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THE NEOTROPICAL BLOODSUCKING MIDGES OF THE *CULICOIDES GUTTATUS* GROUP OF THE SUBGENUS *HOFFMANIA* (DIPTERA: CERATOPOGONIDAE)

By

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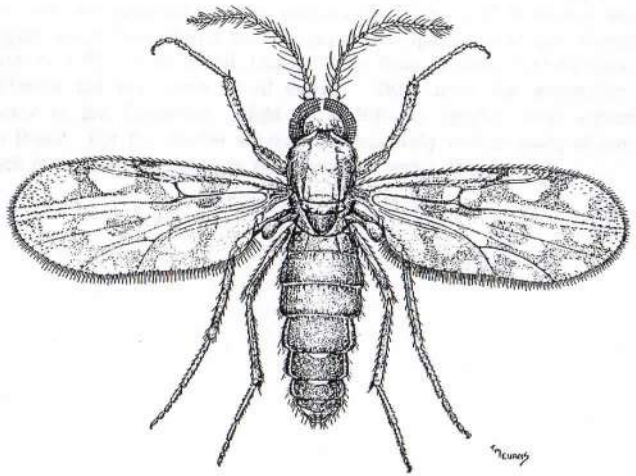

Fig. 1. *Culicoides diabolicus* Hoffman, female (drawing by Thomas Evans).

INTRODUCTION

The Neotropical biting midges related to *Culicoides guttatus* (Coquillett) remain one of the most difficult taxonomic groups in the genus, despite several attempts at their classification (Fox, 1948; Ortiz, 1950a; Wirth & Blanton, 1956, 1959, 1973; Forattini, 1957). Wirth & Blanton (1973) and Aitken et al. (1975) achieved partial success when dealing with the species in a restricted area (Amazon Basin and Trinidad, respectively). Nevertheless, a group of species including *C. batesi* Wirth & Blanton, *C. diabolicus* Hoffman, and *C. filarifer* Hoffman remained an enigmatic complex in which species were usually misidentified, depending on one's selection of key morphological characters. More than 30 years ago the problem was seriously assessed and taxonomic material was gradually accumulated in the U.S. National Museum of Natural History (USNM) and the Florida State Collection of Arthropods (FSCA) waiting for the opportunity for a comprehensive study. This opportunity came in early 1991 when the senior author received the Robert S. McNamara Fellowship of the World Bank to make such a study at the University of Florida School of Veterinary Medicine.

We have examined 9,546 specimens mounted on microscope slides in phenol-balsam according to the method of Wirth & Marston (1968). In addition we made a necessarily less critical examination of about 5,000 pin-mounted specimens in the USNM.

The proclivity for some species of the group to feed on humans focused attention on their taxonomic study many years ago. *Culicoides diabolicus* Hoffman (1925) (Fig. 1) was so named because the types were taken in Panama biting "like the devil." Wirth & Blanton (1959) summarized literature records of *C. diabolicus* [complex] biting man: Adamson (1939) in Trinidad; Gibson & Ascoli (1952) and Wirth (1955) in Guatemala. Wirth & Blanton (1974) reported the following species feeding on man: *foxi* Ortiz, *insignis* Lutz, and *trinidadensis* Hoffman. Aitken et al. (1975) listed the following species biting man in Trinidad (* = most important): *filariferus, flavivenula, foxi*, fusipalpis, insignis, maruim*, pseudodiabolicus*, and *trinidadensis**. They reported that *pseudodiabolicus* was especially abundant in the forest canopy, suggesting that arboreal animals might provide many blood meals. Wirth et al. (1968) had reared *C. pseudodiabolicus* (reported as *diabolicus)* from rotting spadices of the Panama hat palm or "Jipajapa," *Carludovica palmata* Ruiz & Pavon, in Panama. For this reason the Gorgas Memorial Laboratory in 1976 assigned Gary C. Vitale to rear *Culicoides* from bromeliads and other plant materials at their field station on Maje Island in the Bayano River impoundment (Vitale et al., 1981). It was suspected that arboreal *Culicoides* might be involved in the transmission of a number of arboviruses that were causing problems. It was unusually dry in 1976, and although *Culicoides* larvae were found in tree holes, bromeliads, leaf humus, rotting palm stumps, streams, bamboo internodes, and *Heliconia* inflorescences, adults were reared from only the first 3 substrates. No species of the *guttatus* group was reared successfully in this study, although 5 species of the subgenus *Haematomyidium* were reared, mainly from tree holes.

