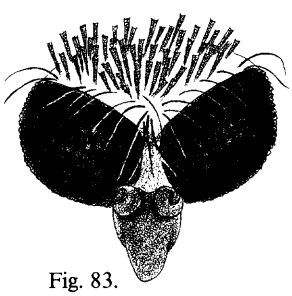


Fig. 83.
An. (*Ano.*) *algeriensis*

27(26). Scutum (Scu) without pale scales on median area (Fig. 84) 28

– Scutum with narrow (Fig. 85) to moderately broad (Fig. 86) pale scales on median area ..... *Anopheles* (*Anopheles*) (in part) 29

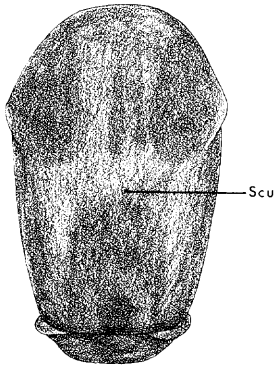


Fig. 84.
An. (*Ano.*) *algeriensis*

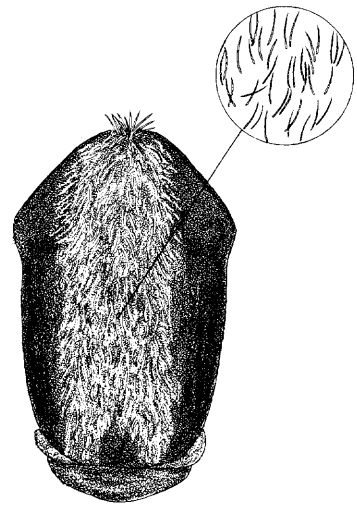


Fig. 85. *An.* (*Ano.*) *maculipennis*

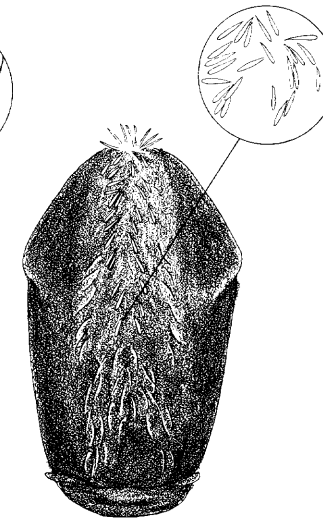


Fig. 86. *An.* (*Ano.*) *plumbeus*

28(27). Erect head scales white on vertex (V), dark brown laterally and posteriorly (Fig. 87) ..... *Anopheles* (*Cellia*) *rhodesiensis rupicola* Lewis (in part)

– Erect head scales dark brown throughout (Fig. 88) ..... *Anopheles* (*Anopheles*) *algeriensis* Theobald

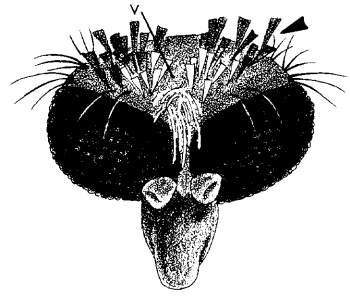


Fig. 87. *An.* (*Cel.*) *rhodesiensis rupicola*

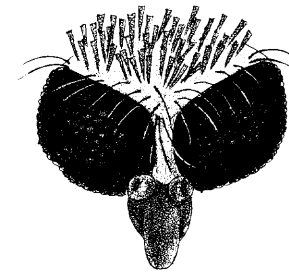


Fig. 88. *An.* (*Ano.*) *algeriensis*

29(27). Wing scales darker and more dense at crossveins and furcations, forming dark spots (Fig. 89) ..... Maculipennis Complex (Note 8) 30

