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## TRITHECOIDES, A NEW SUBGENUS OF CULICOIDES (Diptera, Ceratopogonidae)

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### ABSTRACT

*Trithecoides*, a new subgenus, is proposed for those species of *Culicoides* having three well-developed spermathecae and a long second radial cell. Two of the species are from Africa, and the others are from southern and eastern Asia. The twenty known species are divided into five groups according to the type of mandible and shape of spermathecae and all are described and illustrated. The following ten species are described as new: *albibasis* (Malaya), *baisasi* (Philippines), *barnetti* (Malaya), *culiciphagus* (Solomon Islands), *elbeli* (Malaya), *flaviscutatus* (North Borneo), *paraflavescens* (Ceylon), *sarawakensis* (Sarawak), *subflavescens* (North Borneo), and *tenuipalpis* (Formosa).

### INTRODUCTION

There is a natural group of Oriental and Ethiopian species in *Culicoides*, readily distinguished by habitus and structural characters, which we believe to be worthy of recognition as a new subgenus of *Culicoides*. Okada (1942) was apparently the first to recognize this natural group, which he characterized and named the Fulvithorax Group. He included the species *anophelis* Edwards, *gewertzi* Causey, *flavescens* Macfie, *fulvithorax* (Austen), *humeralis* Okada, *raripalpis* Smith, *macfie* Causey, and *albipennis* Smith and Swaminath. Khalaf (1954), in his classification of *Culicoides*, placed four of these species having three spermathecae (*fulvithorax*, *gewertzi*, and *raripalpis*) in the Fulvithorax Group under his new subgenus *Monoculicoides*, the type of which, *nubeculosus* (Meigen), has only one spermatheca. Amosova (1957) gives a good discussion of some characters of the species related to *raripalpis*.

We are now naming and describing this new subgenus and reviewing the known species in order to furnish the names to other current workers and to make known the characters which we have recently found to be extremely useful in classification. This paper is a preliminary one in a series that we hope will culminate in a monographic treatment of the *Culicoides* of Southeast Asia. From the material we have already received for study it is

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evident that many new species remain to be described, and for this reason we must use caution in attempting to define the major groups of species within the genus *Culicoides*. This paper was in its final stages of preparation when collections from additional localities yielded a considerable number of additional new species. Since these species seemed to strengthen our group classification, and because other workers needed the names proposed herein, we decided not to hold up this paper until these additional species could be described, illustrated, and added to the keys.

### Genus *Culicoides* Latreille

#### Subgenus *Trithecoides* Wirth and Hubert, new subgenus

Type Species: *Culicoides flaviscutatus* Wirth and Hubert, n. sp., by present designation.

Moderately small species, usually with scutum and upper pleura pale yellow contrasting with dark brown scutellum, postscutellum, and lower pleura; some species with anterior part of scutum marked with dark brown or with entire scutum brown. Wing with costa extending regularly to 0.66–0.71 of distance to wing tip; radial cells well developed, especially second radial cell, which is included in a pale spot. Wing markings consisting of 2 anterior pale areas, 1 over r-m crossvein, second over apex of second radial cell; large, distinct, pale areas occasionally present on basal part of wing and across extreme wing tip, other pale areas usually very indistinct, with veins more or less infuscated. Macrotrichia always sparse and limited to tip of wing and along vein  $M_1$ .

Eyes broadly contiguous, bare. Antennal ratio varying from 0.85 to 1.15; antennal segment XII frequently shorter than segment XI; distal sensory tufts present on segments III, XI–XV (in *rariipalpis* Smith lacking on XI). Maxillary palpus usually slender with sensoria scattered on surface of distal portion. Mandibular teeth of several distinctive types, permitting further subdivision into groups of related species: (1) *anophelis* type: 8–15 teeth with proximal ones larger; (2) *flavescens* type: 20–21 teeth in three series of differently shaped teeth; (3) *macfieii* type: 7–9 curved teeth with distal ones larger; and (4) *rariipalpis* type: 11–16 triangular teeth of subequal lengths.

Hind tibial comb with 4 spines (5 in *tenuipalpis*), second from spur longest; tarsal claw of female with simple pointed tip (bifid in *anophelis* Edwards). Three well-developed, sclerotized spermathecae always present, with small sclerotized ring at junction of ducts. Shape of spermathecae of several types, consistent within groups of apparently related species: (1) *anophelis* type: equal or subequal and slightly pyriform with slender necks; (2) *fulvithorax* type: unequal, sausage-shaped, much longer than broad with broad, unsclerotized entrances to ducts; (3 or 4) *rariipalpis* type: very unequal, 1 large and 2 subequal small ones, with broad, unsclerotized entrances to ducts, all spermathecae (3) more or less as broad as long, or (4) slightly longer than broad.

The male genitalia are characterized by definite apicolateral processes on the tergum 9, margin between them often deeply cleft or bilobed; ventral membrane between sternum 9 and aedeagus never spiculate; basistyle with ventral root greatly reduced, dorsal root slender; aedeagus usually with short basal arch, tapering sides and simple, blunt tip; parameres small with short stem swollen at base, tapering to simple, slender tip, without ventral lobe or distal spines.

The species of the subgenus *Trithecoides* can be grouped into the following five groups according to certain important characters:

**A. Anophelis Group.** Proximal mandible teeth enlarged; scutum more or less infuscated. Spermathecae various. Three Oriental species; mosquito parasites.

**B. Flavescens Group.** Mandible with 20–21 teeth, distal tooth more or less enlarged, teeth in middle of series small, subequal and triangular, 3–6 proximal teeth very sharp, smaller and directed distad. Spermathecae subequal and slightly pyriform with slender sclerotized necks. Scutum various. Three Oriental species.

**C. Tenuipalpis Group.** Mandible with 8 teeth, distal ones largest; spermathecae subequal, pyriform with slender sclerotized necks; palpal segment 3 extremely slender, 4.4 times as long as broad; 5 spines in comb of hind tibia; scutum yellow. One Formosan species.

**D. Fulvithorax Group.** Mandible with 9–11 teeth of subequal lengths. Spermathecae sausage-shaped, much longer than broad, with broad unsclerotized entrances to ducts, suggestion of tapering of sclerotized portion toward duct; ducts of all 3 spermathecae joined at one point near the sclerotized ring. Scutum yellowish. Two Ethiopian species.

**E. Macfieii Group.** Mandible with about 7 curved teeth, distal ones largest. Spermathecae unequal, 1 large and 2 subequal small ones, all about as broad as or little broader than long, with broad, unsclerotized entrances to ducts, ducts of all 3 spermathecae joined at point near sclerotized ring. Scutal adornment various. Three Oriental species.

**F. Raripalpis Group.** Mandible with 11–16 small triangular teeth of subequal lengths. Spermathecae unequal, with broad unsclerotized openings to ducts; 1 large and 2 subequal, small, all slightly longer than broad (except in *albipennis* n. sp.), with ducts from 2 small spermathecae joined together before joining duct from large one at sclerotized ring. Great variation in scutal adornment from pale creamy yellow to part or all infuscated, in some species blackish. Eight Oriental species.

Included species are listed in Table 1 with comparison of mean values of certain quantitative characters of taxonomic use. It is possible that *Culicoides albipennis* Smith and Swaminath (1932) belongs in *Trithecoides* because of the shapes of the three spermathecae, which are subequal with large unsclerotized openings to the ducts. However the unmarked, whitish wings with the second radial cell not unusually large, the swollen third palpal segment with a definite pit, the silvery-gray scutum with dark punctures at the bases of the hairs, yellowish-brown scutellum and uniformly pale brown legs with dark brown knee spots are not typical of *Trithecoides*. The male genitalia of *albipennis* figured by Smith and Swaminath are close to *Trithecoides*, but the arch of the aedeagus is higher and basal arms more slender, the parameres have the stem longer and more slender and less bent near the basal knob, and the ninth tergum lacks a mesal cleft or submedian lobes, thus differing from the other species assigned to this subgenus.

The species with most remarkable habits are *anophelis* Edwards, *culiciphagus* n. sp., and *baisasi* n. sp., which take second-hand blood meals from the abdomens of engorged mosquitoes. Edwards (1922) and Laird (1946) give good summaries of locality records and the hosts involved. Most records of *anophelis* attacking vertebrate hosts directly are apparently based on misidentifications. We have ascertained this from actual examination of specimens from which some of these records were taken. However, we have seen two specimens from Segambut, Malaya, labelled "biting cow" and two labelled "biting human" which are definitely *anophelis*. Other records of feeding on vertebrate hosts are available for the following species: On man—*barnetti* n. sp., *elbeli* n. sp., *flavescens* Macfie, *flaviscutatus* n. sp., *gewertzi* Causey, *humeralis* Okada, *macfieii* Causey, *matsuzawai* Tokunaga, *raripalpis* Smith

and *sarawakensis* n. sp. On cattle—*flavescens* Edwards and *macfieii* Causey. On deer—*barnetti* n. sp. and *flaviscutatus* n. sp.

Johannsen (1931) and Mayer (1934) report that a species of this group (which Johannsen determined as *anophelis*) was bred from water in the leaf axils of *Colocasia indica* in Java. Hopkins (1952) reported that *fulvithorax* (Austen) was reared from stems of banana and plantain in West Africa which were just beginning to rot before the stems fell over. DasGupta and Ghosh (1956) also reared *palpifer* DasGupta and Ghosh from the bases of rotting banana plants in India.

**Table 1.** Systematic Arrangement of Species of the Subgenus *Trithecoides*, with Mean Values of certain quantitative Characters.

Species	Wing Length (mm.)	Antennal Ratio	Palpal Ratio	Number of Mandibular Teeth	Spermatheca Mandible Type (see Discussion)
(A) Anophelis Group					
1. <i>anophelis</i> Edwards	1.01	1.00	2.1	15	A-1
2. <i>culiciphagus</i> n. sp.	0.97	0.99	2.3	8	D-1
3. <i>baisasi</i> n. sp.	0.94	—	2.3	—	D-1
(B) Flavescens Group					
4. <i>flavescens</i> Macfie	1.03	1.10	2.8	21	A-2
5. <i>subflavescens</i> n. sp.	1.01	1.11	2.8	20	A-2
6. <i>paraflavescens</i> n. sp.	1.13	1.12	3.0	20	A-2
(C) Tenuipalpis Group					
7. <i>tenuipalpis</i> n. sp.	1.53	1.09	4.4	8	A-3
(D) Fulvithorax Group					
8. <i>fulvithorax</i> (Austen)	0.99	0.97	2.2	11	B-4
9. <i>ochrothorax</i> Carter	1.03	0.93	2.1	9	B-3
(E) Macfieii Group					
10. <i>macfieii</i> Causey	0.99	1.15	2.0	7	C-3
11. <i>humeralis</i> Okada	1.17	1.04	2.2	7	C-3
12. <i>palpifer</i> D. & G.	0.92	1.01	2.1	7	C-3
(F) Raripalpis Group					
13. <i>elbeli</i> n. sp.	0.84	0.89	2.4	12	D-4
14. <i>sarawakensis</i> n. sp.	0.81	1.05	2.7	13	D-4
15. <i>raripalpis</i> Smith	0.77	1.15	2.1	11	D-4
16. <i>gewertzi</i> Causey	0.88	1.01	2.6	16	D-4
17. <i>albibasis</i> n. sp.	0.89	1.03	2.2	11	C-4
18. <i>barnetti</i> n. sp.	0.92	0.88	2.4	12	D-4
19. <i>matsuzawai</i> Tokunaga	1.01	0.85	2.5	11	D-4
20. <i>flaviscutatus</i> n. sp.	0.85	0.93	2.5	12	D-4

In this paper, measurements are of single specimens or of series with values given as "mean (minimum value—maximum value,  $n$  = number of measurements)." Wing length is measured from the basal arculus to the wing tip. Proportions given for antennal and palpal segments refer to relative lengths of segments; the antennal ratio is determined by dividing the combined length of the last five by that of the preceding eight, and the palpal ratio is the length of the third segment divided by the greatest breadth. Length of the spermathecae is obtained by measuring from the tip of the sclerotized portion of the neck (or from the opening of the duct when no neck is present) to the apex of the spermatheca. All descriptions are based upon slide-mounted material.

The types of our new species are deposited in the U.S. National Museum in Washington. Paratypes, when available, will be deposited in the British Museum (Natural History) in London, the Indian Museum in Calcutta, the Department of Health in Manila, the Bishop Museum in Honolulu and the School of Public Health of the University of Sydney, Australia. Specimens which were borrowed from the British Museum are marked "BMNH" in the lists of specimens examined. The first country listed under distribution and set off from the following ones by a semicolon is the type locality.

We have been fortunate in being able to study the types of the Causey collection in the U.S. National Museum, Washington, D.C. We have seen paratypes of Tokunaga's species (through kindness of P. H. Arnaud) and of the species described by DasGupta and Ghosh which are deposited in the U.S. National Museum. Wirth studied Macfie's and Edwards' types in the British Museum in 1957. According to correspondence from Dr. P. Sen, types of Smith's Assam species were not preserved.

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#### KEYS TO THE SPECIES OF THE SUBGENUS TRITHECOIDES

##### Females

1. Scutum entirely dark brown, or yellow with dark brown areas on anterior margin ..... 2
- Scutum uniformly yellow ..... 10

- 2 (1). Scutum entirely dark brown..... 3  
 Scutum yellow with dark brown areas on anterior margin..... 7
- 3 (2). Mandible with 6-8 curved teeth, distal ones largest..... 4  
 Mandible with 10-15 small, subequal, triangular teeth; spermathecae unequal with large unsclerotized entrances to ducts; large spermatheca longer than wide, ducts of 2 small spermathecae joined before duct of large one; wing dark at apex (faintly pale in *elbeli*)..... 5
- 4 (3). Spermathecae unequal, with large unsclerotized entrances to ducts; third palpal segment 2.0 times as long as broad; large spermatheca about as wide as long, ducts of all 3 spermathecae joined at one point; wing pale at apex; halter dark; small species, wing 1.0 mm long..... 10. **macfiei**  
 Spermathecae subequal, pyriform, with slender sclerotized necks; palpal segment 3 very slender, 4.4 times as long as broad; large species, wing 1.5 mm long..... 7. **tenuipalpis**
- 5 (3). Halter pale; fore femur with distinct subapical pale band; pale spot over second radial cell fairly large; antennal ratio 0.86-0.94; palpal ratio 2.4; 11-12 mandibular teeth ..... 13. **elbeli**  
 Halter dark; fore femur dark distally or with rather indistinct pale band..... 6
- 6 (5). Fore femur dark distally; antennal ratio 1.02-1.09, sensoria present on segments III, XI-XV; 12-15 mandibular teeth; palpal ratio 2.5-3.0; pale spot over second radial cell small and contrasting poorly ..... 14. **sarawakensis**  
 Fore femur with indistinct subapical pale band; antennal ratio 1.11-1.19; sensoria present on segments III, XII-XV only; 11-12 mandibular teeth; palpal ratio 2.1-2.2; pale spot over second radial cell small but contrasting..... 15. **raripalpis**
- 7 (2). Mandible with 7 teeth, distal ones largest; halter knob pale; hind femur dark, unbanded; spermathecae unequal, not pyriform ..... 11. **humeralis**  
 Mandible with 12-23 teeth..... 8
- 8 (7). Mandible with 19-23 teeth, apical tooth very large and widely spaced, middle teeth triangular, 4-5 proximal teeth very short, spine-like and directed distad; halter pale; spermathecae subequal and pyriform with sclerotized necks.....  
 ..... 6. **paraflavescens**  
 Mandible with 12-15 teeth; halter knob dark..... 9
- 9 (8). Mandible with proximal teeth largest; spermathecae subequal, pyriform with short sclerotized necks; palpus very short and stout; female claws bifid at tip; hind femur with broad, sometimes indistinct, subapical pale band (parasitic on mosquitoes)..... 1. **anophelis**  
 Mandible with even, fine teeth; spermathecae very unequal with large, unsclerotized entrances to ducts; palpus slender; claws of female not bifid; hind femur dark..... 16. **gewertzi**
- 10 (1). Mandible with 8 large curving teeth, proximal ones slightly larger (parasitic on mosquitoes)..... 11  
 Mandible with teeth small and uniform in size or distal ones larger..... 12