One of the main reasons for the present study developed from the incrimination of Culicoides *insignis* Lutz as the main vector of bluetongue virus in cattle in the Caribbean and adjacent continental areas. The data base supporting the incrimination of *C. insignis* as the primary vector of bluetongue viruses in the Middle American region continues to grow. This species has been found to be the predominant form present in association with ruminant livestock in Florida (Kramer et al., 1985), the Caribbean (Greiner et al., 1984; Greiner and Rawlins, 1987; Greiner et al., 1989, 1990a, 1990b, and 1992) and in Central America (Homan et al., 1985, and Greiner et al., 1992). Furthermore, *C. insignis* feeds on cattle in Central America (Homan et al., 1985) and in the Caribbean (Greiner et al., 1990b). Natural infections of bluetongue virus have been detected in *C. insignis* in Florida (Greiner

et al., 1985, 1992) and in Central America (Greiner et al., 1992). Tanya et al., (1992) were able to transmit bluetongue virus into sheep via *C. insignis* following of intrathoracic inoculation of virus. This species was also shown to support replication of virus in *C. insignis* fed on a virus-containing blood meal via an artificial membrane (Tanya et al., 1992). Because of the wide distribution of this species through much of the neotropics, the difficulty in distinguishing members of the *C. guttatus* group, the need for revising the taxonomy of this group of biting midges becomes more apparent.

Fox (1958) had protested the extremely broad species interpretations and extensive synonymies proposed in the *guttatus* Group by Barbosa (1947), Lane (1950), and Ortiz (1950a). Fox based his arguments on morphological features of the male parameres, insisting that *C. inamollae* Fox & Hoffman was a distinct species from *C. insignis*. Although Fox's arguments were not accepted by later workers, the status of *C. inamollae* was brought into question again when it was found that the pupal descriptions of *insignis* Forattini et al. (1956) and Forattini (1957) from Brazil, Linley (1965) from Jamaica, and Blanton & Wirth (1979) from Florida did not agree in all details. This raised the possibility that the bluetongue vector in the Caribbean might be a different species from typical *insignis* described from Brazil. For this reason we made an especially critical study of our material of *insignis*, which is reported in detail in the discussion under that species.

TERMINOLOGY (SEE FIGS. 2, 3)

Detailed acounts of the external anatomy of *Culicoides* can be found in the papers by Wirth (1952), Forattini (1957), Wirth & Blanton (1959, 1974), Blanton & Wirth (1979), and Downes & Wirth (1981). Special terms used in our descriptions include: wing length (WL) is measured from the basal arculus to the wing tip; the costal ratio (CR) is obtained by dividing the costal length measured from the basal arculus to the tip of the costa, by the wing length. Antennal ratio (AR) is the combined length of the 5 elongated distal flagellar segments (XI-XV) divided by the combined lengths of the 8 shorter preceding segments (III-X). The antennal sensilla trichodea ratio (ATR) as defined by Meiswinkel (1989) is obtained by dividing the length of the longest blunt-tipped trichodea on female antennal segment VI by the length of antennal segment VI. Palpal ratio (PR) is the length of the 3rd palpal segment divided by its greatest breadth. Proboscis/head ratio (P/HR) is obtained by dividing the length of the proboscis measured from the tormae (sclerotic thickening at the base of the labrum) to the tip of the labrum-epipharynx by the distance from the tormae to the median hair socket between the eyes.