– Wing scales uniformly distributed, dark spots inapparent (Fig. 90) 31

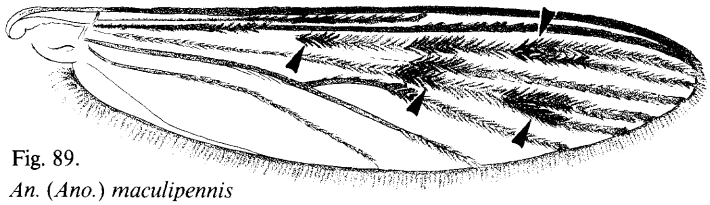


Fig. 89.
An. (*Ano.*) *maculipennis*

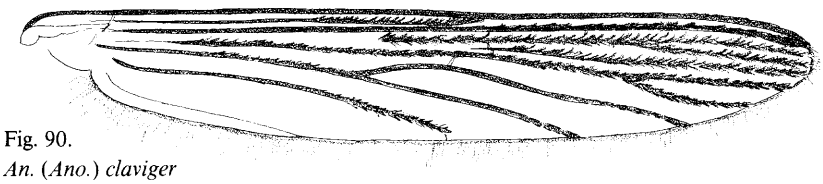


Fig. 90.
An. (*Ano.*) *claviger*

30(29). Wing with distinct dark spots (Fig. 91); scutum (Scu) dark brown (Fig. 92); scutal fossa (SF) usually with narrow, piliform pale scales, atleast on extreme upper margin (Fig. 92) ..... *maculipennis* Meigen and *subalpinus* Hackett and Lewis (Note 9)

– Wing spots usually less distinct (Fig. 93); scutum pale brown (Fig. 94); scutal fossa without pale scales (Fig. 94) ..... *martinius* Shingarev and *sacharovi* Favre (Note 10)

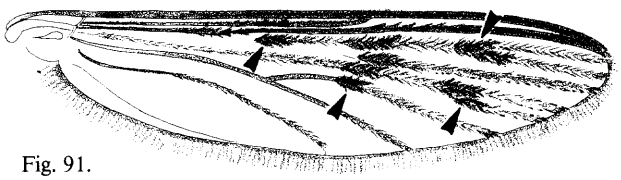


Fig. 91.
An. (*Ano.*) *maculipennis*

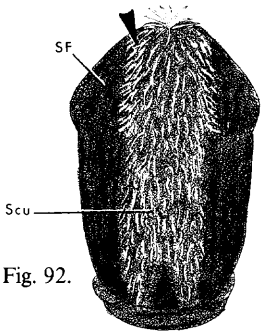


Fig. 92.

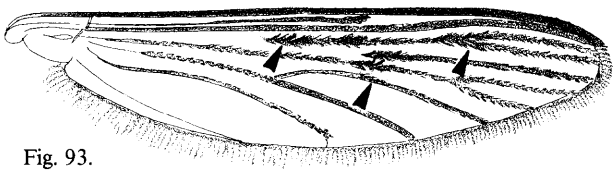


Fig. 93.
An. (*Ano.*) *sacharovi*

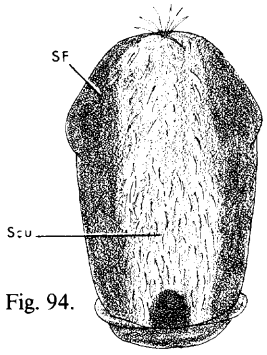


Fig. 94.

31(29). Labellum (La) distinctly paler than remainder of proboscis (P) (Fig. 95) ..... *marteri sogdianus* Keshishian (Note 11)

– Labellum not paler than remainder of proboscis (Fig. 96) 32

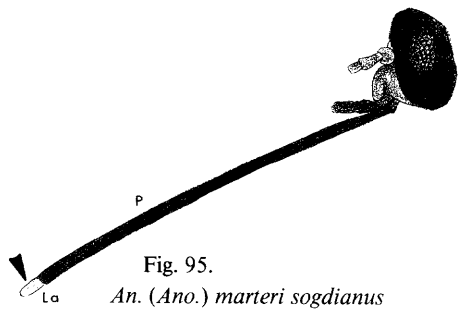


Fig. 95.
An. (Ano.) marteri sogdianus

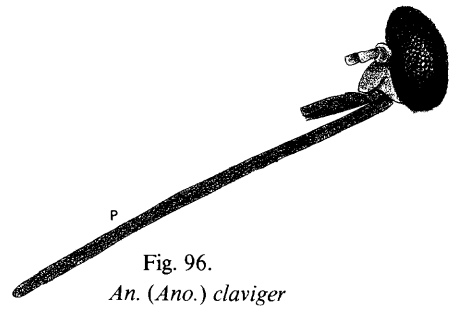


Fig. 96.
An. (Ano.) claviger

32(31). Scutum (Scu) with very narrow, piliform pale scales on median area (Fig. 97); lower proepisternal setae (PeSL) (Note 12) present (Fig. 98); palpomere 5 ($MPlp_5$) not longer than 0.50 length of palpomere 4 ($MPlp_4$) (Fig. 99) ..... *claviger* (Meigen)