- 11 (10). Femora banded; wing with pale spot covering second radial cell nearly to its base ..... **3. baisasi**  
 Femora unbanded; wing with pale spot covering about 1/2 of second radial cell ..... **2. culiciphagus**
- 12 (10). Mandible with 21–24 teeth; spermathecae subequal and pyriform with short sclerotized necks and small openings to ducts; hind femur with broad, pale band, apex narrowly infuscated; wing pale-streaked, apex not pale; scutellum pale..... 13  
 Mandible with 7–12 teeth; spermathecae unequal, openings to ducts large..... 14
- 13 (12). Apical mandibular tooth very large and widely spaced, middle teeth triangular, 5–6 proximal teeth very short, spine-like and directed distad; hind femur scarcely darkened on proximal half ..... **4. flavescens**  
 Apical mandibular tooth scarcely larger than middle series, only 2–3 very small spinelike teeth in proximal series; hind femur distinctly infuscated on proximal half..... **5. subflavescens**
- 14 (12). Spermathecae sausage-shaped, all 3 much longer than largest diameter; Ethiopian species ..... 15  
 Spermathecae round or oval, only larger one sometimes elongate; Oriental species ..... 16
- 15 (14). Mandible with 10–12 small, subequal, triangular teeth..... **8. fulvithorax**  
 Mandible with 9–10 curved teeth, distal ones largest; halter knob pale.....  
 ..... **9. ochrothorax**
- 16 (14). Mandible with 7 curved teeth, distal ones largest; hind femur dark, sometimes with narrow pale subapical band..... **12. palpifer**  
 Mandible with 10–12 small, subequal, triangular teeth..... 17
- 17 (16). Hind femur with distal pale band ..... 18  
 Hind femur dark..... 19
- 18 (17). Hind femur with pale band to knee; halter dark; wing largely pale on proximal half, apex not pale..... **17. albibasis**  
 Hind femur with subapical pale band; halter pale; wing largely dark on proximal half, apex distinctly and broadly pale..... **18. barnetti**
- 19 (17). Wing tip broadly and distinctly pale, pale area extending more than 1/3 distance from vein  $M_1$  to vein  $R_5$ ..... **19. matsuzawai**  
 Wing tip narrowly and sometimes faintly pale, pale area extending less than 1/3 distance from vein  $M_1$  to vein  $R_5$  ..... **20. flaviscutatus**

#### Males

1. Tergum 9 with pair of submedian lobes on caudal margin between apicolateral processes..... 2  
 Tergum 9 without or with very inconspicuous submedian lobes, aedeagus with truncate tip ..... 11
- 2 (1). Tergum 9 with submedian lobes nearly as long as apicolateral processes..... 3  
 Submedian lobes less than 1/2 as long as apicolateral processes ..... 7

- 3 (2). Tergum 9 with submedian lobes broadly rounded, apicolateral processes extremely short..... 16. **gewertzi**  
Tergum 9 with submedian lobes at least slightly angular on outer side..... 4
- 4 (3). Tergum 9 with apices of submedian lobes much closer to apices of apicolateral processes than to each other..... 5  
Tergum 9 with apices of submedian lobes as close to each other as to apices of apicolateral processes..... 6
- 5 (4). Parameres with distal part of stem tapering to laterally-directed sharp tip, scutum yellow..... 20. **flaviscutatus**  
Parameres with slender distal part of stem elongate, directed laterad and then bent back on itself, scutum dark brown..... 13. **eibeli**
- 6 (4). Tergum 9 narrow distally, about 1/2 as broad across apicolateral processes as at base; scutum uniformly yellow..... 18. **barnetti**  
Tergum 9 broad distally, 2/3 to 3/4 as broad across apicolateral processes as at base; scutum yellow with dark brown area on anterior margin... 6. **parafflavescens**
- 7 (2). Tergum 9 with submedian lobes long and pointed, apicolateral processes over 1/2 as long as distance between their bases..... 8. **fulvithorax**  
Tergum 9 with submedian lobes shorter, rounded on inner side, apicolateral processes less than 1/2 as long as distance between their bases..... 8
- 8 (7). Aedeagus with slender, rounded tip..... 9  
Aedeagus with broader, truncate tip..... 10
- 9 (8). Scutum yellow with dark brown area on anterior margin..... 1. **anophelis**  
Scutum uniformly yellow..... 5. **subflavescens**
- 10 (8). Scutum yellow, basal 1/2 of wing much paler than apical 1/2..... 17. **albibasis**  
Scutum dark brown, basal 1/2 of wing not paler than apical 1/2 ..... 15. **raripalpis**
- 11 (1). Scutum dark brown..... 10. **macfie**  
Scutum yellow..... 12
- 12 (11). Scutum with dark brown spot on humeral angle..... 11. **humeralis**  
Scutum entirely yellow..... 12. **palpifer**

#### A. *Anophelis* Group.

##### 1. *Culicoides* (*Trithecoides*) *anophelis* Edwards. Figs. 1, 21.

*Culicoides anophelis* Edwards, 1922, Bull. Ent. Res. 13: 161 (female; Malaya, Sumatra, India; ex *Anopheles* mosquitoes; fig. wing, abdomen, parasitized mosquito).—Johannsen, 1931, Arch. f. Hydrobiol. Suppl. Bd. 9: 428 (Java, reared from leaf axils of *Colocasia indica*) [description indicates this is a species with scutum entirely yellow].—Macfie, 1932 [partim], Ann. Mag. Nat. Hist. ser. 10, 9: 493 (Tonkin; ex *Anopheles*) [India and Malaya records are of *flaviscutatus* n. sp.].—Macfie, 1934, Tijdschr. Ent. 77: 214 (Sumatra).—Smith and Swaminath, 1932 [partim], Ind. Med. Res. Mem. 25: 183 (Assam; notes, ex *Anopheles* and *Phlebotomus*, also on cattle [sic]).—Mayer, 1934, Arch. f. Hydrobiol. Suppl. Bd. 13: 187 (Java; larva, fig. mandible, labium).—Macfie, 1937, Roy. Ent. Soc. London, Proc. (B) 6: 114 (descr. notes on cotypes).—Causey, 1938, Amer. Jour.

Hyg. 27 : 409 (female; Siam; descr. notes, fig. spermathecae [in part, some were *flavescens* Macfie]).—Okada, 1942, Nat. Hist. Soc. Formosa, Trans. 32 : 140 (Formosa; female; fig. habitus, palpus, spermathecae, antenna; ex *Anopheles* host).—Laird, 1946, Roy. Soc. New Zealand, Trans. 76 : 158 (records mosquito hosts; fig. female on host; New Britain, new record, bibliography).—Arnaud, 1956, Microent. 21 : 91 (Formosa; female, fig. details).—Amosova, 1957, Ent. Obozr. 36 : 273 (compared *raripalpis*).

*Female.* Length of wing 1.01 (0.93–1.09,  $n = 13$ ) mm.

Head: Antenna with lengths of flagellar segments in proportion of 21–15–15–16–17–17–18–19–24–22–26–30–43, antennal ratio 1.00 (0.91–1.10,  $n = 8$ ); distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 1a) with lengths in proportion of 10–17–22–10–11, segments 2 and 3 short and very stout, third segment  $2.1 \times (1.6–2.3, n = 13)$  as long as greatest breadth, with sensoria scattered on surface of apical half of segment. Mandible (fig. 1c) with 15 (12–19,  $n = 26$ ) curved teeth, proximal ones largest.

Thorax: Scutum yellowish brown, dark brown on anterior 1/4; scutellum, postscutellum and part of pleuron near coxal bases dark brown. Legs pale brown; fore and mid legs with knees pale, and broad apical band on femora and basal band on tibiae pale; hind leg with knee dark, broad, sometimes indistinct, subapical pale band on femur, and tibia with base and apex broadly pale; tarsal claws (fig. 1f) divided at tip on all legs.

Wing (fig. 21): Pattern as figured; generally with dark streaks along veins and moderately pale areas in cells; 2 large very pale yellow spots, one centering on r-m cross-vein and other on apex of second radial cell, apex of wing narrowly pale. Costa extending to 0.69 (0.67–0.71,  $n = 13$ ) of distance to wing tip. Halter infuscated.

Abdomen: Dark brown, terga poorly sclerotized. Three spermathecae (fig. 16), all very slightly unequal, measuring 0.039 by 0.033, 0.040 by 0.033, and 0.038 by 0.031 mm., subspherical to slightly pyriform, entrances to ducts very narrow and sclerotized a short distance.

*Male genitalia* (figs. 1d, e). Sternum 9 with very slightly perceptible caudomedian excavation; tergum 9 tapering to broad apex, apicolateral processes large, broad at base, tapering to slender tips, distomedian margin of tergum between them with small submedian lobes and distinct median notch. Basistyle with ventral root very small, dorsal root slender; dististyle curving, swollen on basal half, tapering distally to slender point. Aedeagus with basal arms stout, basal arch extending to 0.4 of total length, distal portion slender with rounded tip. Parameres each with large basal knob, basal portion bent laterally, stem very stout on short basal portion, tapering rapidly to very slender, laterally curved, simple point.

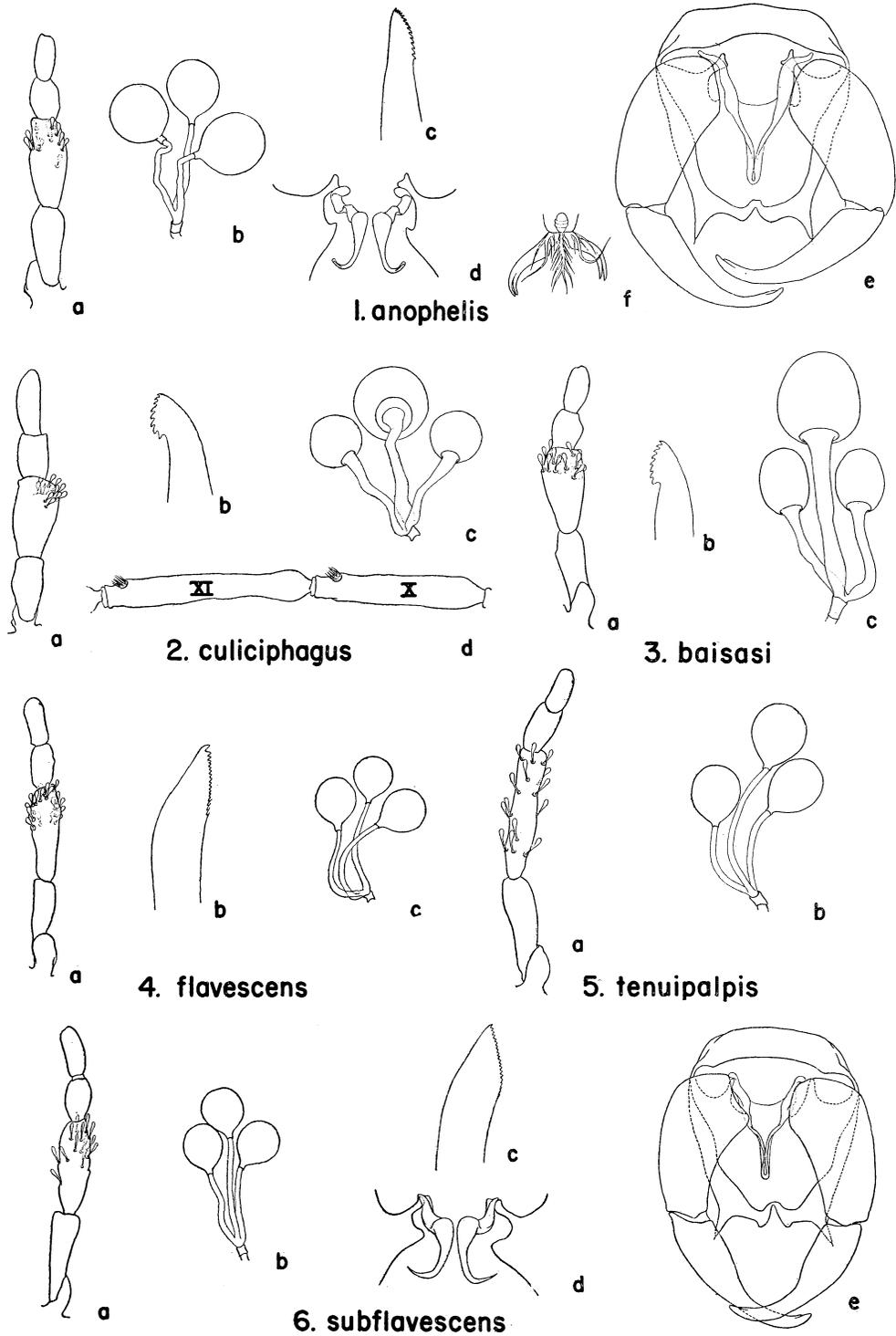
**DISTRIBUTION:** Malaya, India, Sumatra; Burma, Ceylon, Hong Kong, Indochina, Taiwan, Thailand.

**BURMA:** 9 females, Leben, Ywathit, Pyiban, Okset near Mandalay, Nyaung Bin Tha, Sule Gone, Yewon, Oct.–Nov. 1957, W. Büttiker and P. F. Beales, on *Anopheles vagus* and *subpictus*.

**CEYLON:** Female, Peradeniya, Nov. 1913, A. Rutherford, on *Anopheles maculatus*; male, 49 females, Colombo, 19 Feb. 1958, Med. Res. Inst., light trap.

**HONG KONG:** 5 females, Shomson Hill, 31 Mar. 1932, R. B. Jackson, attached to *Anopheles minimus* (BMNH).

**INDIA:** Female, Doom Doom, Assam, 4 Nov. 1943, D. E. Hardy, on *Anopheles vagus*;



**Figs. 1-6.** *Culicoides* species. Fig. 1, *anophelis*: a, palpus; b, spermathecae and ducts; c, mandibular teeth; f, tarsal claws of female; d, parameres; e, genitalia of male, parameres removed. 2. *culiciphagus* female: a, palpus; b, mandible; c, spermathecae; d, antennal

2 males, 3 females, Dum Dum, W. Bengal, 1957, P. Sen; female, Golagat, Assam, 15 Jan. 1925, P. J. Barraud, attached to abdomen of *Culex vishnui* caught in stable (BMNH).

MALAYA: 9 females, Kuala Lumpur, Apr.-Aug. 1920, W. A. Lamborn, on *Anopheles karwari*, *A. rossi*, *A. umbrosus*, *A. fuliginosus*, *A. sinensis* (BMNH); 5 females, Kuala Lumpur, Mar.-Apr. 1916, A. T. Stanton, on *Anopheles karwari*, *A. fuliginosus* (BMNH); female, Kuala Lumpur, Mar. 1958, R. Traub, light trap; 6 females, Segambut, Selangor, Mar., Apr. 1955, H. C. Barnett, on *Culex tritaeniorhynchus*; 2 females, Segambut, 28 Feb. 1955, biting cow, and 2 females, 5 Mar. 1955, biting human, collected by H. C. Barnett.

TAIWAN: 21 females, Taipei, Oct. 1951, light trap, H. C. Barnett.

THAILAND: 2 females, 1933, O. R. Causey.

This species resembles *culiciphagus* n. sp. and *baisasi* n. sp. the only other known mosquito parasites, in having large mandibular teeth proximal in the series. It differs, however, in having subequal spermathecae with slender sclerotized necks similar to those of *flavescens* Edwards and *subflavescens* n. sp., species which are also similar to *anophelis* in color characters, but which have entirely different mandibular teeth of a unique type. The bifid tarsal claws of *anophelis* are unique in the group, and are present on all legs and in both sexes. Arnaud (1956) gives this character, but only for the hind legs. Some *anophelis* specimens from Ceylon have wings with much smaller pale costal spots than the other material examined, but they are the same in all other respects including structural characters. This species is evidently replaced in the Philippines and the Solomon Islands, respectively, by the closely related mosquito parasites, *baisasi* and *culiciphagus*.

There is an earlier name which may possibly be found to invalidate the use of *anophelis*. According to Macfie (1932), "The species for which Lalor (1912) proposed the name *Ceratopogon ferox* is presumably the same as *C. anophelis* Edw., although the figures in which the wings are shown suggest that more than one species was under consideration. Lalor's name, however, is not valid, because it was published, together with the account and figures of the insect, in a Government report ('Investigation of Malaria at Kyaukpyu,' pp. 15-17, Govt. Printing Office, Rangoon, July 1912) specifically stated to be ('Not for sale'), and subsequent references to it have been without descriptions." Because the inclusion of the words "Not for Sale" would not be grounds for considering Lalor's report not validly published under the rules of nomenclature, contrary to Macfie's opinion, we regard the name *ferox* Lalor to be validly proposed. We believe it will be best to leave *ferox* Lalor as a "species dubium" of *Culicoides* related to *anophelis* Edwards, with its exact position depending on study of Lalor's type material if it still exists or on a closer study for diagnostic characters from his figures and description.

## 2. *Culicoides* (Trithecoides) *culiciphagus* Wirth and Hubert, n. sp. Figs. 2, 22.

*Female*. Length of wing 0.98 (0.95-1.0,  $n = 3$ ) mm.