Variation. During the present study we have observed considerable variation in several characters used for many years by previous authors as diagnostic characters in defining species:

1. Antennal sensillar pattern. The majority of the species show a typical pattern of sensilla coeloconica on antennal segments 3,11-15. We can be quite sure that this pattern is constant in those species in which we have checked a large series of individuals (especially from many localities), such as *C. batesi* Wirth & Blanton, *filarifer* Hoffman, *foxi* Ortiz, *franklini* n. sp., *fusipalpis* Wirth & Blanton, *lutzi* Costa Lima, *ocumarensis* Ortiz, and *paraignacioi* n. sp. *Culicoides trinidadensis* Hoffman and *insignis* Lutz always have additional sensilla coeloconica on segments 5, 7, and 9, and some specimens of the latter species also bear sensilla on segments 4, 6, 8, and/or 10. Some specimens of *C. fernandoi* Tavares & Souza and *pseudodiabolicus* Fox have extra sensilla on segments 7 and 9, and some specimens of *tidwelli* n. sp. bear extra sensilla on 3, 5, 7, 9, and 10.

2. Palpus. The shape of the third palpal segment and the nature of the sensory pit are very good characters. Nevertheless, in large series (i.e., *C. filarifer* or *ocumarensis)* we have observed variation in the length of the slender extension beyond the pit.

3. Wing pattern: distal pale spot in cell M1. In large series we have observed this spot clearly defined in some specimens, faint in others, and completely absent in others. Moreover, some specimens show a definite spot on one wing, and a faint spot on the other, or a faint spot on one wing, which is absent on the other. Due to this fact, we mentioned this character in the key as "cell M1 with primarily one (or two) distal pale spot(s)," based on the state of the character in the type, and also in the majority of the specimens.

4. Wing pattern: dark spot on r-m crossvein. In specimens characterized by having a pale r-m, some specimens show a darkish line, but not a definite dark spot. Due to this fact, we mention this character in the key as "r-m crossvein primarily pale."

5. Spermathecae: shape.

6. Extension of the basal arch of the aedeagus and degree of fusion of the parameres at the base.

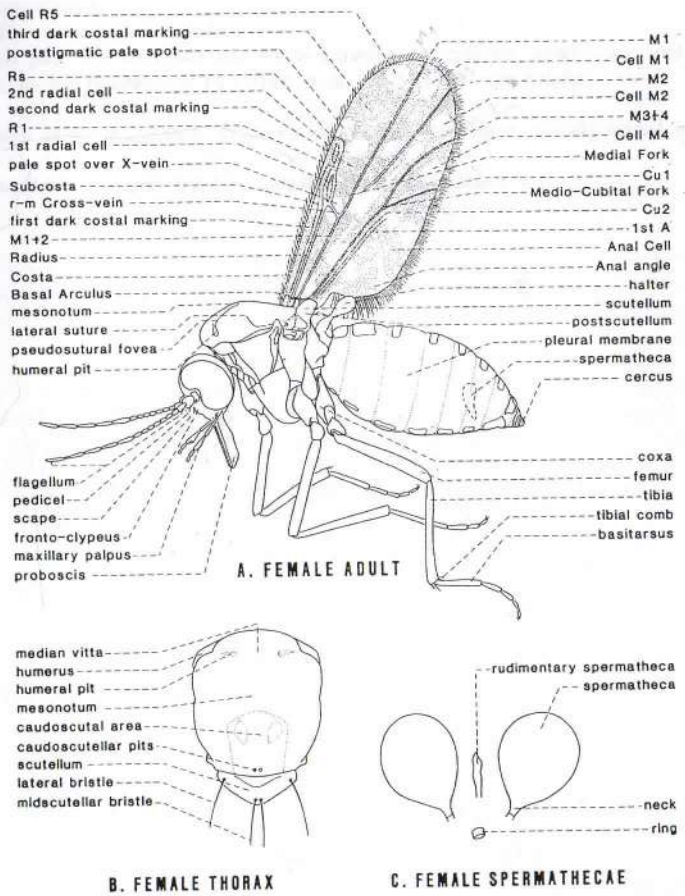

Fig. 2. *Culicoides* adult morphology: A, female with parts labelled; B, dorsal view of thorax; C, spermathecae (from Arnaud 1956).