– Scutum with narrow to moderately broad, spatulate pale scales on median area (Fig. 100); lower proepisternal setae absent (Fig. 101); palpomere 5 longer than 0.50 length of palpomere 4 (Fig. 102) ..... *plumbeus* Stephens

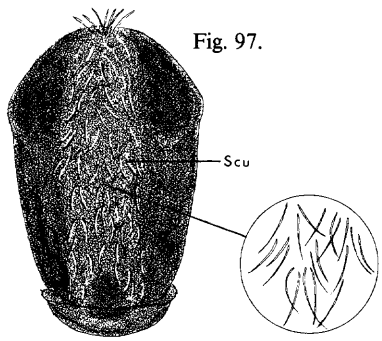


Fig. 97.
An. (Ano.) claviger

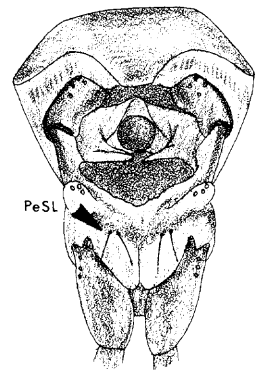


Fig. 98.

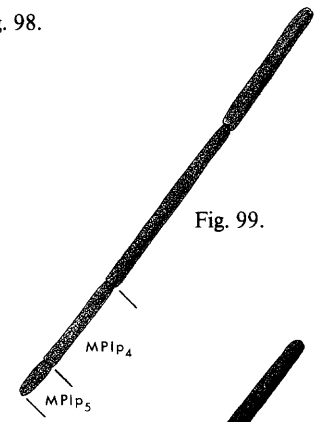


Fig. 99.

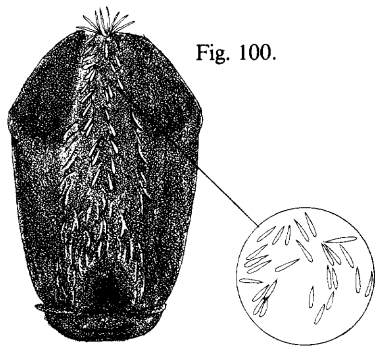


Fig. 100.
An. (Ano.) plumbeus

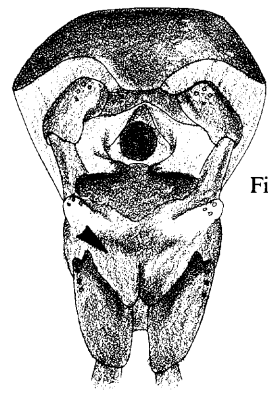


Fig. 101.

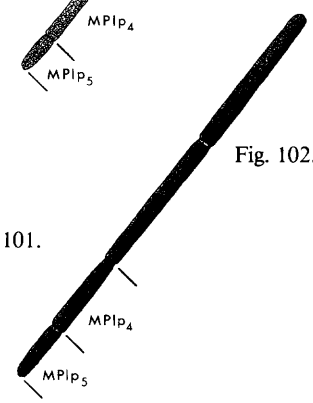


Fig. 102.

33(2). Basolateral area of clypeus (Clp) with a patch of dark laterally projecting scales (Fig. 103) 34

– Clypeus without scales (Fig. 104) 39

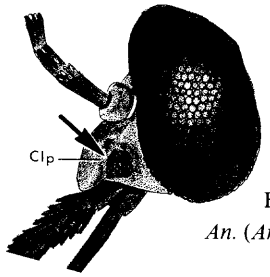


Fig. 103.
An. (Ano.) coustani

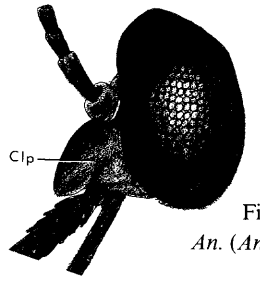


Fig. 104.
An. (Ano.) lindesayi

34(33). Hindtarsomeres 4 and 5 (Ta-III$_{4,5}$) entirely pale (Fig. 105) 35

– Hindtarsomeres 4 and 5 not entirely pale (Fig. 106) 36

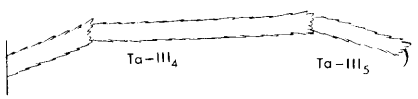


Fig. 105. *An. (Ano.) coustani*

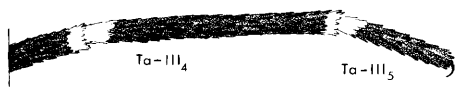


Fig. 106. *An. (Ano.) gigas simlensis*

35(34). Hindtarsomere 1 (Ta-III$_1$) broadly pale at base and apex, hindtarsomere 2 (Ta-III$_2$) pale over approximately apical half, hindtarsomere 3 (Ta-III$_3$) dark at base only or entirely pale (Fig. 107); abdominal sternum VII with a group of posteromedian dark scales (Fig. 108) ..... *coustani* Laveran