Head: Antenna (fig. 2d) with flagellar segments in proportion of 28-26-27-27-29-27-27-27-39-36-43-41-56, antennal ratio 0.99; distal sensory tufts present on segment III, XI-XV. Palpal segments (fig. 2a) in proportion of 8-12-21-10-13, segment 3 distinctly

segments X and XI. 3. *baisasi* female: a, palpus; b, mandible; c, spermathecae. 4. *flavescens* female: a, palpus; b, mandible; c, spermathecae. 5. *tenuipalpis* female: a, palpus; b, spermathecae. 6. *subflavescens*: a, palpus; b, spermathecae; c, mandible of female; d, parameres; e, genitalia of male, parameres removed.

swollen distally,  $2.3 \times$  as long as greatest breadth, with sensillae clustered on surface distally. Mandible (fig. 2b) slender with apex bent abruptly, bearing 8 ( $n = 6$ ) large recurved teeth, basal ones somewhat larger, all somewhat hatchet-shaped.

Thorax: Rather uniformly tawny yellowish brown, scutellum and postscutellum unicolorous with scutum and pleura. Legs yellowish brown, without distinct pale or dark bands; tarsal claws simple, not apically bifid.

Wing (fig. 22): Pattern as figured; markings indistinct, 2 areas on anterior margin slightly darker; 2 distinct pale spots, over r-m crossvein and over distal 1/3 of second radial cell. Costa extending to 0.70 (0.70-0.71,  $n = 3$ ) of distance to wing tip. Halter infuscated.

Abdomen: Pale brown, terga poorly sclerotized,  $2 \times$  as broad as long on segment 3. Three spermathecae (fig. 2c), 1 large and 2 small, each longer than broad, without sclerotized necks, openings to ducts large; large spermatheca with few transverse wrinkles. (Spermathecae collapsed and not measured in available slides).

*Male.* Unknown.

DISTRIBUTION: Solomon Islands.

Holotype, female, 3 female paratypes, Guadalcanal, Solomon Islands, 1944, J. N. Belkin, from *Anopheles lungae* Belkin and Schlosser (type no. 64307, USNM).

This species is closely related to *anophelis* Edwards, as evidenced by its parasitic habit on mosquitoes, the larger proximal teeth on the mandible, its rather uniformly pale tawny brown color, and poorly marked wings. It is much more closely related to *baisasi* n. sp. from the Philippines, described below, from which it can be distinguished by the characters given in the description of that species. The *raripalpis*-like spermathecae, the very long antennae, the short and distally swollen third palpal segment, and the peculiar shape of the mandible place *culiciphagus* and *baisasi* in a unique and intermediate position in the subgenus between *anophelis* and the *Raripalpis* Group of species.

### 3. *Culicoides* (*Trithecoides*) *baisasi* Wirth and Hubert, n. sp. Figs. 3, 23.

*Female.* Length of wing 0.95 (0.90-1.02,  $n = 7$ ) mm.

Head: Antenna with flagellar segments in proportion of 20-19-20-20-22-20-20-26-24-30-33-46, antennal ratio 0.98 (0.94-1.00,  $n = 5$ ); distal sensory tufts present on segments III, XI-XV. Palpal segments (fig. 3a) in proportion of 9-16-20-9-11, segment 3 short and stout,  $2.1 \times$  (1.9-2.3,  $n = 6$ ) as long as greatest breadth, with sensoria grouped together on apical 1/3 of segment. Mandible (fig. 3b) slender with apex bent abruptly, bearing 8 ( $n = 11$ ) large recurved teeth, basal ones somewhat larger, all somewhat hatchet-shaped.

Thorax: Scutum, scutellum and upper 1/2 of pleuron yellow; postscutellum and lower part of pleuron slightly darkened. Legs dark with distinct pale bands; fore leg with knee spot dark, narrow subapical band on femur and sub-basal band on tibia pale; mid leg with knee, distal 1/3 of femur and basal 1/4 of tibia pale; hind leg with knee spot dark, subapical band on femur and all of tibia pale; claws simple.

Wing (fig. 23): As figured; pale markings extensive; 2 small dark areas on costal margin, one over vein  $R_1$ , second past end of second radial cell; large pale area over r-m crossvein, pale area covering second radial cell nearly to its base, wing narrowly pale at apex. Costa extending to 0.69 (0.69-0.71,  $n = 7$ ) of distance to wing tip. Halter pale.

Abdomen: Pale brown, terga poorly sclerotized,  $2\times$  as broad as long on segment 3. Three spermathecae (fig. 3c), large 1 measuring 0.041 by 0.038 mm. and 2 small ones measuring 0.028 by 0.022 mm., without sclerotized necks, openings to ducts large; large spermatheca transversely rugulose.

*Male.* Unknown.

DISTRIBUTION: Philippine Islands; Malaya.

Holotype, female, Taft, Samar, Philippine Islands, 26 Nov. 1955, I. Balatbat, from carabao-baited trap (Type no. 64308, USNM). Paratypes, 28 females, all but one taken from carabao-baited traps from the Philippine Islands: Luzon I.: female, Juban, Sorsogon Pr., 7 March 1958, M. Delfinado, on *Aedes poecilus* (Theobald); female, Tala, Rizal Pr., 24 Jan. 1956, J. G. Santos; female, San Pablo, Laguna Pr., 19 Dec. 1955, G. Balgita; Samar I.: 5 females, Taft, Samar Pr., 16 Jan., 3 May, 15, 26 Nov. 1956, I. Balatbat. Mindanao I.: 15 females, Kidapawan, Cotabato Pr., June, Aug., 1956, F. Kalaw, some on *Anopheles vagus limosus* King; female, Cotabato, 11 Nov. 1955, A. Gonzales; 2 females, Tagum, Davao Pr., 30 May 1956, B. Fontanilla; female, Zamboanga, Zamboanga Pr., 19 Nov. 1955, D. Casimiro. Malaya: female, Kuala Singgora, Pahang, 17 July 1958, light trap. R. H. Wharton.

The mandible, spermathecae, and palpus relate this species to *culiciphagus*, from which it can be distinguished by the larger pale wing markings, the presence of distinct leg bands, and the pale halteres.

This species is dedicated to Dr. F. E. Baisas, of the Institute of Malariology, Tala, Philippines, in recognition of his leadership in Philippine medical entomology.

#### B. Flavescens Group.

#### 4. *Culicoides* (*Trithecoides*) *flavescens* Macfie, NEW STATUS. Figs. 4, 24.

*Culicoides anophelis* Edwards, var. *flavescens* Macfie, 1937, Roy. Ent. Soc. London, Proc. (B) 6: 114 (female; Malaya, on cattle).

*Culicoides anophelis* (misident., not Edwards), Causey, 1938, Amer. Jour. Hyg. 27: 409 (female; Siam; *partim*).

*Female.* Length of wing 1.03 (0.97–1.07,  $n=8$ ) mm.

Head: Antenna with flagellar segments in proportion of 22–19–20–21–21–21–19–19–26–27–32–35–55, antennal ratio 1.10 (1.08–1.13,  $n=8$ ); distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 4a) in proportion of 10–18–25–11–13, segment 3 very slender,  $2.8\times$  (2.5–3.1,  $n=7$ ) as long as greatest breadth, with sensoria scattered on surface. Mandible (fig. 4b) with 21 (18–24,  $n=13$ ) teeth, apical tooth distinctly larger and separated from second, distal teeth of series larger, teeth in middle of series small and even, triangular, 5–6 proximal teeth in series very sharp and directed distad.

Thorax: Scutum pale yellow, scutellum pale brown, postscutellum darker brown, pleuron yellow above, dark brown on lower 1/2. Legs pale brown; fore and mid legs with knees, distal 1/2 of femora and basal 1/2 of tibiae pale yellow; hind femur brown with broad subapical pale band, knee dark, hind tibia entirely pale; claws simple.

Wing (fig. 24): As figured; pale areas extensive, brown infuscation prominent along veins; 2 small dark brown areas on costal margin, 1 over vein  $R_1$ , second just past end of second radial cell; pale areas over r–m crossvein and second radial cell very large,

latter spot covering second radial cell nearly to base and scarcely extending past apex of cell into cell  $R_5$ ; apex of wing usually dark, indistinctly pale in the palest specimens. Costa extending to 0.71 (0.69–0.72,  $n = 8$ ) of distance to wing tip. Halter pale.

Abdomen: Yellow, terga unsclerotized except on segment 8 which is brown. Three spermathecae (fig. 4c) subequal, each measuring 0.033 by 0.026 mm., slightly pyriform, entrances to ducts very slender and sclerotized a short distance.

*Male.* Unknown.

DISTRIBUTION. Malaya; North Borneo, Philippines, Sarawak, Thailand.

MALAYA: Female, Kuala Lumpur, 1936, J. Buckley, on cattle (cotype of *flavescens*) (BMNH); 2 females, same, but 11 July 1937 [det. *anophelis* by Macfie, *sic*] (BMNH); female, same, but 13 March 1955, H. C. Barnett, light trap; female, same but March 1958, R. Traub, light trap; 2 females, Serdang, Selangor, 13, 15 Feb. 1955, H. C. Barnett, light trap; female, Segambut, Selangor, 1 Feb. 1955, H. C. Barnett, biting human; female, Telok Pelandok, Port Dickson, Negri Sembilan, 18 July 1958, R. Traub, light trap; female, Telok Sisek, Kuantan, Pahang, 14 June 1958, R. H. Wharton, light trap; 7 females, Dungun, Bukit Besi, Trengganu, 6 Aug. 1958, R. Traub, light trap.

NORTH BORNEO: 3 females, Labuan Island, Sept.–Oct. 1948, Dec. 1951, D. H. Colless, at light; 2 females, Tambunan, Nov. 1950, D. H. Colless, at light.

PHILIPPINES: female, Taft, Samar, 6 Jan. 1956, I. Balatbat.

SARAWAK: 4 females, Limbang, Dec. 1950, D. H. Colless, at light.

THAILAND: 7 females, Bangkok and Chiengrai, 1931–1935, O. R. Causey.

This species was first confused with *anophelis* Edwards and was the basis for some erroneous records of *anophelis* biting vertebrates. Macfie recognized it as different in 1937, but called it a variety of *anophelis*. However, *flavescens* is quite different and is readily recognized by its distinctive mandibular teeth, simple tarsal claws, and entirely yellow scutum.

##### 5. *Culicoides (Trithecoides) subflavescens* Wirth and Hubert, n. sp. Fig. 6.

*Female.* Length of wing 1.01 (0.97–1.07,  $n = 8$ ) mm.

Head: Antenna with flagellar segments in proportion of 22–20–21–22–22–22–20–21–30–31–35–37–56, antennal ratio 1.11 (1.07–1.16,  $n = 9$ ); distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 6a) in proportion of 12–19–23–10–12, segment 3 slender,  $2.8 \times$  (2.7–3.1,  $n = 10$ ) as long as greatest breadth, with sensoria scattered on surface. Mandible (fig. 6c) with 20 (18–22,  $n = 16$ ) teeth, distal teeth almost imperceptibly enlarged, teeth in middle of series triangular, 3–4 proximal teeth in series very short and sharp and directed distad.

Thorax: Scutum pale yellow, scutellum yellow to somewhat brown, postscutellum darker brown, pleuron yellow above, dark brown on lower 1/2. Legs pale brown; fore and mid legs with knees, distal 1/2 of femur and basal 1/2 of tibia pale yellow; hind femur brown with broad subapical pale band, hind tibia entirely pale; claws simple.

Wing: Similar to that of *flavescens*; pale areas extensive, brown infuscation along veins; 2 small dark brown areas on costal margin, one over vein  $R_1$ , second just past end of second radial cell; pale areas over r–m crossvein and second radial cell very large, latter spot covering second radial cell nearly to base and scarcely extending past apex of

cell into cell  $R_5$ ; apex of wing not pale. Costa extending to 0.71 (0.70–0.73,  $n=8$ ) of distance to wing tip. Halter pale.

Abdomen: Yellow, terga unsclerotized. Three spermathecae (fig. 6b), subequal, each measuring 0.031 by 0.025 mm., subspherical to slightly pyriform, entrances to ducts very slender and sclerotized a short distance.

*Male genitalia* (figs. 6d, e). Sternum 9 with very shallow caudomedian excavation; tergum 9 long, not greatly tapering, apicolateral processes moderately long and very slender and pointed, slightly divergent. Basistyle with ventral root very small, dorsal root long and slender; dististyle slightly curving, slender, apex slender and pointed. Aedeagus with basal arms slender, not greatly divergent, basal arch to 2/7 of total length, mid portion abruptly narrowed, distal point very slender and rounded apically. Parameres each with small basal knob, basal portion abruptly bent laterad, stem short and moderately swollen at extreme base, tapering gradually to slender, simple point curving ventrolaterad distally.

DISTRIBUTION: North Borneo.

Holotype, female, allotype, male, Labuan Island, North Borneo, Jan. 1949, D. H. Colless at light (type no. 64309, USNM). Paratypes, 3 males, 28 females, same data as type, but dates Sept.–Oct. 1948 to Apr. 1952.

This species is very close to *flavescens* Macfie, but is distinguished by the basal part of the hind femur being darker and by the apical mandibular tooth being less enlarged and not set off from the others. It is known only from North Borneo, where it was taken in the same light collections with the more widespread *flavescens*. The value of the mandibular character, together with the absence of *subflavescens* collections from other parts of the range of *flavescens* lead us to believe it is a distinct species and not a variety.

#### 6. *Culicoides* (*Trithecoidea*) *paraflavescens* Wirth and Hubert, n. sp. Figs. 7, 25.

*Female*. Length of wing 1.13 (1.07–1.16,  $n=10$ ) mm.

Head: Antenna with flagellar segments in proportion of 21–19–20–21–22–22–21–22–30–29–38–39–56, antennal ratio 1.12 (1.09–1.20,  $n=9$ ); distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 7a) in proportion of 11–18–26–12–16, segment 3 slender,  $3.0 \times$  (2.9–3.5,  $n=10$ ) as long as greatest breadth, with sensoria scattered on surface of apical half. Mandible (fig. 7c) with 20 (19–23,  $n=12$ ) teeth, apical tooth distinctly larger and separated from second, distal teeth of series large, decreasing in size to smaller, even, triangular teeth, 4–5 proximal teeth in series very sharp and directed distad.

Thorax: Scutum pale yellow, dark brown on anterior 1/4; scutellum and postscutellum dark brown, pleuron yellow above, dark brown on lower 1/2. Legs pale brown; fore and mid legs with knees, distal 1/2 of femur and basal 1/2 of tibia pale yellow; hind femur brown with broad subapical pale band, knee dark, hind tibia entirely pale; claws simple.

Wing (fig. 25): As figured; pale areas not as extensive as in *flavescens* and *subflavescens*; 2 dark brown areas on costal margin, one small area over vein  $R_1$ , second larger area just past end of second radial cell, cell  $R_5$  posterior to the latter distinctly infuscated across to vein  $M_1$ ; veins  $M_1$  and  $M_2$  infuscated along entire length to wing tip; pale areas over r–m crossvein and second radial cell moderately large, former spot covering about 1/2 of first radial cell and latter covering second radial cell nearly to base; apex of wing pale

at apices of cells  $R_5$  and  $M_1$ . Costa extending to 0.70 (0.69–0.72,  $n = 10$ ) of distance to wing tip. Halter pale.

Abdomen: Pale brown, terga poorly sclerotized,  $2 \times$  as broad as long on segment 3. Three spermathecae (fig. 7b), subequal, each measuring 0.035 by 0.026 mm., slightly pyriform, entrances to ducts very slender and sclerotized a short distance.

*Male genitalia* (figs. 7d, e). Sternum 9 with shallow caudomedian excavation; tergum 9 with apicolateral processes short and slender, caudomedian margin between them convex with pair of mesally-rounded submedian lobes nearly as long as apicolateral processes. Basistyle with ventral root imperceptible, dorsal root slender; dististyle curving with slender, pointed tip. Aedeagus with basal arch extending to nearly  $1/3$  of total length, basal arms stout, distal portion moderately slender and tapering to slender rounded apex. Parameres each with stout basal arm bent laterocephalad, stem stoutly swollen, tapering gradually to fine, simple, distal points curving laterocephalad.

DISTRIBUTION: Ceylon.

Holotype, female, allotype, male, Kalutaluwewa, Colombo, Ceylon, 19 Feb. 1958, Medical Research Institute, light trap (type No. 64430, USNM). Paratypes, 5 males, 15 females, same data as type.

This species is closely related to *flavescens*, since it has the same type of mandible teeth. It is distinguished from both *flavescens* and *subflavescens* by the dark brown fore part of the scutum, by the dark brown color of the scutellum, and by the wing being darker, particularly behind the dark costal area in cell  $R_5$  and on the basal half of vein  $M_2$ .