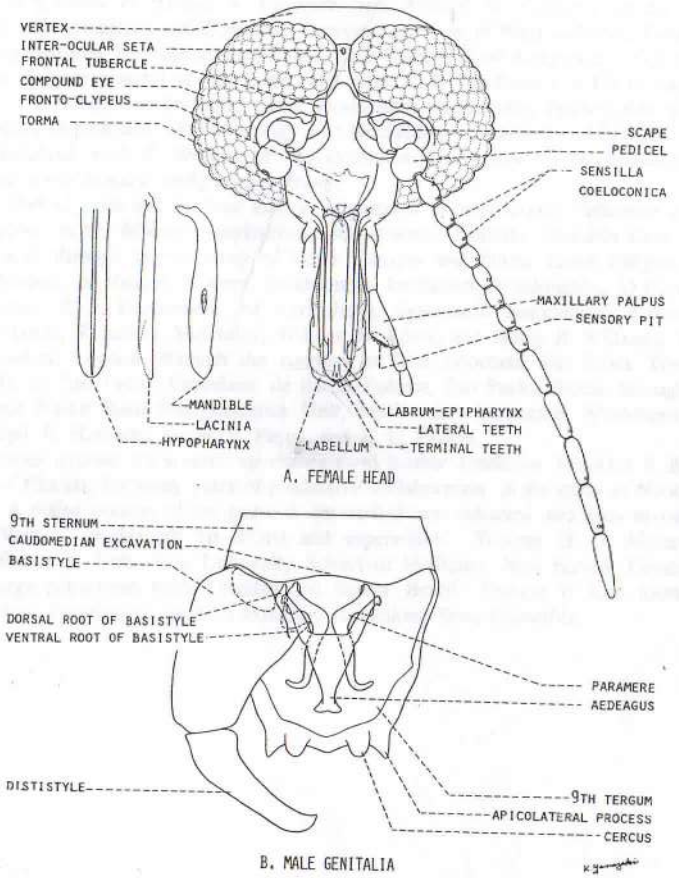

Fig. 3. *Culicoides* adult morphology: A, head and mouthparts of female, schematic, parts labelled; B, male genitalia, schematic, parts labelled (from Arnuad 1956).

On the other hand, there are some characters that are very useful for determinations, some of them overlooked by previous authors:

1. Shape of the proximal antennal segments, as well as the length transition between segment 10 and 11 (illustrated for each species).
2. ATR ratio.
3. Eye separation.
4. Number of mandibular teeth.
5. Palpal pit. We think the distinction between an irregular, subdivided, and clearly defined pit, as was pointed out by Aitken et al. (1975) to be very helpful.
6. P/H ratio.
7. Position of the apicolateral processes of the male 9th tergum (widely spaced or closer together).
8. Apex of the aedeagus (rounded papilla, blunt, or truncate).

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Subgenus *Hoffmania* Fox

Culicoides, subgenus *Hoffmania* Fox, 1948: 21. Type species, *Culicoides inamollae* Fox & Hoffman, by original designation.

Diagnosis. Wing with second radial cell ending in a pale spot; veins at base of mediocubital fork often pale-bordered in cell M4; small dark spot often present over r-m crossvein or at end of R4+5. Female antennal sensillar pattern usually 3,11-15. Eyes bare; usually contiguous. Spermathecae 2 plus vestigial 3rd and sclerotized ring; ovoid with short necks. Male genitalia rounded distally with apicolateral processes minute to small; gonocoxite with ventral root absent, dorsal root short and slender; aedeagus usually with basal arch low and the anterior margin often with sclerotized rim, distal process slender, usually with internal sclerotized peg at base and with apical papilla; parameres with short basal arm, often fused basally or joined in a mesal bridge, short and slender distally with minute fringing setae.

Immature Stages (see Fig. 4). Pupa with respiratory horn having tracheal rings extending 2/3 length of horn; operculum with short, stout spines, a unique elongate process near posterior end; ad setae long, subequal; caudal segment with a V-shaped patch of spines on disc.