– Hindtarsomeres 1 and 2 narrowly pale at apex only, hindtarsomere 3 pale over apical third to two-thirds (Fig. 109); abdominal sternum VII with or without posteromedian dark scales (Fig.110) ..... *tenebrosus* Doenitz (Note 13)

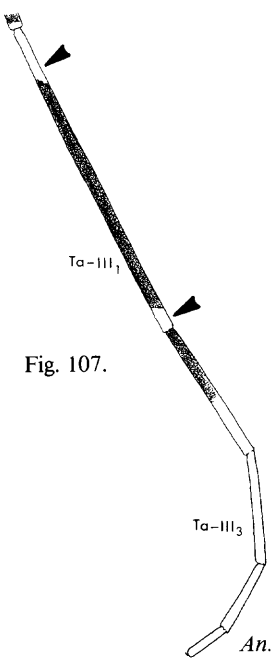


Fig. 107.

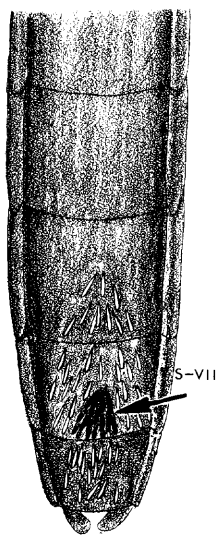
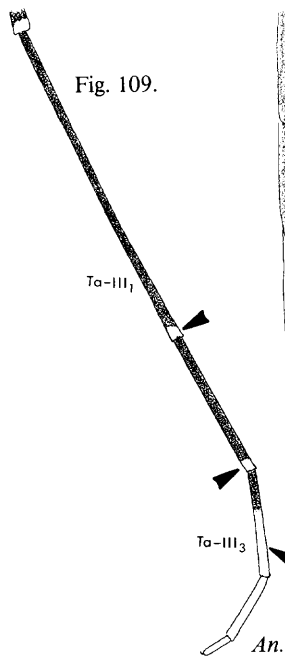


Fig. 108.

An. (Ano.) coustani

Fig. 109.



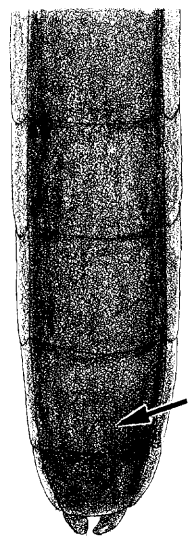


Fig. 110.

An. (Ano.) tenebrosus

36(34). Hindtarsomere 4 (Ta-III_4) pale at apex only or entirely pale, hindtarsomere 5 (Ta-III_5) dark (Fig.111) ... 37

– Hindtarsomere 4 usually pale at base and apex, hindtarsomere 5 entirely dark or pale at base only (Fig. 112) ... 38

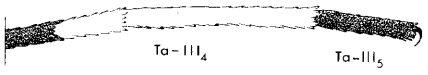


Fig. 111. *An.* (*Ano.*) *pseudopictus*

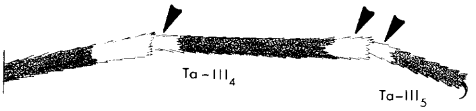


Fig. 112. *An.* (*Ano.*) *peditaeniatus*

37(36). Hindtarsomere 4 (Ta-III_4) pale at apex only (Fig.113) ... *hyrcanus* (Pallas)