### C. Tenuipalpis Group.

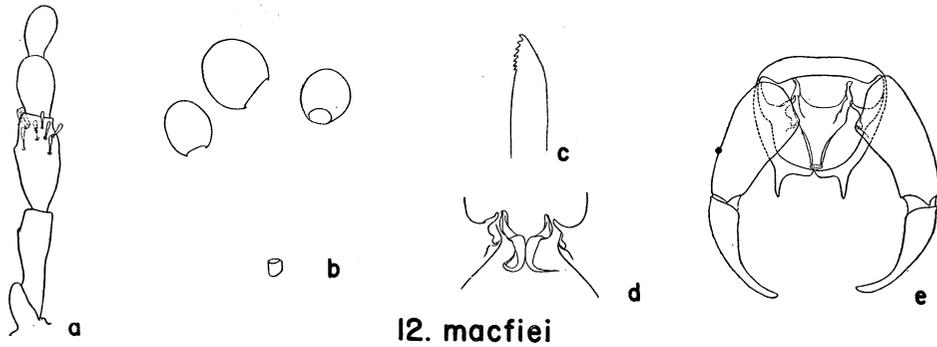
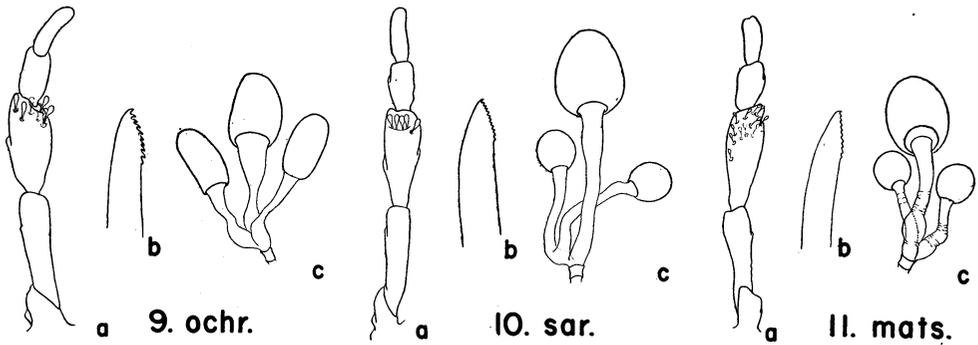
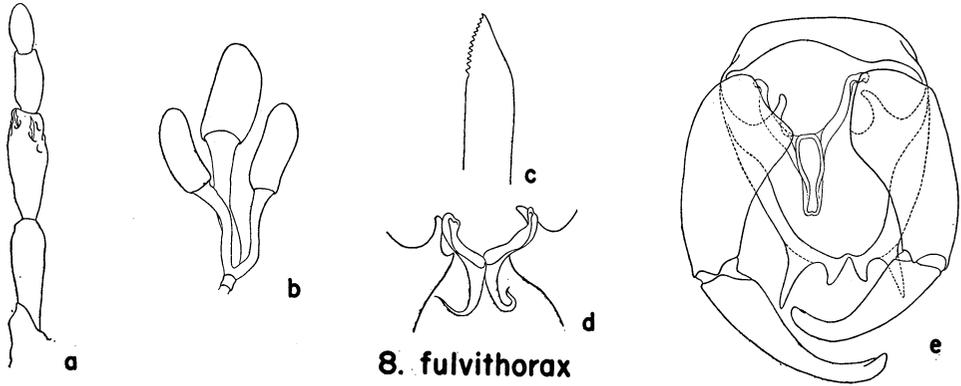
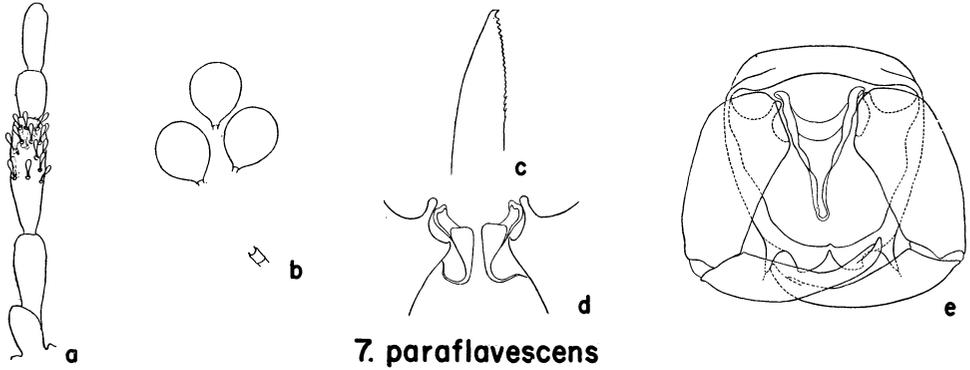
#### 7. *Culicoides* (*Trithecoides*) *tenuipalpis* Wirth & Hubert, n. sp. Figs. 5, 26.

*Female*. Length of wing 1.53 mm.

Head: Eyes contiguous a short distance, bare. Antenna with flagellar segments in proportion of 36–32–32–32–33–32–32–31–46–47–56–58–76, antennal ratio 1.09; distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 5a) in proportion of 15–26–40–12–17; segment 3 very long and slender, not thicker than segments 2 or 4,  $4.4 \times$  as long as broad with sensoria scattered over entire surface of segment. Proboscis long; mandible with 8 teeth, distal ones slightly larger and more widely spaced.

Thorax: Dark brown, without pattern (as seen in slide-mounted specimen). Legs dark brown; knees dark, fore and mid femora with narrow subapical pale ring and all tibiae with narrow sub-basal pale ring; tarsi paler brown; hind tibial comb with 5 spines, second from spur longest.

Wing (fig. 26): Pattern as figured; 2 marks on costal margin, and lines along veins very dark brown; with well defined pale spots as follows: large spot over r-m crossvein extending in full breadth to costal margin; large spot over second radial cell, extending nearly to its base and only slightly past its tip and into cell  $R_5$   $2/3$  way to vein  $M_1$ ; large elongate spot at wing tip in cell  $R_5$  filling nearly all of apex of cell; a small spot broadly meeting wing margin in cell  $M_1$ ; a small spot straddling middle of vein  $M_2$ ; large spots broadly meeting wing margin in apices of cells  $M_2$  and  $M_4$ , latter broadly bordering vein



**Figs. 7-12.** *Culicoides* species. 7. *paraflavescens*: 8. *fulvithorax*: 12. *macfieii*: a, palpus; b, spermathecae; c, mandibular teeth of female; d, parameres; e, genitalia of male, parameres removed. 9. *ochrothorax*: 10. *sarawakensis*: 11. *matsuzawai*: a, palpus; b, mandibular teeth; c, spermathecae of female.

$M_{3+4}$  on distal 2/3; spots in cell  $M_2$  in front of mediocubital fork and lying behind stem of medial fork; 2 spots in distal portion of anal cell, larger behind stem of mediocubital fork and small one at wing margin; base of wing pale broadly from front to hind margins. Macrotrichia scanty in apices of cells  $R_5$  and  $M_1$ ; costa extending to 0.69 of distance to wing tip, 2 distinct radial cells, second broad and  $2 \times$  as long as first. Halter pale, slight trace of infuscation on knob.

Abdomen: Dark brown; three spermathecae (fig. 5b), subequal, measuring 0.042 by 0.032, 0.040 by 0.029 and 0.039 by 0.029 respectively, pyriform with short sclerotized necks.

*Male.* Unknown.

DISTRIBUTION: Formosa.

Holotype, female, Formosa, 1954, collector Su-yung Liu (CGDI-0064). (Type no. 64431, USNM).

This species occupies an anomalous position in the subgenus, resembling *macfieii* Causey in mandibular structure and color of the scutum, but appearing more like *anophelis* Edwards and the Flavescens Group in wing pattern and spermathecal structure, while the extremely slender third palpal structure and 5 tibial spines are unique in the subgenus.

#### D. Fulvithorax Group.

##### 8. *Culicoides* (*Trithecoides*) *fulvithorax* (Austen). Figs. 8, 27.

*Johannseniella fulvithorax* Austen, 1912, Bull. Ent. Res. 3: 105 (E. Afr. Protect.; female). *Culicoides fulvithorax*, Carter, Ingram and Macfie, 1920, Ann. Trop. Med. & Parasit. 14: 230 (Gold Coast; descr. notes; fig. spermathecae; syn.: *ochrothorax* Carter [sic]).—Colaco, 1946, Inst. Med. Trop. Lisbon, An. 3: 257 (syn.: *ochrothorax* Carter [sic], *citrinus* Kieffer [sic], *ruficollis* Goetghebuer).—Hopkins, 1952, Ann. Trop. Med. Parasit. 46: 170 (bionomics; reared from rotten banana).—Nicholas, 1953, idem. 47: 187 (Bionomics: Br. Cameroons).—Nicholas, Kershaw, Keay and Zahra, 1953, idem. 47: 97 (bionomics). *Culicoides ruficollis* Goetghebuer, 1935, Rev. Zool. Bot. Africaines 27: 174 (male; Belg. Congo; fig. wing).

*Female.* Length of wing 0.99 (0.94–1.07,  $n = 10$ ) mm.

Head: Antenna with flagellar segments in proportion of 20–17–20–20–23–22–22–23–30–27–30–33–48, antennal ratio 0.97 (0.87–1.03,  $n = 9$ ); distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 8a) in proportion of 9–20–21–10–10, segment 2 not longer than 3, segment 3 moderately slender,  $2.2 \times$  (2.0–2.6,  $n = 4$ ) as long as greatest breadth, with sensoria borne on surface distally. Mandible (fig. 8c) with 11 (10–14,  $n = 18$ ) moderately large teeth of subequal lengths.

Thorax: Scutum and upper pleuron pale yellow; small prescutellar area, scutellum, postscutellum, and lower 1/2 of pleuron dark brown. Legs dark brown; fore leg with black knee spot, distinct pale bands subapical on femur and sub-basal on tibia; mid leg with knee pale, apex of femur and base of tibia broadly pale; hind leg with indistinct pale subapical band on femur, knee spot dark, narrow pale apical and basal bands on tibia; claws with simple tips.

Wing (fig. 27): Pattern as figured; posterior portion of wing infuscated along veins,

rather pale in cells; anterior margin moderately infuscated, 2 small pale yellow spots centered over r-m crossvein and over tip of second radial cell, latter covering only distal 1/3 of cell; apex of wing very narrowly and indistinctly pale. Costa extending to 0.68 (0.66-0.69,  $n=9$ ) of distance to wing tip. Halter variable, usually dark, occasionally pale.

Abdomen: Pale brown, terga poorly sclerotized,  $2\times$  as broad as long on segment 3. Three spermathecae (fig. 8b), unequal, sausage-shaped; large one measuring 0.043 by 0.023 mm., 2 small ones each measuring 0.038 by 0.017 mm.; openings of ducts broad and unsclerotized, ducts large and sac-like near spermathecae, becoming more slender at a common junction point near sclerotized ring.

*Male genitalia* (figs. 8d, e). Sternum 9 with shallow caudomedian excavation; tergum 9 with apicolateral processes very long and slender, with pointed apices, caudomedian margin between them convex with pair of sharp-pointed submedian lobes half as long as apicolateral processes. Basistyle with ventral root imperceptible, dorsal root slender; dististyle curving with slender, pointed tip. Aedeagus with basal arch extending to nearly 1/2 of total length, basal arms moderately slender, distal part moderately slender and tapering to bluntly rounded apex. Parameres each without basal knob, basal arm moderately stout and slightly curved, arching laterad and then cephalad; stem not greatly swollen, tapering gradually to slender, simple point directed ventrad.

DISTRIBUTION: East Africa; Belgian Congo, Gold Coast, Liberia, Nigeria, Uganda.

BELGIAN CONGO: 15 females, Gangala Na Bodio, Oriental, 29 Apr. 1955, Baker and Schmidt.

LIBERIA: 2 females, Kpain, 1953-54, Dr. W. Peters (BMNH).

MADAGASCAR: 4 females, Tamatave, Ivoloina, Mar. 1952, A. Grejzbine (South African Institute of Medical Research).

MOYEN CONGO: 5 females, Moyonbe, 15 Dec. 1955, Taufflieb (South African Institute of Medical Research).

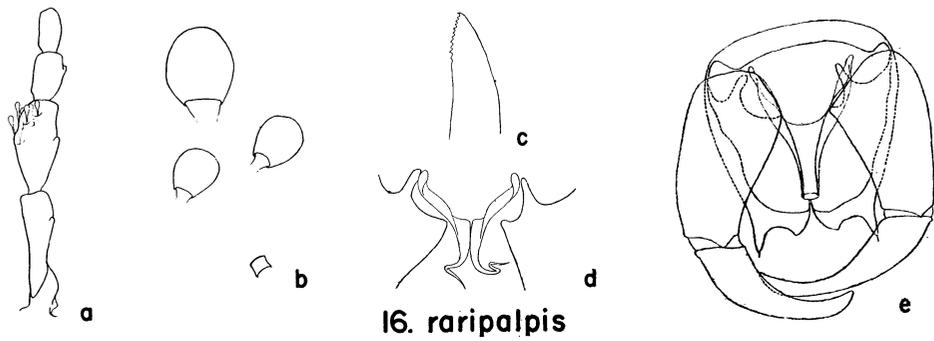
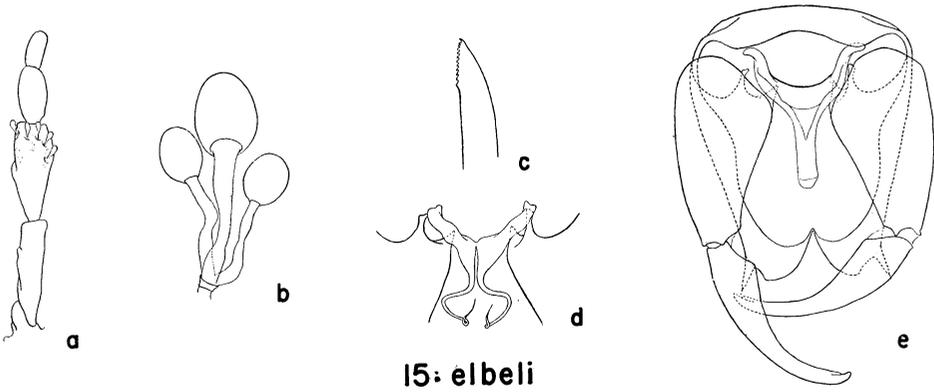
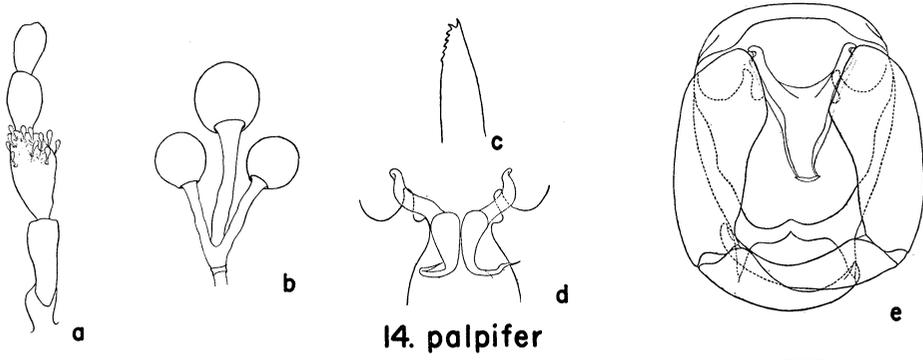
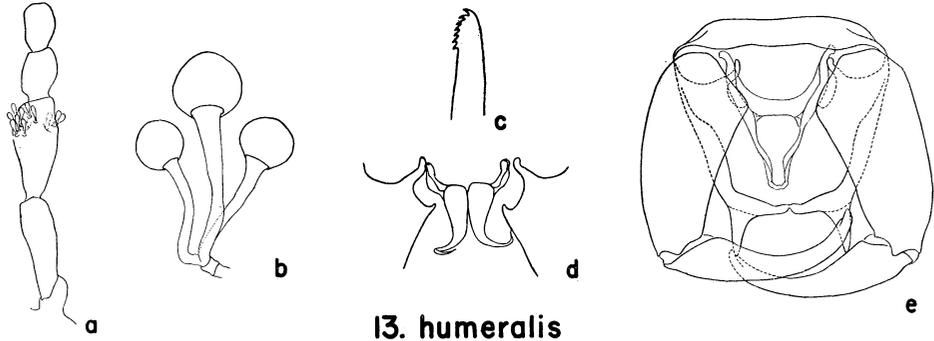
NIGERIA: Male, female, Kunba, Br. Cameroons, 13 Nov. 1951, Hopkins, coll. (South African Institute of Medical Research).

UGANDA: 3 females, Bwamba, Bubukwanga, 28 Sept.-2 Oct. 1948, W. H. R. Lumsden (BMNH).