Larva unique in having dark brown head capsule; thorax with contrasting purplish pigmented patches, most abundant on prothorax, often faint; no lateral pigmented spots. Head elongated, anterior end more or less narrower, ventral side with a suture; head setae long; parahypostomal setae located close to subgenal ring; hypostome without denticle; labium pointed, with 3 folds; epipharynx moderately sclerotized, with 4 combs, denticles on dorsal comb long, thin, and uniform in size, on 2nd and 3rd combs very small.

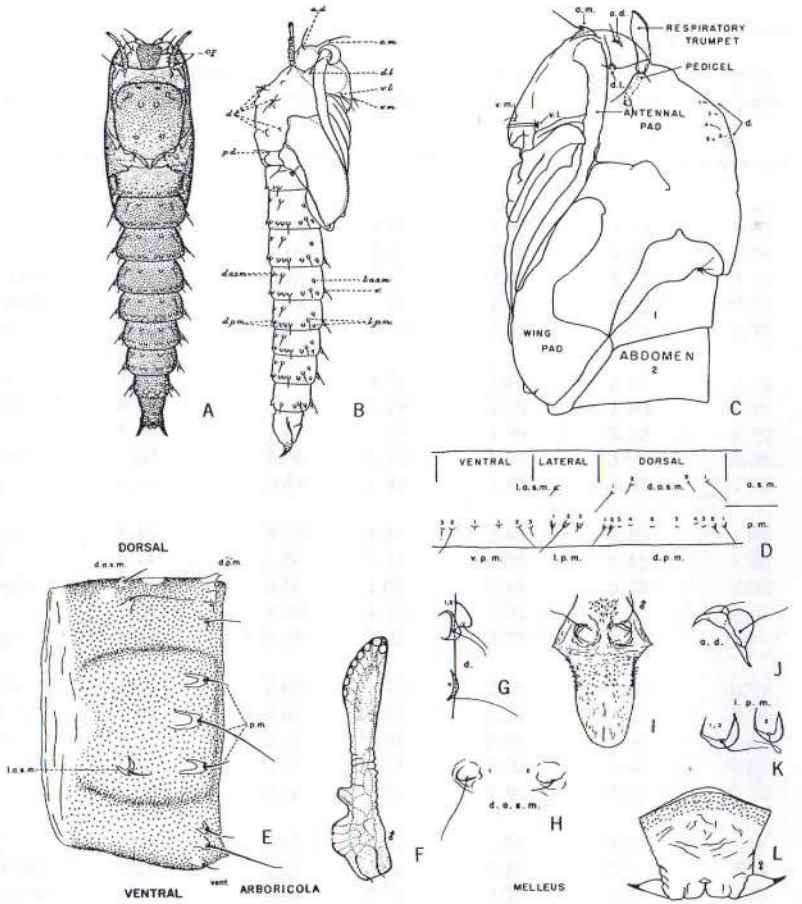


Fig. 4. *Culicoides* pupa (A,B from Carter et al 1920; C-D, F-L from Jones 1961; E from Linley 1970); for key to abbreviations see text.

Key to Species Groups of Subgenus *Hoffmania* in the Neotropical Region

1. Cell R5 with a separate pale spot present anterior to base of vein Ml . . . . . *hylas* Species Group
– Cell R5 without a separate pale spot present anterior to base of vein M1, pale area . . continuous from r-m crossvein to borders of vein M1 . . . . . *guttatus* Species Group

***Culicoides guttatus* Group**

REFERENCES: Wirth & Blanton 1956 (revision); Wirth & Blanton 1959 (Panama species); Wirth & Blanton 1974 (Amazon Basin); Aitken et al. 1975 (Trinidad); Wirth et al. 1988 (wing photo atlas).

Diagnosis. Base of cell M4 pale where it borders veins M3+4 and Cul; no pale spot anterior to base of vein Ml; antennal sensillar pattern 3,11-15, sometimes also present on some or all of segments 5, 7, 9.