– Hindtarsomere 4 entirely pale (Fig. 114) ... *pseudopictus* Grassi

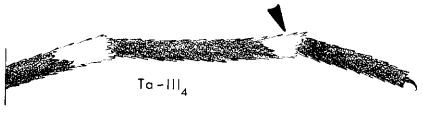


Fig. 113. *An.* (*Ano.*) *hyrcanus*

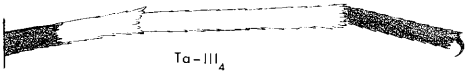


Fig. 114. *An.* (*Ano.*) *pseudopictus*

38(36). Humeral crossvein (h) with patch of dark scales (Fig. 115); remigium (Re) mostly dark-scaled (Fig. 115); pale markings on hindtarsomeres 4 and 5 (Ta-$III_{4,5}$) variable, often without basal pale bands (Fig. 116) ... *nigerrimus* Giles (Note 14)

– Humeral crossvein without scales (Fig. 117); remigium mostly pale-scaled (Fig. 117); hindtarsomere 4 and usually 5 with basal pale bands (Fig. 118) ... *peditaeniatus* (Leicester)

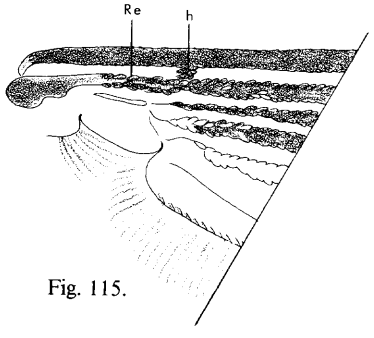


Fig. 115.

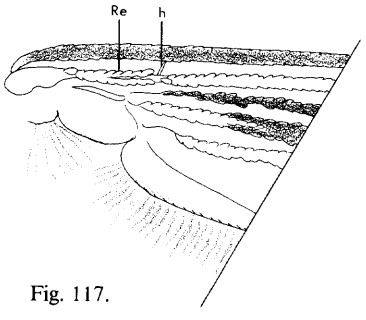


Fig. 117.

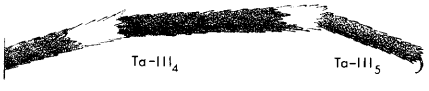


Fig. 116.
An. (*Ano.*) *nigerrimus*

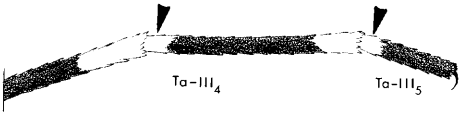


Fig. 118.
An. (*Ano.*) *peditaeniatus*

39(33). Costa (C) dark-scaled except at apex (Fig. 119); hindfemur (Fe-III) with broad subapical pale band (Fig. 120); hindtarsomeres 4 and 5 (Ta-$III_{4,5}$) entirely dark (Fig. 121) ..... *lindesayi* Giles

– Costa with several pale-scaled areas prior to apex (Fig. 122); hindfemur narrowly pale at base and apex only (Fig. 123); hindtarsomeres 4 and 5 narrowly pale at tarsal joints (Fig. 124)..... *gigas simlensis* (James)

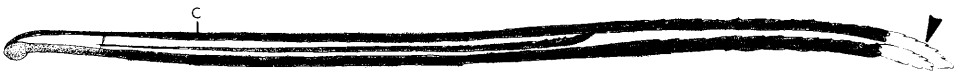


Fig. 119.

Fig. 120.

Fig. 121.
An. (Ano.) lindesayi

Fig. 122.

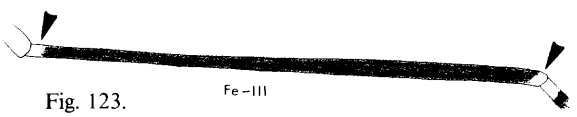


Fig. 123.

Fig. 124.
An. (Ano.) gigas simlensis

EXPLANATION OF NOTES

1. *Anopheles (Cel.) rhodesiensis rupicola* can be found with (couplet 9) and without (couplet 28) contrasting pale and dark spots on the costa (C), radius (R) and radius-one (R_1). This variation of the wing scaling is often seen in desert species and may not be confined solely to the C, R and R_1.

2. The variety *An. (Cel.) turkhudi telamali* described by Saliternik and Theodor (1942) from "Palestine" was not seen during this study. *Anopheles turkhudi* was found during a faunistic survey of the Sinai Peninsula (Margalit and Tahori 1973), but it was not listed by Pener and Kitron (1985) in a survey of northern Israel. In an annotated list of the mosquitoes of Israel (Margalit and Tahori 1974), they record only the subspecies *An. turkhudi telamali*; however, J. Margalit (per-

sonal communication) feels that the status of *An. turkhudi telamali* as a valid subspecies may be in doubt.