The sausage-shaped spermathecae will separate *fulvithorax* (Austen) and *ochrothorax* Carter, the two known Ethiopian species, from the Oriental species of *Trithecoides*. *Ochrothorax* differs from the present species in having curved mandibular teeth with the distal ones largest, the second palpal segment much longer, the spermathecae shorter and the hind femur entirely dark.

The Nigerian specimens were loaned by the South African Institute of Medical Research through the kindness of Dr. B. de Meillon. They were reared by Hopkins (1952) from the rotting stems of banana and plantain. The description of the hitherto unknown male is based on one of these reared specimens.

We have received one female from Dr. de Meillon, collected by him at S. Kavirondo, Kenya, 1948, biting, which may represent a distinct species, possibly *fulvicollis* Goetghebuer. In view of the variation within our series of *fulvithorax*, it is possible that the Kenya specimen may fall within the normal range, when and if it is extended by further collecting. There-



**Figs. 13-16.** *Culicoides* species. 13. *humeralis*: 14. *palpifer*: 15. *elbeli*: 16. *raripalpis*: a, palpus; b, spermathecae; c, mandibular teeth of female; d, parameres; e, genitalia of male, parameres removed.

fore, we choose not to commit ourselves to a specific placement of the Kenya specimen at this time. It is characterized by longer wing (1.23 mm.); slender third palpal segment (palpal ratio 3.1); antennal ratio 0.98; 12-13 fine even teeth; dark hind femur and pale hind tibia; knee spot prominent on fore leg and moderately so on mid leg; very short shrunken spermathecae, a measurable small one (0.028 by 0.022 mm.); scutellum yellow, concolorous with scutum; wing almost uniformly infuscated, with small pale spots at base, over r-m crossvein and apex of second radial cell and very narrowly pale at wing tip.

**9. *Culicoides (Trithecoides) ochrothorax* Carter. Figs. 9, 28.**

*Culicoides ochrothorax* Carter, 1919, Ann. Trop. Med. Parasit. 12: 298 (female; Gold Coast; fig. wing).

*Culicoides citrinus* Kieffer, 1921, Soc. Ent. France, Ann. 90: 15 (female; Kribi, Kameroun).

**New Synonymy.**

*Female.* Length of wing 1.03 (1.00-1.07,  $n=2$ ) mm.

Head: Antenna with flagellar segments in proportion of 21-19-21-21-21-21-20-26-24-26-28-43, antennal ratio 0.93 (0.89-0.98,  $n=2$ ); distal sensory tufts present on segments III, XI-XV. Palpal segments (fig. 9a) in proportion of 9-25-20-10-x, segment 2 much longer than 3, segment 3 moderately slender,  $2.1-2.2 \times$  ( $n=2$ ) as long as greatest breadth, with sensoria borne on surface distally. Mandible (fig. 9b) with 9 (9-10,  $n=4$ ) teeth, proximal 8 curved basad and apical 1 slightly more separated and pointing distad.

Thorax: Scutum and upper pleuron pale yellow; scutellum, postscutellum and lower 1/2 of pleuron dark brown. Legs dark brown; knee spots black on all legs; fore and mid legs with broad subapical femoral and sub-basal tibial bands; hind femur all dark, tibia all pale; claws with simple tips.

Wing (fig. 28): Pattern as figured; rather uniformly infuscated; anterior margin only slightly darker, with 2 small pale spots, one centering over r-m crossvein, other on apex of second radial cell; wing tip with very narrow and indistinct pale area. Costa extending to 0.67 (0.66-0.69,  $n=2$ ) of distance to wing tip. Halter pale.

Abdomen: Pale brown, terga poorly sclerotized,  $2 \times$  as broad as long on segment 3. Three spermathecae (fig. 9c), unequal, sausage-shaped, with broad unsclerotized entrances to ducts; large spermatheca measuring 0.038 by 0.028 mm., 2 small ones each 0.035 by 0.018 mm.; ducts swollen at bases, slender toward common junction near sclerotized ring.

*Male.* Unknown.

**DISTRIBUTION:** Gold Coast; Belgian Congo, Cameroons, Liberia.

**BELGIAN CONGO:** Female, Gangala Na Bodio near Mangava, Oriental, 29 Apr. 1955, Baker and Schmidt.

**LIBERIA:** Female, Kpain, 1953-1954, W. Peters (BMNH).

This species has been considered a synonym of *fulvithorax* (Austen), but we believe the following points of difference justify its specific recognition: mandibular teeth curved, the distal one pointing away from the others, the second palpal segment much longer than the third, the spermathecae shorter, and the hind femur entirely dark. *Culicoides citrinus* Kieffer is provisionally synonymized with *ochrothorax* rather than *fulvithorax*, because Kieffer does not mention any pale banding of the hind femur, although this is a very questionable point. *Culicoides ruficollis* Goetghebuer is left as a synonym of *fulvithorax*, although it is impossible to determine by the original description and figure where it belongs.

## E. Macfiei Group.

**10. *Culicoides (Trithecoides) macfiei* Causey. Figs. 12, 29.**

*Culicoides macfiei* Causey, 1938, Amer. Jour. Hyg. 27: 411 (Siam; male, female; fig. wing, spermathecae, male genitalia).

*Female.* Length of wing 0.99 (0.84–1.10,  $n = 6$ ) mm.

Head: Antenna with flagellar segments in proportion of 21–17–18–20–22–21–22–22–31–31–40–41–55, antennal ratio 1.15 (1.05–1.21,  $n = 5$ ); distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 12a) in proportion of 11–17–20–11–10, segment 3 moderately stout,  $2.0 \times$  (1.8–2.2,  $n = 9$ ) as long as greatest breadth with sensoria on surface of segment distally. Mandible (fig. 12c) with 7 (6–8,  $n = 16$ ) curved teeth, distal ones largest.

Thorax: Dark brown, including scutum, scutellum, postscutellum and pleura. Legs dark brown; fore leg with knee slightly darkened, apex of femur and base of tibia broadly pale; mid leg with knee, apex of femur and base of tibia broadly pale; hind femur entirely dark, tibia with broad basal and apical pale bands; claws simple.

Wing (fig. 29): Pattern as figured; 3 darker areas on costal margin, small but distinct pale spots over r–m crossvein and at apex of second radial cell, wing tip narrowly but distinctly pale, rest of wing dark along veins but paler in cells. Costa extending to 0.69 (0.67–0.70,  $n = 6$ ) of distance to wing tip. Halter infuscated.

Abdomen: Dark brown terga well sclerotized,  $2 \times$  as broad as long on segment 3. Three spermathecae (fig. 12b), unequal, large one measuring 0.031 by 0.032 mm., and 2 small subequal ones, each measuring 0.025 by 0.024 mm., their shapes slightly broader than long, with broad, unsclerotized entrances to ducts, ducts of all 3 spermathecae joined at one point (according to Causey's figure).

*Male genitalia* (fig. 12d, e). Sternum 9 with imperceptible caudomedian excavation; tergum 9 short and rather broad distally, with long slender apicolateral processes and distomedian margin between them nearly transverse, not lobate. Basistyle with ventral root small and pointed and dorsal root slender; dististyle curving with slender, pointed tip. Aedeagus with basal arch extending to about 1/3 of total length, sides straight and tapering to blunt, slightly rounded tip. Parameres each with prominent basal knob, stem short, broad at base, gradually tapering to stout, but sharp-pointed, laterally bent tip.

**DISTRIBUTION:** Thailand; India, Malaya.

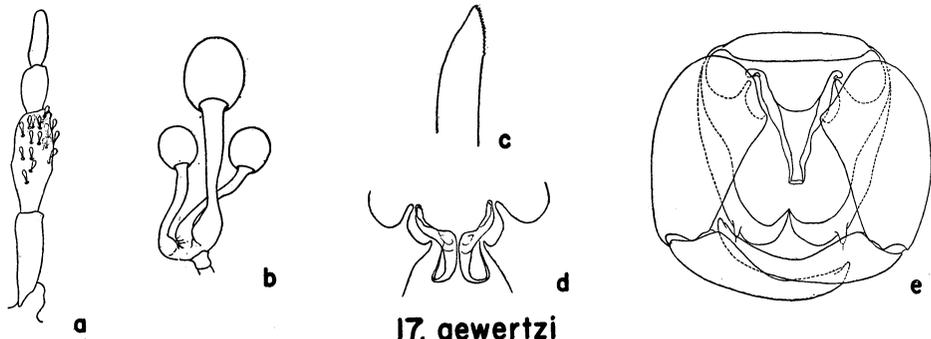
**MALAYA:** Female, Kuala Lumpur, 1936, J. G. Buckley, on cattle (BMNH); 2 females Segambut, 5 Mar. 1955, H. C. Barnett, biting cow.

**THAILAND:** 4 males, 10 females, Bangkok and Chiengrai, 1931–1935, O. R. Causey; female, Ban Na Muang, Dansai, Loei, 30 Sept. 1954, R. E. Elbel.

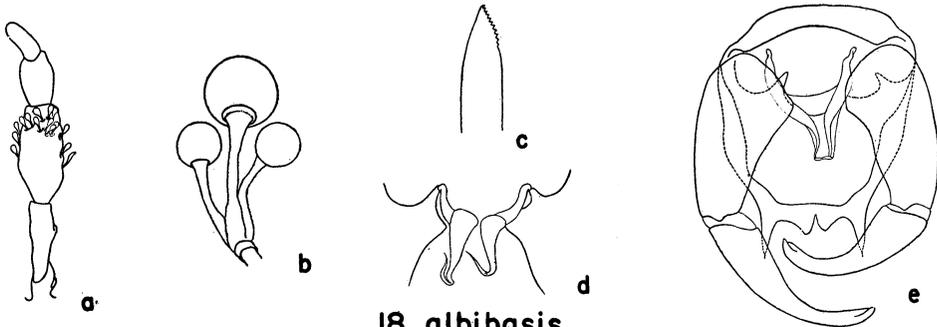
Pinned specimens of *macfiei* may be distinguished from *raripalpis* Smith by the pale wing tip, which is entirely dark in *raripalpis*. The latter species, as well as *sarawakensis* n. sp. and *elbeli* n. sp., share with *macfiei* the uniformly dark thorax, but all have 10–15 small even mandibular teeth.

**11. *Culicoides (Trithecoides) humeralis* Okada. Figs. 13, 30.**

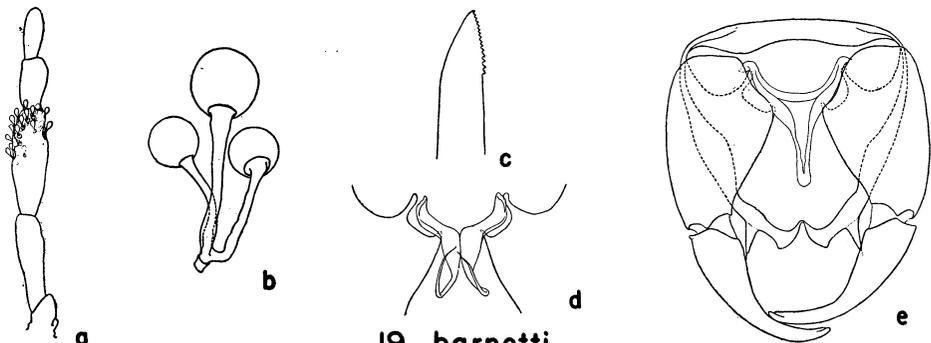
*Culicoides humeralis* Okada, 1941 Tokyo Imp. Univ., Jour. Coll. Agr. 15: 20 (female; Honshu, Japan; fig. habitus, antenna, palpus, spermathecae).



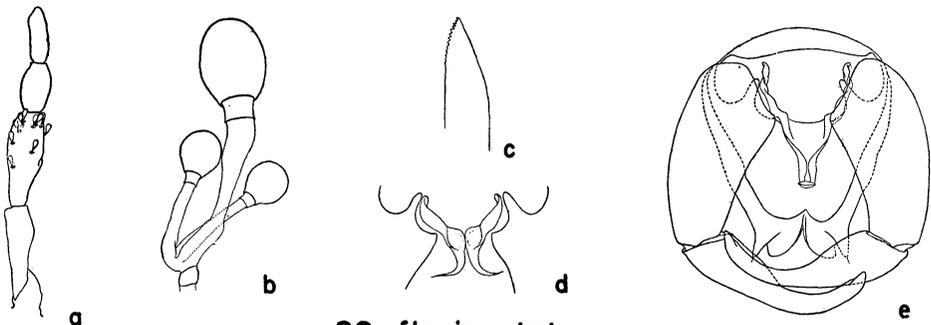
**17. gewertzi**



**18. albibasis**



**19. barnetti**



**20. flaviscutatus**

**Figs. 17-20.** *Culicoides* species. 17. *gewertzi*: 18. *albibasis*: 19. *barnetti*: 20. *flaviscutatus*: a, palpus; b, spermathecae; c, mandibular teeth of female; d, parameres; e, genitalia of male, parameres removed.

*Culicoides raripalpis* Smith, var. no. 1, Tokunaga, 1940, Tenthredo 3: 147 (female; Formosa; descr., fig. wing; antenna, spermathecae).—Okada, 1942, Nat. Hist. Soc. Formosa, Trans. 32: 143 (female; Taiwan, Japan; notes; fig. mandible, spermatheca, palpus; syn.: *humeralis* Okada).

*Culicoides raripalpis* Smith (misident.), Amosova, 1957, Ent. Obozr. 36: 234 (female; Ussuri, USSR; descr., notes, distr., biol.; fig. wing, palpus, eyes, spermathecae).—Arnaud, 1956, Microent. 21: 126 (Japan; discussion, synonymy).

*Female.* Length of wing 1.17 (1.10–1.26,  $n = 10$ ) mm.

Head: Antenna with flagellar segments in proportion of 19–17–19–19–20–19–20–20–28–26–29–33–47, antennal ratio 1.04 (0.98–1.09,  $n = 8$ ); distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 13a) in proportion of 8–19–20–10–12, segment 3 moderately swollen,  $2.2\times$  (1.9–2.4,  $n = 12$ ) as long as greatest breadth, with open sensory area distally. Mandible (fig. 13c) with 7 (7–8,  $n = 21$ ) prominent curved teeth, distal ones largest.

Thorax: Scutum bright yellow, anterior margin with dark brown spot on each humeral angle and large median spot; scutellum and postscutellum dark brown; pleuron yellow on upper 1/2, dark brown below; coxae dark brown. Legs dark brown; base of femur narrowly pale; fore leg with dark knee spot and broad pale subapical femoral and sub-basal tibial bands; mid leg with distal 1/3 of femur and basal 1/3 of tibia yellow; hind femur dark to tip, hind tibia yellow with broad dark band just beyond middle; claws simple.

Wing (fig. 30). Pattern as figured; 3 very dark costal areas, second radial cell pale on distal half, wing tip broadly pale. Costa extending to 0.67 (0.66–0.71,  $n = 8$ ) of distance to wing tip. Halter knob pale.

Abdomen: Light brown, terga poorly sclerotized,  $2\times$  as broad as long on segment 3. Three spermathecae (fig. 13b), unequal, with large entrances to ducts; large one measuring 0.032 by 0.034 mm., broader than long; 2 small ones each measuring 0.024 by 0.025 mm., also broader than long; ducts of all 3 spermathecae joining at one point just before sclerotized ring.

*Male genitalia* (figs. 13d, e). Sternum 9 with scarcely perceptible caudomedian excavation; tergum 9 with apicolateral processes large, slender, with pointed apices, caudomedian margin between them transverse with only faintly indicated mesal notch. Basistyle with ventral root imperceptible, dorsal root slender; dististyle curving with slender, pointed tip. Aedeagus with basal arch extending to about 1/2 of total length, basal arms moderately slender; distal portion stout and tapering to blunt apex. Parameres each without basal knob, basal portion slender and curving laterad and then cephalad, stem stout, gradually tapered to moderately slender, bent, simple tip (hitherto unknown male described from Malaya).

**DISTRIBUTION:** Japan; Malaya, Taiwan, Thailand, Eastern Siberia.

**MALAYA:** Female, Kuala Lumpur, Selangor, 1936, J. G. Buckley (BMNH), det. as *raripalpis* by Macfie; 2 females, 15 Feb. 1955, H. C. Barnett, light trap; female, 31 March 1958, R. Traub, light trap; male, 12 June 1958, R. Traub, light trap; female, swamp forest, Pekan Road, Kuantan, Pahang, 3 April 1957, R. H. Wharton, light trap; female, Kangar Rest House, Perlis, 12 July 1958, R. Traub, light trap.

**TAIWAN:** 22 females, Chia-lo, Chien-Shih, Shin tsu, 14 Dec. 1953, Su-Yung Liu; 5 females, Tung Shih, 13 Oct. 1951, H. C. Barnett.

**THAILAND:** 2 females, Ban Na Muang, Dansai, Loei, 30 Sept. 1954, R. E. Eibel; female, Pulau Panjang, Phangnga, 5 Oct. 1954, in cowshed; 6 females, Chiangmai, Apr.–May 1958, V. Notananda.