Table 1. Numerical Characters of Species of the *Culicoides guttatus* Group

Species of *Culicoides*	Wing Length (mm)	Costal Ratio	Antennal Ratio	ATR Ratio	Palpal Ratio	P/H Ratio
batesi	1.10	0.68	1.07	2.40	2.70	0.81
biestroi	1.48	0.67	1.20	1.40	4.00	1.06
bimaculatus	0.94	0.66	1.15	2.00	2.75	1.12
brasilianum	1.35	0.67	1.12	2.05	3.70	0.98
brownei	1.07	0.68	1.14	2.55	2.85	0.87
charrua	1.73	0.68	0.95	1.60	3.50	1.12
coutinhoi	0.98	0.66	1.09	2.20	2.80	0.85
davidi	1.06	0.67	1.19	1.90	3.50	0.95
diabolicus	1.00	0.68	1.10	2.20	3.20	0.86
diffusus	1.10	0.67	1.20	1.90	4.35	1.19
fernandoi	1.36	0.66	1.14	2.40	3.50	1.00
filarifer	1.14	0.64	1.11	2.20	3.45	1.02
flavivenula	0.95	0.66	1.09	2.45	3.20	1.00
foxi	1.28	0.68	1.10	1.80	4.20	1.22
franklini	1.02	0.68	1.12	2.95	2.60	0.61
fusipalpis	1.03	0.67	1.10	2.15	3.50	0.93
guttatus	1.40	0.67	0.93	2.30	4.00	0.99
ignacioi	1.53	0.69	0.95	2.05	3.60	1.09
insignis	1.22	0.64	1.27	2.20	3.40	1.02
lutzi	1.10	0.66	1.22	2.80	2.40	0.76
marium	1.08	0.67	1.12	1.65	4.25	1.14
ocumarensis	1.05	0.67	1.12	2.20	3.55	0.97
paraignacioi	1.14	0.68	0.99	2.00	4.05	1.07
paramaruim	1.04	0.66	1.07	2.00	2.70	0.86
plaumanni	1.18	0.66	1.14	2.60	3.25	0.86
pseudodiabolicus	1.00	0.66	1.12	2.35	2.80	0.89
ruizi	1.18	0.67	1.06	1.95	2.10	0.65
tidwelli	0.99	0.69	1.20	2.30	2.25	0.75
travassosi	1.06	0.68	1.21	2.05	3.30	0.98
trinidadensis	1.22	0.64	1.27	1.75	3.40	1.02

Key to Species of the *Culicoides guttatus* Group

1. Wing markings diffuse, pale spots not brightly contrasting; mesonotum uniformly grayish brown pruinose; halter dark 2
-- Wing with contrasting pattern of dark and pale spots; mesonotum and halter various. 6

2. Third palpal segment with definite sensory pit 3
-- Third palpal segment without pit, sensilla scattered on surface 4

3. Third palpal segment elongated, with a single, rounded, sensory pit; eyes contiguous by a distance equal to diameter of 1.5 ommatidial facets; mandible with 22-23 very small teeth; P/H ratio 1.19; pale area on r-m crossvein small, rounded .... *diffusus* Spinelli, n. sp.
-- Third palpal segment shorter, slightly broad in middle, pit subdivided; eyes contiguous by a distance equal to diameter of 2.5 ommatidial facets; mandible with 16 teeth; P/H ratio 0.95; pale area on r-m crossvein large, reaching costa ..... *davidi* Spinelli, n. sp.

4(2). Antennal sensillar pattern 3,5,7,9,11-15; apicolateral processes of male 9th tergum close together; aedeagus with blunt apex and subapical projections extending ventrolaterad ..... *trinidadensis* Hoffman
-- Antennal sensillar pattern 3,11-15; apicolateral processes of male 9th tergum widely spaced; aedeagus without subapical projections, apex with small bulbous or ball-like tip 5

5. Third palpal segment long and slender (palpal ratio 4.25); male 9th tergum with mesal cleft; apex of aedeagus with ball-like tip ..... *maruim* Lutz
-- Third palpal segment stouter (palpal ratio 2.70); male 9th tergum without mesal cleft; apex of aedeagus with small bulbous tip ..... *paramaruim* Wirth & Blanton

6(1). Cell R5 with 2 pale spots distal to the one lying at apex of 2nd radial cell 7
-- Cell R5 with 1 pale spot distal to the one lying at apex of 2nd radial cell 8