3. The upper proepisternal setae (PeSU) occur in a group above the forecoxae on the upper part of the proepisternum.

4. The dark spots on the anal vein (1A) of *An.* (*Cel.*) n. sp. may be reduced to the point that the entire vein appears pale-scaled. However, the species can be separated from *An. stephensi* by the combination of the reduction in pale scales on the scutal fossa (SF), and the reduction or absence of pale scales on the abdominal sterna.

5. The preaccessory sector dark (PASD) spot is defined as the isolated group of dark scales occurring on the radius (R) before the splitting of radius-one (R_1) and the radial sector (R_s), and located between the sector pale (SP) and accessory sector pale (ASP) spots. The PASD is equivalent to the sector dark (SD) spot of Wilkerson and Peyton (1990), as illustrated in their Figure 1 for the condition where the ASP is present on the costa (C), subcosta (Sc) and R, thereby producing SD spots on all three veins. The typical condition for the presence of the isolated PASD spot on the R in Southwest Asian *Cellia* is the absence of the ASP spots and the fusing of the SD spots on the C and Sc.

6. *Anopheles* (*Cel.*) *culicifacies* has been found to be a complex of four sibling species (designated species A, B, C and D), distinguishable only by fixed chromosomal inversions. Species A has been identified from an urban area on the border between Oman and the United Arab Emirates by Akoh et al. (1984), and from Sistan and Baluchistan Province, Iran by Zaim and Javaherian (1991). Species A and B have been detected in Punjab Province, Pakistan (Mahmood et al. 1984).

7. Adult females of *An.* (*Cel.*) *apoci* and *An.* (*Cel.*) *paltrinierii* cannot be distinguished except for the morphology of the pharyngeal armature. Males of *An. paltrinierii* can be separated by the absence of leaflets on the aedeagus (Shidrawi and Gillies 1987).

8. In southwestern Asia the Maculipennis Complex is represented by at least four sibling species, including *An. maculipennis*, *An. martinius*, *An. sacharovi* and *An. subalpinus*. Identifications of the species are best accomplished by characters of the eggs or by differences in chromosomal inversions (White 1978).

9. *Anopheles* (*Ano.*) *maculipennis* and *An. subalpinus* can be distinguished by the intercostal membrane of the egg float, which is rough in *An. maculipennis* and smooth in *An. subalpinus*, and by chromosomal inversion differences. *Anopheles* subalpinus is known to occur with certainty only in Iran, Iraq, Syria and Turkey. Postiglione et al. (1970) found *An. subalpinus* in Turkey, suggesting that previous records of *An. messeae* Falleroni may also be *An. subalpinus*. White (1978) shows the geographic distribution of *An. messeae* falling short of the Southwest Asian Region. The presence of *An. melanoon* Hackett in Turkey requires confirmation.

10. *Anopheles martinius* and *An. sacharovi* can be distinguished by the fixed paracentric inversions of their polytene chromosomes (White 1978).

11. Ribeiro et al. (1985) collected *An.* (*Ano.*) *marteri* Senevet and Prunelle in northeastern Portugal, and after reviewing its geographical distribution, bioecology and taxonomy from the literature, determined that *An.* (*Ano.*) *marteri sogdianus* is a junior synonym of *An. marteri*, and that *An. marteri* is a polymorphic, monotypic species. However, based on their conclusions concerning the distribution of subspecies and expected morphological divergence of subspecies, *An. marteri sogdianus* will be treated as a valid subspecies in this study.

12. The lower proepisternal setae (PeSL) occur individually or as a group mesad of the forecoxae and below the upper proepisternal setae (PeSU) on the lower part of the proepisternum.

13. The posteromedian dark scales of abdominal sternum VII in *An.* (*Ano.*) *tenebrosus* were occasionally absent in specimens from Egypt, Israel and Saudi Arabia. However, the pale banding of hindtarsomeres 1–3 is a reliable character for distinguishing *An. tenebrosus* from *An. coustani*.

14. The adults of *An.* (*Ano.*) *nigerrimus* are generally similar to *An. peditaeniatus*, and apparently the extent of pale banding on the hindtarsomeres is often variable. See Harrison and Scanlon (1975) for a discussion of characters which help to separate the two species. Early records of *An. nigerrimus* from Pakistan may be *An. peditaeniatus* (B.A. Harrison, personal communication).

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