U. S. S. R. : 20 females, Suputinsky Preserve, Ussuri Land, Maritime Territory, 9, 17 Aug. 1953, I. S. Amosova.

Three other species have a yellow scutum marked with dark brown anteriorly : *anophelis* Edwards differs in having the hind femur with broad subapical band, halter dark, spermathecae pyriform, and the proximal mandibular teeth enlarged ; *gewertzi* Causey has the halter dark, wing only narrowly pale apically, mandibular teeth smaller and more numerous, subequal, and the large spermatheca more elongate and the spermathecal ducts with sacs before the ring, the ducts from the two small ones joining before meeting the duct from the large spermatheca ; *paraflavescens* n. sp. has the mandible with 19–23 teeth as in the Flavescens Group, the spermathecae subequal and pyriform, and the hind femur banded.

Okada (1942) recognized the identity of Japanese *humeralis* with *rariipalpis* var. no. 1 of Tokunaga from Taiwan, but assumed this form to be merely a variety of *rariipalpis*. Amosova (1957) pointed out some of the variation in characters reported for *rariipalpis* from different localities, but was prevented by lack of comparative material from separating his Siberian specimens from *rariipalpis*.

Specimens from Malaya and Thailand are much smaller (wing 0.87–0.94 mm. long) and their measurements were therefore excluded from those given in the description. However, no other significant differences from the typical northern series were found in structural and color characters.

## 12. *Culicoides* (*Trithecoidea*) *palpifer* DasGupta and Ghosh. Fig. 14.

*Culicoides palpifer* DasGupta and Ghosh, 1956, Calcutta Sch. Trop. Med., Bull. 4 : 122 (female ; Calcutta ; larvae bred from rotting banana plants).

*Female.* Length of wing 0.92 (0.80–1.07,  $n = 21$ ) mm.

Head : Antenna with flagellar segments in proportion of 18–16–17–18–21–20–21–20–26–26–28–31–44, antennal ratio 1.01 (0.91–1.05,  $n = 12$ ) ; distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 14a) in proportion of 7–18–17–9–9, segment 3 short and moderately slender,  $2.1 \times$  (1.7–2.6,  $n = 17$ ) as long as greatest breadth, sensoria borne distally in shallow, open, pit-like area. Mandible (fig. 14c) with 7 (6–8,  $n = 30$ ) curved teeth, distal ones larger.

Thorax : Scutum bright yellow ; scutellum light brown, postscutellum and lower 1/2 of pleuron brown. Legs dark brown ; fore leg with knee spot dark, broad subapical band on femur and sub-basal band on tibia pale ; mid leg with pale knee, broad pale band at apex of femur and base of tibia ; hind leg with femur usually dark to apex, tibia with broad dark band in middle, ends pale but varying greatly, sometimes with indistinct subapical pale band on femur, and tibia all pale ; tarsal claws simple.

Wing : Markedly dark areas on costal margin, disc quite dark along veins and indistinctly paler areas in cells ; 2 very pale spots on costal margin, one centering over r-m crossvein, other on apex of second radial cell, latter variable in size ; apex of wing broadly pale. Costa extending to 0.69 (0.67–0.71,  $n = 21$ ) of distance to wing tip. Halter infuscated or pale.

Abdomen : Dark brown, sclerotized terga very broad,  $3.2 \times$  as broad as long on segment 3. Three spermathecae (fig. 14b), unequal, with large entrances to ducts ; large one measuring 0.030 mm. by 0.030 mm., 2 small ones each measuring 0.023 mm. by 0.022 mm. average, shapes variable, ranging from slightly broader than long to slightly longer than

broad; ducts of all 3 spermathecae always joined at one point just before ring, without enlarged sacs at junction.

*Male genitalia* (figs. 14d, e). Sternum 9 with shallow caudomedian excavation; tergum 9 with apicolateral processes large, slender, with pointed apices, caudomedian margin between them cleft mesad. Basistyle with ventral root imperceptible, dorsal root slender; dististyle curving with slender, pointed tip. Aedeagus with basal arch extending to about 1/3 of total length, basal arms stout; distal portion stout and tapering to blunt apex. Parameres each with large basal knob, basal portion directed laterad, stem short, very stout at base, tapering greatly to slender, simple point directed ventrolaterad.

**DISTRIBUTION:** India; Malaya, North Borneo, Philippines, Sarawak, Sumatra, Taiwan, Thailand.

**INDIA:** Male, female, Dum Dum, W. Bengal, Aug. 1957, P. Sen (paratypes).

**MALAYA:** 2 females, Serdang, Selangor, 15 Feb. 1955, H. C. Barnett, light trap; 4 females, Ulu Langat, Selangor, 20 Apr. 1955, H. C. Barnett, light trap; 7 females, Kuala Lumpur, Selangor, 15 Feb. 1955, H. C. Barnett, light trap; 2 males, 48 females, Kuala Lumpur, Mar., June, Oct. 1958, R. Traub, light trap; female, Kuala Lumpur, 1936, J. Buckley (det. *rariipalpis* by Macfie) (BMNH); female, Malay States, BM 1932-99, A. T. Stanton (det. *anophelis* by Macfie) (BMNH); female, Kepong, Selangor, 27 March 1958, R. Traub, light trap; male, 2 females, Kuala Kengrong, Girik, Perak, 14 Apr. 1958, R. Traub, light trap; female, Rantau Panjang, Klang, Selangor, Mar. 1958, R. Traub, light trap; female, Sungei Patani, Kedah, 11 July 1958, R. Traub, light trap; female, Kangar Rest House, Perlis, 12 July 1958, R. Traub, light trap; 30 females, Bukit Besi, Dungun, Trengganu, 6 Aug. 1958, R. Traub, light trap.

**N. BORNEO:** 15 females, Labuan I., Sept.-Nov. 1948, D. H. Colless, at light; 2 females, Tambunan, Nov. 1950, Apr. 1952, D. H. Colless, at light.

**PHILIPPINE IS.:** 3 males, 170 females, Angeles, Pampanga Prov., 12, 17 Sept. 1957, I. Balatbat; 2 females, Tala, Rizal Prov., 22 May 1958, M. Delfinado; female, Kidapawan, Cotabato Prov., 13 July 1957, F. Kalaw; female, Tagum, Davao Prov., 30 May 1956, B. Fontanilla, carabao baited trap; female, Maco, Tagum, Davao Prov., Oct. 1946, H. Hoogstraal & D. Heyneman, near sea level (CNHM).

**SARAWAK:** Female, Limbang, Dec. 1950, D. H. Colless, at light.

**SUMATRA:** Female, Fort de Kock, 1926, E. Jacobson (BMNH).

**TAIWAN:** 15 females, Arisan, 25 Apr. 1917, T. Shiraki; 2 females, Arisan, Oct. 1918, Feb.-Mar. 1919, Inamura, Sonan & Yoshino; female, Kalenko, 15 May 1919, T. Shiraki; 6 females, Kappan-San, 25 Mar. 1920, T. Shiraki; 2 females, Shishito, 25 May 1917, T. Shiraki (all from collection of Nat. Taiwan Univ., through the courtesy of Prof. Shi-Tau Yie).

**THAILAND:** 6 females, Bangkok and Chiengrai, 1931-1935, O. R. Causey; 2 females, Pulau Panjang, Phangnga, 17 Nov. 1954, cowshed; 4 females, Koksato, Dansai, Loei, 27 Nov. 1954, R. E. Elbel; 31 females, Ban Na Muang, Dansai, Loei, 30 Sept. 1954, R. E. Elbel; 3 males, 3 females, Chiengmai, Apr.-May 1958, V. Notananda.

Of the Oriental species with the scutum entirely yellow, *palpifer* can be separated from *flavescens* Macfie and *subflavescens* n. sp. by the wing and leg markings, and by shape of the mandibular teeth; from *albibasis* n. sp. and *barnetti* n. sp. by wing markings and shape of mandibular teeth, and from *matsuzawai* Tokunaga and *flaviscutatus* n. sp., which are most similar, by the shape of the mandibular teeth.

This species has about the greatest geographical and morphological range of any of the group. The great variation in the values of the structural characters given in the description could not be broken down with any correlation with each other or with locality; so it is concluded that a single, variable species is represented. There is marked variation in the area of the pale wing markings, the Taiwan specimens reaching the palest extreme. This is one of the few Oriental species whose breeding habits are known, DasGupta and Ghosh (1956) describing it from specimens reared from rotten banana plants ("Different stages of larvae were recovered from the base of the decomposed banana plants which took 7 to 10 days for pupation and 3 days for the adults to emerge out of pupae.").

#### F. Raripalpis Group.

##### 13. *Culicoides* (*Trithecoides*) *eibeli* Wirth and Hubert, n. sp. Figs. 15, 31.

*Female*. Length of wing 0.84 (0.76-0.98,  $n=13$ ) mm.

Head: Antenna with flagellar segments in proportion of 18-17-19-20-20-20-19-19-24-22-25-26-28, antennal ratio 0.89 (0.86-0.94,  $n=10$ ); distal sensory tufts present on segments III, XI-XV. Palpal segments (fig. 15a) in proportion of 6-18-18-10-8, segment 3 slender,  $2.4\times$  (2.2-2.6,  $n=11$ ) as long as greatest breadth, with sensoria on surface of segment distally. Mandible (fig. 15c) with 12 (11-12,  $n=23$ ) fine teeth of subequal lengths.

Thorax: Dark brown including scutum, scutellum, postscutellum and lower part of pleuron. Legs dark brown; fore leg with black knee spot and narrow pale bands subapically on femur and sub-basally on tibia; mid leg with knee, apex of femur and base of tibia pale; hind leg with femur all dark, tibia with narrow basal and broad apical pale bands; claws simple.

Wing (fig. 31): Pattern as figured; moderately dark with large and distinct pale spots over r-m crossvein and centering over end of second radial cell; wing tip distinctly pale in some specimens from Malaya; faint pale spots in apices of anal cell and cell  $M_4$ . Costa extending to 0.70 (0.68-0.72,  $n=13$ ) of distance to wing tip. Halter pale.

Abdomen: Dark brown, terga faintly sclerotized,  $2\times$  as broad as long on segment 3. Three spermathecae (fig. 15b), unequal, one large one measuring 0.033 mm. by 0.027 mm. and 2 small subequal ones each measuring 0.021 mm. by 0.018 mm., their shapes slightly elongate, with broad, unsclerotized entrances to ducts; ducts from 2 small ones joined just before entrance to duct from large one at ring, ducts not sai-like at junctions.

*Male genitalia* (figs. 15d, e). Sternum 9 with very shallow caudomedian excavation; tergum 9 with very deep caudomedian cleft, with large, rounded, sublateral lobes, apico-lateral processes small and slender and only slightly surpassing lobes in length. Basistyle with ventral root imperceptible, dorsal root slender; dististyle curving with slender, pointed tip. Aedeagus with basal arch low and broad, basal arms stout, distal portion moderately stout and tapering to blunt tip. Parameres each with moderately large basal knob not abruptly bent laterad, but directed obliquely anterolaterad; stem with short, moderately stout basal portion, abruptly narrowed to a fine filament, which is sharply directed laterad, then ventrad and then mesad to a fine threadlike tip.

DISTRIBUTION: Malaya; North Borneo, Thailand.

Holotype, female, Ulu Langat, Selangor, Malaya, 20 April 1955, H. C. Barnett light trap (type no. 64310, USNM). Allotype, male, Gombok Forest Reserve, Kuala Lumpur, Selangor, Malaya, 2 Jan. 1956 R. Traub, light trap. Paratypes, male, 81 females:

MALAYA: 12 females, same data as holotype; male, 3 females, same data as allotype; 39 females, Pekan Road, swamp forest, Kuantan, Pahang 3 April 1957, R. H. Wharton, light trap; 3 females, Bukit Besi, Dungun. Trengganu, 6 Aug. 1958, R. Traub, light trap; 2 females, Segambut, 5 March 1955, H. C. Barnett, biting human; 3 females, Rantau Panjang, 6 km. N. of Klang, Selangor, Dec. 1956, R. Traub, light trap; female, Kuala Lumpur, Mar. 1958, R. Traub, light trap.

NORTH BORNEO: Female, Tambunan, Sept. 1949, D. H. Colless, biting human; female, same but Mar., Apr. 1952, swept from grass; 2 females, Kinabatangan Dist., SE end Dewhurst Bay, 2 June 1950, R. F. Inger and D. D. Davis, in primary forest (Chicago Nat. Hist. Mus. Borneo Zool. Exped. 1950).

THAILAND: 14 females, Ban Na Muang, Dansai, Loei, 30 Sept. 1954, R. E. Elbel; female, Chiangmai, Apr.-May 1958, V. Notananda.

This species is closely related to *varipalpis* Smith and *sarawakensis* n. sp., but can be readily distinguished by the pale halteres and banded fore femora as well as by the numerous structural characters given in the key.

This species is named in honor of Robert E. Elbel of the University of Oklahoma, who collected a large amount of valuable natural history material in Southeast Asia for the Smithsonian Institution.

Variation in wing characters of *elbeli* may provide a clue to the possible further separation into two or three subspecies or species, the status or nature of which is impossible to determine with our available material. There is one variation found generally in Malaya and in Tambunan, Borneo (but not in our Thailand material), having a pale wing with the pale spot over r-m crossvein meeting the costa, the wing tip distinctly and sometimes broadly pale and the anal cell with a more or less distinct pale spot in distal portion and touching the mediocubital stem. This variant also is smaller, wing length 0.71-0.84 mm. A second variant including all our Thailand material and three specimens from Malaya (Ulu Langat) is larger (wing length 0.90-0.99 mm.) and has a darker wing, the spot over the crossvein is small and usually does not reach the costa, the wing tip is narrowly pale or completely dark and the anal cell is dark at the apex or with an indistinct pale spot restricted to the margin of the wing. Four specimens from North Borneo (Tambunan and Dewhurst Bay) are intermediate in size and wing markings. There are no ascertainable differences in the other structural or color characters routinely studied.

**14. *Culicoides (Trithecoides) sarawakensis* Wirth and Hubert, n. sp. Figs. 10, 32.**

*Female.* Length of wing 0.81 (0.76-0.86,  $n = 10$ ) mm.

Head: Antenna with flagellar segments in proportion of 20-17-19-20-20-19-19-21-28-27-31-31-45, antennal ratio 1.05 (1.02-1.09,  $n = 10$ ); distal sensory tufts present on segments III, XI-XV. Palpal segments (fig. 10a) in proportion of 8-20-21-10-11, segment 3 slender,  $2.7 \times$  (2.5-3.0,  $n = 10$ ) as long as greatest breadth, with sensoria on surface of segment distally. Mandible (fig. 10b) with 13 (12-15,  $n = 12$ ) fine teeth of subequal lengths.

Thorax: Dark brown, including scutum, scutellum, postscutellum and pleuron. Legs dark brown; fore leg with femur dark to tip, tibia with narrow basal pale ring; mid leg with knee, apex of femur and base of tibia pale; hind leg with femur all dark, tibia with broad basal and narrow apical pale bands; claws simple.

Wing (fig. 32): Pattern as figured; relatively dark and uniform except for only moderately contrasting pale spots centering over radial crossvein and distal 1/2 of second radial

cell; apex of wing not pale. Costa extending to 0.70 (0.69–0.73,  $n=10$ ) of distance to wing tip. Halter infuscated.

Abdomen: Dark brown, terga poorly sclerotized,  $2\times$  as broad as long on segment 3. Three spermathecae (fig. 10c), unequal, large one measuring 0.041 by 0.031 mm. and 2 small subequal ones each measuring 0.020 by 0.019 mm., large spermatheca thus much longer than broad; with broad unsclerotized entrances to ducts, ducts from 2 small ones joined just before entrance to duct from large one at ring, ducts not sac-like at junctions.

*Male.* Unknown.

DISTRIBUTION: Sarawak; Brunei, Malaya, Philippines.

Holotype, female, Umah Akeh, Baram River, Sarawak, June 1953, D. H. Colless, biting man (type no. 64311, USNM). Paratypes, 12 females, Sarawak: 4, same data as type; 1, Lg. San, Baram River; 3, Lg. Kaseh, Baram River; 1, Lg. Tap, Akah River, all collected June 1953 by D. H. Colless, biting man.

BRUNEI: Female, Brunei, Dec. 1950, D. H. Colless, biting man.

MALAYA: Female, Pekan Road, swamp forest, Kuantan, Pahang, 3 April 1957, R. H. Wharton, light trap.

PHILIPPINES: Female, Pikit, Cotabato Prov., Mindanao, 16 Dec. 1946, F. G. Werner, near sea level.

This species is closely related to *raripalpis* Smith and *elbeli* n. sp., but may be readily distinguished from them by its unbanded front femur, and from the latter by its dark halteres, as well as by the structural characters mentioned in the key.

**15. *Culicoides* (*Trithecoides*) *raripalpis* Smith. Figs. 16, 33.**

*Culicoides raripalpis* Smith, 1929, Indian Jour. Med. Res. 17: 256 (female; Assam; fig. palpus, wing, spermatheca; biting man); Macfie, 1932, Ann. Mag. Nat. Hist. ser. 10, 9: 493 (spermathecae compared with *anophelis*); Macfie, 1937, Roy. Ent. Soc. London, Proc. (B) 6: 115 (female; Malaya; notes); Macfie, 1937, Ann. Trop. Med. Parasit. 31: 469 (Malaya; notes); Causey, 1938, Amer. Jour. Hyg. 27: 409 (male, female; Siam; fig. wing, spermathecae, male genitalia).

*Female.* Length of wing 0.77 (0.76–0.79,  $n=3$ ) mm.

Head: Antenna with flagellar segments in proportion of 16–14–16–16–17–16–15–16–25–25–28–29–43, antennal ratio 1.15 (1.11–1.19,  $n=5$ ); distal sensory tufts present on segments III, XII–XV (Thailand) or III, XI, XIII–XV (Malaya). Palpal segments (fig. 16a) in proportion of 7–16–16–7–7, segment 3 slender,  $2.1\times(2.1-2.2, n=5)$  as long as greatest breadth, with sensoria on surface of segment distally. Mandible (fig. 16c) with 11 (11–12,  $n=8$ ) fine teeth of subequal lengths.

Thorax: Dark brown, including scutum, scutellum, postscutellum and pleuron. Some Malayan specimens with scutum paler, yellowish on anterior portion. Legs dark brown, fore femur with subapical pale ring, fore tibia with basal pale ring; mid leg with knee, apex of femur and base of tibia pale; hind leg with femur all dark, tibia with narrow basal and apical pale rings; claws simple.

Wing (fig. 33): Pattern as figured; relatively dark with veins more darkly infuscated, prominent pale spots over r–m crossvein and over distal 1/3 of second radial cell, latter spot small but contrasting, apex of wing not pale. Costa extending to 0.66 (0.64–0.67,  $n=3$ ) of distance to wing tip. Halter deeply infuscated.

Abdomen: Dark brown. Three spermathecae (fig. 16b), unequal, large one measuring 0.030 by 0.026 mm. and 2 small subequal ones each measuring 0.019 mm. by 0.017 mm., their shapes longer than broad, with broad unsclerotized entrances to ducts; ducts from 2 small ones joined just before entrance to duct from large one at ring, ducts not sac-like at junctions.

*Male genitalia* (figs. 16d, e): Sternum 9 with very shallow caudomedian excavation; tergum 9 with small caudomedian notch and long, pointed, apicolateral processes, submedian lobes between processes not well developed. Basistyle with ventral root small and pointed and dorsal root slender; dististyle curving with slender, pointed tip. Aedeagus with basal arch extending to not quite half of total length of aedeagus, basal arms stout and nearly straight; distal apex slightly tapering to moderately stout, truncate tip. Parameres each without prominent basal knob, basal half rather slender and bent laterally, stem slightly swollen at base, gradually tapered to slender, bent, simple tip.

DISTRIBUTION: Assam; Malaya, Thailand.

MALAYA: Female, Kuala Lumpur, 1936, J. G. Buckley (BMNH, det. *raripalpis* by Macfie); 9 females, Telok Pelandok, Port Dickson, Negri Sembilan, 18 July 1958, R. Traub, light trap.

THAILAND: 6 males, 8 females, Bangkok and Chiengrai, 1931-1935, O. R. Causey.

Of the species of *Trithecoides* with dark brown scutum, *macfiei* Causey may be readily distinguished from *raripalpis* by having 6-7 mandibular teeth with the distal ones largest. The two new species, *sarawakensis* and *elbeli*, which have 10-15 fine even mandibular teeth like *raripalpis*, can be separated by the pale halter color in *elbeli*, banding of the fore femur, and structural characters as outlined in the key. *Raripalpis* is the only known species of *Trithecoides* which lacks sensoria on antennal segments XI or XII. As pointed out elsewhere most of the records of *raripalpis* were based on misidentified species with a yellow scutum, insufficient importance having been placed on scutal markings.

#### 16. *Culicoides* (*Trithecoides*) *gewertzi* Causey. Figs. 17, 34.

*Culicoides gewertzi* Causey, 1938, Amer. Jour. Hyg. 27: 409 (Siam; male; fig. wing, male genitalia).

*Female*. Length of wing 0.88 (0.81-0.91,  $n = 10$ ) mm.

Head: Antenna with flagellar segments in proportion of 19-16-18-19-19-18-17-18-24-23-27-28-44, antennal ratio 1.01 (0.95-1.05,  $n = 10$ ); distal sensory tufts present on segments III, XI-XV. Palpal segments (fig. 17a) in proportion of 7-17-22-10-10; segment 3 slender,  $2.6 \times$  (2.3-3.0,  $n = 10$ ) as long as greatest breadth, with sensoria on surface of segment distally; segment 5 extremely slender. Mandible (fig. 17c) with 16 (15-17,  $n = 17$ ) fine teeth of subequal lengths.

Thorax: Scutum yellow, dark brown on anterior margin; scutellum, postscutellum and lower 1/2 of pleuron dark brown. Legs dark brown; fore leg with black knee spot, femur with subapical pale band, tibia with basal pale band; mid leg with knee, apex of femur and base of tibia pale; hind leg with femur dark to apex, tibia with basal and apical pale bands; claws simple.

Wing (fig. 34): Pattern as figured; costal margin with darker infuscation; small but distinct pale spots over r-m crossvein and centered on apex of second radial cell; apex of wing narrowly pale, rest of wing darkly infuscated except for indistinct paler areas between

some of the veins. Costa extending to 0.69 (0.68-0.71,  $n = 10$ ) of distance to wing tip. Halter infuscated.

Abdomen: Dark brown, sclerotized terga broad,  $3 \times$  as broad as long on segment 3. Three spermathecae (fig. 17b), unequal, large one measuring 0.038 by 0.030 mm., and 2 small subequal ones each measuring 0.021 by 0.021 mm., large one definitely longer than broad; with broad unsclerotized entrances to ducts, ducts from 2 small ones joined in common sac just before entrance to sac-like duct from large one at ring.

*Male genitalia* (figs. 17d, e). Sternum 9 without caudomedian excavation; tergum 9 strongly cleft distally on midline, forming 2 rounded submedian lobes greatly exceeding small apicolateral processes. Basistyle with ventral root scarcely evident, dorsal root short; dististyle curving to slender, pointed apex. Aedeagus with basal arch extending to  $1/3$  of total length, basal arms stout, sides nearly straight, tapering to bluntly pointed tip, but with slight evidence of shoulder-like subapical lateral swelling. Parameres each short and stout, basal knob not developed, abruptly bent in mid part, stem very short, stout and gradually tapering to laterally curved, simple, pointed tip.

DISTRIBUTION: Thailand; Malaya, North Borneo, Sarawak.

MALAYA: Female, Ulu Langat, Selangor, 20 Apr. 1955, H. C. Barnett light trap; 3 females, Serdang, Selangor, 13, 15 Feb. 1955, H. C. Barnett, light trap; 5 females, Segambut, Selangor, 1 Feb., 2, 5 March 1955, H. C. Barnett, biting human; 6 females, Rantau Panjang, 4 mi. N. of Klang, Selangor, Sept., Dec., 1956, Mar. 1958, R. Traub, light trap; female, Telok Pelandok, Port Dickson, Negri Sembilan, 18 July 1958, R. Traub, light trap; 3 females, Kuantan, Pahang, swamp forest, Pekan Road, 3 Apr. 1957, R. H. Wharton, light trap; female, Kedah, Sungei Patani, 11 July 1958, R. Traub, light trap; 2 females, Kuala Singgora, Pahang, 17 July 1958, R. H. Wharton, light trap; 9 females, Bukit Besi, Dungun, Trengganu, 6 Aug. 1958, R. Traub, light trap.

NORTH BORNEO: 26 males, 92 females, Labuan I., Sept.-Nov. 1948, Jan. 1949, Sept., Dec. 1951, D. H. Colless, at light.

SARAWAK: 3 females, Limbang, Dec. 1950, D. H. Colless, at light; 2 females, same, but Dec. 1951, biting man.

THAILAND: 7 males, 3 females, Bangkok and Chiengrai, 1931-1935, O. R. Causey.

17. *Culicoides* (*Trithecoides*) *albibasis* Wirth and Hubert, n. sp. Figs. 18, 35.

*Female*. Length of wing 0.89 (0.86-0.93,  $n = 12$ ) mm.

Head: Antenna with flagellar segments in proportion of 19-15-15-17-17-18-18-19-23 23-29-28-41, antennal ratio 1.05 (0.92-1.13,  $n = 6$ ); distal sensory tufts present on segments III, XI-XV. Palpal segments (fig. 18a) in proportion of 8-18-18-8-11, segment 3 moderately slender,  $2.2 \times$  (2.1-2.7,  $n = 6$ ) as long as greatest breadth, with sensoria borne on distal surface. Mandible (fig. 18c) with 11 (10-12,  $n = 24$ ) small triangular teeth of subequal lengths.

Thorax: Anterior part of scutum and upper part of pleuron bright yellow; scutum in prescutellar area, scutellum, postscutellum and lower  $1/2$  of pleuron dark brown. Legs dark brown; all knees pale with broad pale bands on each side; hind tibia also pale at apex; claws with simple tips.

Wing (fig. 35): Pattern as figured; in most specimens with entire wing proximad of r-m crossvein pale, sometimes with faint infuscation in a band just proximad of crossvein, leaving r-m crossvein in center of a small pale spot which may not attain costal margin;

pale spot at end of second radial cell very small and centered on tip of cell; prominent broad darker areas on costal margin proximad and distad of this spot; end of wing not pale. Costa extending to 0.70 (0.69-0.71,  $n = 12$ ) of distance to wing tip. Halter infuscated.

Abdomen: Pale brown, terga poorly sclerotized,  $2 \times$  as broad as long on segment 3. Three spermathecae (fig. 18b), unequal, large one measuring 0.027 by 0.031 mm., and 2 small ones measuring 0.017 by 0.020 mm., all of them broader than long, with broad unsclerotized entrances to ducts; collapsed in available specimens and not measured, but obviously broader than long; ducts from 2 small ones joined before entrance to duct from large spermatheca proximal to sclerotized ring.

*Male genitalia* (figs. 18d, e). Sternum 9 with very shallow caudomedian excavation; tergum 9 with sides convex, apicolateral processes well developed but slender and pointed, caudomedian margin between them convex, with small median notch and pair of small but distinct, angular, submedian lobes. Basistyle with ventral root imperceptible, dorsal root slender; dististyle curving and tapering to very slender, pointed tip. Aedeagus with basal arch to 1/3 of total length, basal arms stout, distal portion quite stout and truncate at tip. Parameres each without basal knob, basal portion very slender and curved laterad; stem swollen at base, very short, 2 parameres apparently fused a short way at proximal corners of stems, stem tapering abruptly to slender simple point curving ventrad.

DISTRIBUTION: Malaya; Philippines.

Holotype, female, allotype male, Kuala Lumpur, Selangor, Malaya, 15 Feb. 1955, H. C. Barnett, light trap (type no. 64312, USNM). Paratypes, 6 males, 64 females:

MALAYA: 2 males, 7 females, same data as type except dates 15 and 20 Feb. 1955; male, 19 females, Kuala Lumpur, March, Oct. 1958, R. Traub, light trap; 4 females, Kuala Lumpur, 26 June 1937, on cattle (Buckley) (BMNH, det. *rariipalpis* by Macfie); female, Perlis, Kangar Rest House, 12 July 1958, R. Traub, light trap; female, Singapore, 29 Apr. 1953, cowshed, R. Course.

PHILIPPINES: 3 males, 25 females, Angeles, Pampanga Prov., 17 Sept. 1957, I. Balatbat, light trap; female, Tala, Rizal, 21 May 1958, M. Delfinado; female, Zamboanga, Dec. 1955, D. Casimiro; 5 females, Mindoro, 31 Oct. 1955, M. Santos.

The pale basal wing area is a striking, although not invariable, character, and in connection with the distally pale femora, dark halteres, even, fine mandibular teeth, and bright yellow scutum will serve readily to distinguish this species.

#### 18. *Culicoides* (*Trithecoides*) *barnetti* Wirth and Hubert, n. sp. Figs. 19, 36.

*Female*. Length of wing 0.92 (0.79-0.99,  $n = 16$ ) mm.

Head: Antenna with flagellar segments in proportion of 20-18-20-22-21-21-21-21-25-24-27-27-42, antennal ratio 0.88 (0.85-0.92,  $n = 7$ ); distal sensory tufts present on segments III, XI-XV. Palpal segments (fig. 19a) in proportion of 9-17-22-10-8, segment 3 slender,  $2.4 \times$  (2.1-3.3,  $n = 10$ ) as long as greatest breadth, with sensoria borne on surface distally, segment 5 very slender. Mandible (fig. 19c) with 12 (11-16,  $n = 25$ ) minute, triangular teeth of subequal lengths.

Thorax: Scutum and upper pleuron bright pale yellow; scutellum, postscutellum and lower 1/2 of pleuron dark brown. Legs dark brown; fore leg with knee spot blackish, pale bands subapically on femur and sub-basally on tibia; mid leg with knee usually dark, femur with broad subapical pale band, tibia with broad sub-basal pale band; hind leg with

blackish knee spot very prominent, femur with distinct subapical pale band, tibia entirely pale; claws not bifid.

Wing (fig. 36): Pattern as figured; very small dark anterior spot over vein  $R_1$ , another broad one subapically in cell  $R_5$ ; pale spots over r-m crossvein and second radial cell very large, continuing caudad as less distinct pale bands to posterior wing margin, pale area over second radial cell extending proximad nearly to base of cell, extending very little past apex of second radial cell; pale area at wing tip very broad and distinct. Costa extending to 0.70 (0.68–0.72,  $n=6$ ) of distance to wing tip. Halter pale.

Abdomen: Whitish, terga faintly sclerotized,  $2 \times$  as broad as long on segment 3; segment 8 dark brown. Three spermathecae (fig. 19b), unequal, with broad unsclerotized entrances to ducts; large one measuring 0.034 by 0.030 mm., usually slightly longer than broad, smaller ones each measuring 0.021 by 0.021 mm.; ducts from 2 small spermathecae joined a considerable distance before entering duct from large one, a definite sac-like swelling on latter at ring.

*Male genitalia* (figs. 19d, e). Sternum 9 with scarcely perceptible caudomedian excavation; tergum 9 with short, slender apicolateral processes, the caudal margin between them convex, with deep median cleft and large, angular, submedian lobes. Basistyle with ventral root imperceptible, dorsal root slender; dististyle curving with slender, pointed tip. Aedeagus with low, broad basal arch, attaining  $1/3$  of total length of aedeagus, distal portion with concave sides, narrowed to slender, rounded tip. Parameres each with moderately slender lateral arm, stem moderately swollen basally, gradually narrowed to very slender, simple filaments bent ventrad.

**DISTRIBUTION:** Malaya; Philippines.

Holotype, female, Ulu Langat, Selangor, Malaya, 20 April 1955, H. C. Barnett, light trap (type no. 64313, USNM). Allotype, male, Kuala Lumpur, Selangor, Malaya, 31 March 1958, R. Traub, light trap. Paratypes, 5 males, 182 females:

**MALAYA:** 6 females, same data as type; 7 females, Kuala Lumpur, 15 Feb. 1955; 129 females, Serdang, 13, 15 Feb. 1955, all collected in Selangor Province in light traps by H. C. Barnett; female, Kepong, Selangor, 8 Mar. 1955, H. C. Barnett, biting deer; 2 females, Segambut, Selangor, 1 Feb. 1955, H. C. Barnett, biting human; male, 19 females, Kuala Lumpur, March, June 1958, R. Traub, light trap; female, Kuala Kengrong, Girik, Perak, 14 Apr. 1958, R. Traub, light trap; male, Rantau Panjang, Klang, Selangor, Mar. 1958, R. Traub, light trap; male, Pekan Road, swamp forest, Kuantan, Pahang, 3 Apr. 1957, R. H. Wharton, light trap; female, Kuala Singgora, Pahang, 17 July 1958, light trap, R. H. Wharton; 7 females, Bukit Besi, Dungun, Trengganu, 6 Aug. 1958, R. Traub, light trap.

**PHILIPPINES:** male, 6 females, Angeles, Pampanga Prov., 17 Sept. 1957, I. Balatbat, light trap; female, Kidapawan, Cotabato Prov. 13 July 1957, F. Kalaw, carabao-baited trap; female, Pikit, Cotabato Prov., 16 Dec. 1946, F. G. Werner, at light; female, Taft, Samar Prov., 26 Nov. 1955, I. Balatbat; male, Tala, Rizal, 21 May 1958, M. Delfinado; 2 females, E. Slope Mt. McKinley, 1000 m., Davao Prov., 25 Sept. 1946, F. G. Werner, at light.

This species is easily recognized, even from pinned material, by the bright yellow scutum, prominently banded hind femora, pale halteres, and the broad pale apex of the wing. In three female specimens from Ulu Langat, Malaya, the knee of the middle leg is pale instead of dark. In some Philippine specimens the large spermatheca is considerably elongate, nearly twice as long as broad.

We are very pleased to name this species in honor of Major Herbert C. Barnett of the Walter Reed Army Institute of Research in appreciation of his long and keen interest in the taxonomy and habits of the biting midges and his open-minded inquiry into their possible significance as disease vectors.

**19. *Culicoides (Trithecoides) matsuzawai* Tokunaga. Figs. 11, 37.**

*Culicoides matsuzawai* Tokunaga, 1950, Japanese Jour. Sanit. Zool. 1: 64 (female; Japan; fig. wing; habits, biting man);—Arnaud, 1956, Microent. 21: 112 (female; Japan; fig. details).

*Female.* Length of wing 1.01 (0.94–1.09,  $n = 2$ ) mm.

Head: Antenna with flagellar segments in proportion of 21–20–22–23–23–23–23–27–25–27–28–44, antennal ratio 0.85; distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 11a) in proportion of 8–22–20–10–11, segment 3 slender,  $2.5 \times$  as long as greatest breadth, with sensoria borne on surface of distal 1/2. Mandible (fig. 11b) with 11 (10–11,  $n = 4$ ) small teeth of subequal lengths.

Thorax: Scutum and upper pleuron pale yellow; prescutellar area of scutum, scutellum, postscutellum and lower 1/2 of pleuron dark brown. Legs dark brown; fore leg with knee spot dark brown, pale subapical band on femur and sub-basal band on tibia; mid leg with knee, apical 1/3 of femur and basal 1/3 of tibia broadly pale; hind leg with femur all dark, tibia quite pale, with broad basal and narrow apical pale bands which are almost indistinguishable; claws simple.

Wing (fig. 37): Pattern as figured; small pale spots over r-m crossvein and apex of second radial cell; pale area at wing tip very broad and distinct; fairly distinct pale areas also in cell  $M_4$ , midway in cell  $M_2$ , apex of anal cell and base of wing, costa extending to 0.69 (0.67–0.71,  $n = 2$ ) of distance to wing tip. Halter pale.

Abdomen: Dark brown, terga poorly sclerotized,  $2 \times$  as broad as long on segment 3. Three spermathecae (fig. 11c), unequal, with broad unsclerotized entrances to ducts; large one measuring 0.040 by 0.029 mm., 2 small ones each measuring 0.018 by 0.018 mm.; ducts from 2 small ones joining just before junction with duct from large one, which is swollen just before latter junction.

*Male.* Unknown.

DISTRIBUTION: Japan.

JAPAN: 4 females, Muradokoro, Nishimera-mura, Miyazaki, Kyushu, 3 July 1950, M. Tokunaga (paratypes).

The other Japanese species of *Trithecoides*, *humeralis* Okada, can be readily distinguished by the infuscated humeri, wing only narrowly pale at apex, and larger distal mandibular teeth. *Matsuzawai* is most similar to *barnetti* n. sp. from Malaya and the Philippines, which has the hind femur distinctly banded, and *flaviscutatus* n. sp. from India to Borneo, which has the wing tip only faintly and indistinctly pale.

**20. *Culicoides (Trithecoides) flaviscutatus* Wirth and Hubert, n. sp. Figs. 20, 38.**

*Culicoides anophelis* Edwards (partim, misident.), 1922, Bull. Ent. Res. 13: 161 (Sumatra record); Macfie, 1932, Ann. Mag. Nat. Hist. ser. 10, 9: 493 (fig. spermathecae; Malaya records).

*Culicoides raripalpis*, (misident., not Smith 1929) Macfie, 1937, Roy. Ent. Soc. London, Proc. (B) 6: 115 (notes; Malaya records).

*Female.* Length of wing 0.85 (0.74–1.01,  $n = 14$ ) mm.

Head: Antenna with flagellar segments in proportion of 20–17–19–20–20–19–19–19–24–23–27–27–43, antennal ratio 0.93 (0.88–0.99,  $n = 12$ ); distal sensory tufts present on segments III, XI–XV. Palpal segments (fig. 20a) in proportion of 6–16–19–9–9, segment 3 slender,  $2.5 \times$  (2.2–2.8,  $n = 12$ ) as long as greatest breadth, sensoria borne on surface of segment distally. Mandible (fig. 20c) with 12 (10–13,  $n = 28$ ) small triangular teeth of subequal lengths.

Thorax: Scutum and upper pleuron pale yellow; scutellum, postscutellum and lower 1/2 of pleuron dark brown. Legs dark brown; fore leg with knee spot blackish, femur with subapical and tibia with sub-basal broad, pale bands; mid leg with knee pale, apex of femur and base of tibia broadly pale; hind leg with femur all dark, tibia usually with narrow basal and apical pale bands; claws simple.

Wing (fig. 38): Pattern as figured; anterior margin dark brown with 2 large pale spots, one centering over r–m crossvein and other over end of second radial cell; less distinct pale spots also present on disc of wing and at tip of wing, including apices of cells  $R_5$  and  $M_1$ . Macrotrichia moderately abundant at wing margin in cells  $R_5$ ,  $M_1$  and  $M_2$ , and in rows along distal 1/3 of vein  $M_1$ ; costa extending to 0.69 (0.66–0.72,  $n = 14$ ) of distance to wing tip. Halter usually pale.

Abdomen: Light brown; terga poorly sclerotized,  $2.3 \times$  as broad as long on segment 3. Three spermathecae (fig. 20b), unequal, with broad, unsclerotized entrances to ducts; large one elongate, measuring 0.035 mm. by 0.028 mm. and 2 small ones measuring 0.019 mm. by 0.017 mm.; ducts from 2 small spermathecae joined just before junction with duct from large one at sclerotized ring, latter duct enlarged and sac-like just before junction; ducts each with hyaline ring near spermatheca.

*Male genitalia* (figs. 20c, d). Sternum 9 transverse, without caudomedian excavation; tergum 9 long and tapering, with deep caudomedian cleft and pair of large sublateral lobes curving toward and nearly as long as triangular, pointed apicolateral processes. Basistyle with ventral root inapparent, dorsal root slender; dististyle markedly curving to slender, pointed tip. Aedeagus with basal arch extending to 2/5 of total length, basal arms stout; sides nearly straight, tapering to slender tip. Parameres each without basal knob, basal portion curving laterad and then cephalad from stem; stem quite short, swollen on short basal portion, quickly tapering to simple, filiform tip curving ventrolaterad.

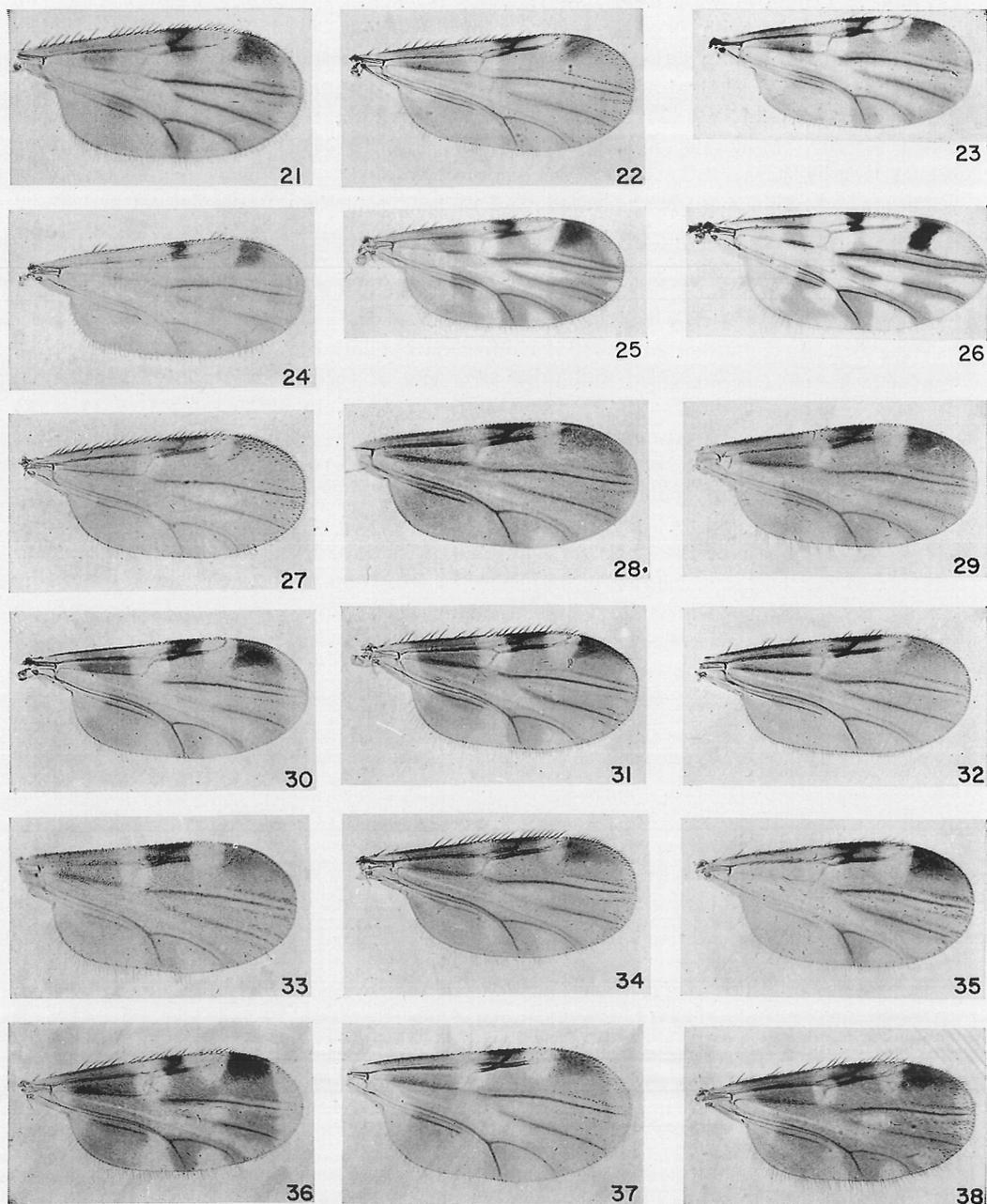
DISTRIBUTION: North Borneo; Ceylon, India, Malaya, Philippines, Sarawak, Sumatra, Thailand.

Holotype, female, allotype, male, Labuan Island, N. Borneo, Sept.–Nov. 1948, D. H. Colless, at light (type no. 64314, USNM). Paratypes, 20 males, 70 females: 13 males, 38 females, same data as type, except Oct. 1951 and Feb.–Mar. 1952; female, Sept. 1948, biting man. 2 females, Tambunan, N. Borneo, June, 1949, D. H. Colless, biting man. 8 females, Limbang, Sarawak, Dec. 1951, D. H. Colless, biting man; 7 males, 21 females, same except Dec. 1950, at light.

*Other specimens:*

CEYLON: 4 females, Colombo, 19 Feb. 1958, Med. Res. Inst., light trap.

INDIA: 7 females, Dharwar, BM 1932–99, R. Newstead (BMNH); 4 females, "India" BM 1932–99 (BMNH) (all reported as *anophelis* by Macfie, 1932); 6 females, Guanati, Assam, Dec. 1936, C. S. Swaminath, BM 1948–585 and BM 1949–76 (det. as *rariipalpis* by Macfie).



**Figs. 21-38.** Wings of *Culicoides* species. 21. *anophelis*; 22. *culiciphagus*; 23. *baisasi*; 24. *flavescens*; 25. *paraflavescens*; 26. *tenuipalpis*; 27. *fulvithorax*; 28. *ochrothorax*; 29. *macfiei*; 30. *humeralis*; 31. *elbeli*; 32. *sarawakensis*; 33. *rariipalpis*; 34. *gewertzi*; 35. *albibasis*; 36. *barnetti*; 37. *matsuzawai*; 38. *flaviscutatus*.

MALAYA: 4 females, Malay States, A. T. Stanton, BM 1932-99 (reported as *anophelis* by Macfie 1932) (BMNH); 4 females, Kuala Lumpur, 1936, J. Buckley, BM 1948-585 (reported as *varipalpis* by Macfie 1937) (BMNH); 8 females, Kuala Lumpur, 15, 19 Feb. 1955, H. C. Barnett, light trap; male, 15 females, March, Oct. 1958, R. Traub, light trap; 4 females, Ulu Langat, Selangor, 20 Apr. 1955, H. C. Barnett, light trap; 14 females, Subang Forest Pres., Kuala Lumpur, 12 June 1958, R. Traub, light trap; 6 females, Serdang, Selangor, 13, 15 Feb. 1955, H. C. Barnett, light trap; 4 females, Segambut, Selangor, 2 Mar. 1955, H. C. Barnett, biting human; female, Kepong, Selangor, 8 Mar. 1955, H. C. Barnett, biting deer; 4 females, Ampang Reservoir, Selangor, 2 July 1958, R. Traub, light trap; 2 females, Kuala Singgora, Pahang, 17 July 1958, R. H. Wharton, light trap; 4 females, Bukit Besi, Dungun, Trengganu, 6 Aug. 1958, R. Traub, light trap; 3 females, Kuala Kengrong, Girik, Perak, 14 Apr. 1958, R. Traub, light trap; male, female, Telok Sisek, Kuantan, Pahang, 14 June 1958, R. H. Wharton, light trap; 5 females, Pekan Road, swamp forest, Kuantan, Pahang, 3 Apr. 1957, R. H. Wharton, light trap.

PHILIPPINES: Female, Angeles, Pampanga Prov., 17 Sept. 1957, I. Balatbat, light trap; 14 females, Camp Baclayan, E. slope Mt. Apo, Davao Prov., Mindanao, Nov. 10-13, 1946, F. G. Werner, biting man, elev. 1800 m. (Chicago Natural History Museum Collection).

SUMATRA: Female, Deli IBE 1916-168 (reported as *anophelis* by Edwards 1922) (BMNH).

THAILAND: 17 females, Ban Na Muang, Dansai, Loei, 30 Sept. 1954, R. E. Elbel; female, Paiao, 5 Mar. 1952, D. C. Thurman, light trap; 13 females, Chiengrai and Bangkok, 1931-1935, O. R. Causey; 15 females, Pulau Panjang, Phangnga, 5-10-54, cowshed; male, female, Chiengmai, Apr.-May 1958, V. Notananda.

In the early literature this species was confused with *anophelis* Edwards and *varipalpis* Smith, but most of the records have been corrected here as a result of study of material kindly loaned by the British Museum (Natural History). The combination of even mandibular teeth, entirely pale scutum, well-marked wing, pale halter, and entirely dark hind femur will serve to distinguish *flaviscutatus* from other similar species. There is considerable variation in the hind tibia of this species, the color ranging from brown with pale basal and apical bands to completely yellow.

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## TENTH PACIFIC SCIENCE CONGRESS

The Tenth Pacific Science Congress of the Pacific Science Association will be held at the University of Hawaii, Honolulu, from 21 August to September 1961. Bishop Museum and U. S. National Academy of Sciences are sponsoring the Congress with the cooperation of the University of Hawaii. The Pacific Science Association is an international, non-governmental organization, with headquarters at Bishop Museum. Communications between congress, which are held about every four years, are maintained through the Association office, and through the activities of standing committees in various phases of science. The present chairman of the standing Committee on Pacific Entomology is J. J. H. Szent-Ivany (Port Moresby).

The president of the Tenth Congress is L. H. Snyder, president of the University of Hawaii, and the Secretary-General is H. J. Coolidge, Executive Director of the Pacific Science Board (National Academy of Sciences). C. E. Pemberton and Alexander Spöehr (Director of Bishop Museum) are members of the Executive Committee. The Organizer of the Section of Biological Sciences is R. L. Usinger, and the Organizer of the Division of Zoology (terrestrial) and Entomology is J. L. Gressitt. The latter division embraces both the representation of the Standing Committee on Pacific Entomology and the Standing Committee on Terrestrial Zoology of the Pacific (chairman, A. W. B. Powell, Auckland). It is hoped that many entomologists may attend and participate. A Circular of Information will be issued in August 1960.

A "List of Entomologists of the Pacific Area" is available gratis on writing to the Pacific Science Association, or the Entomology Department, Bishop Museum, Honolulu.