7. Vein R4+5 with a small blackish spot just beyond apex; r-m crossvein dark; 3rd palpal segment slender (palpal ratio 3.30), slightly broader beyond middle, pit subdivided; P/H ratio 0.98; aedeagus with terminal papilla ..... *travassosi* Forattini
-- Vein R4+5 without small blackish spot just beyond apex; r-m crossvein pale; 3rd palpal segment stout (palpal ratio 2.10), pit irregular; P/H ratio 0.65; aedeagus with blunt tip ..... *ruizi* Forattini

8. Third palpal segment fusiform, without pit, sensilla scattered on surface; antennal sensillar pattern 3,11-15; r-m crossvein slightly darkened; usually 1 distal pale spot in cell M1; halter pale; aedeagus with terminal papilla ..... *fusipalpis* Wirth & Blanton
-- Third palpal segment with palpal pit (single, irregular or subdivided); antennal sensillar pattern, r-m crossvein, pale spots in cell Ml, halter, and aedeagus various 9

9. Crossvein r-m primarily pale (faintly darkened in some specimens of some species, but not a definite dark spot) 10
-- Crossvein r-m dark, at least on anterior 1/2 18

10. Vein R4+5 with a small blackish spot just beyond apex; 3rd palpal segment stout (palpal ratio 2.75), with conspicuous irregular pit; halter dark brown; pale areas predominant in the wing pattern ..... *bimaculatus* Floch & Abonnenc
-- Vein R4+5 without small blackish spot just beyond apex; 3rd palpal segment, halter, and wing pattern various 11

11. Cell M1 primarily (typical form) with 2 distal pale spots (distal spot faint or absent in some specimens of some species) 12
-- Cell M1 primarily (typical form) with 1 distal pale spot (a 2nd one sometimes developed in *C. batesi)* 16

12. Large species (wing length 1.35 mm); wing pattern with extensive pale areaspredominant; proximal antennal segments stout, 1.35 times as long as broad; halter knob dark .... *brasilianum* Forattini
-- Smaller species (wing length 0.99-1.14 mm); wing pattern with dark areas predominant; proximal antennal segments elongated, about twice as long as broad; halter knob dark or pale 13

13. Halter knob dark 14
-- Halter knob pale 15

14. Wing length 1.14 mm; costal ratio 0.64; male 9th tergum with apicolateral processes widely spaced ..... *filarifer* Hoffman
-- Wing length 1.05 mm; costal ratio 0.67; male 9th tergum with apicolateral processes closer together ..... *ocumarensis* Ortiz

15. Third palpal segment slender (palpal ratio 3.20), with definite extension behind tip; palpal segments 4 and 5 slender; antennal sensillar pattern 3,11-15; male 9th tergum with apicolateral processes widely spaced ..... *diabolicus* Hoffman
-- Third palpal segment stout (palpal ratio 2.25), nearly without extension behind tip; palpal segments 4 and 5 short and rounded; antennal sensillar pattern 3,(5),(7),(9-10),11-15; male 9th tergum with apicolateral processes closer together ..... *tidwelli* Spinelli, n. sp.

16(11). Halter knob dark; wing dark smoky brown with pattern of rather indistinct pale grayish spots; r-m crossvein faintly darkened; third palpal segment moderately stout (palpal ratio 2.70), pit irregular; apex of vein M3+4 dark .... *batesi* Wirth & Blanton
-- Halter knob pale; wing with very contrasting pattern; r-m crossvein always pale; 3rd palpal segment and vein M3+4 various 17

17. Third palpal segment slender (palpal ratio 3.20), with definite, shallow, round pit; apices of veins M2 and M3+4 dark; macrotrichia abundant, also present in anal cell; parameres broadly fused at bases ..... *flavivenula* Costa Lima
-- Third palpal segment stout (palpal ratio 2.40), pit irregular; apices of veins M2 and M3+4 broadly pale; macrotrichia sparse in apices of cells R5, M1 and M2; parameres connected by a short loop ..... *lutzi* Costa Lima

18(9). Cell M1 with 1 distal pale spot; halter dark 19
-- Cell M1 with 2 distal pale spots (the distal one faint or absent in some specimens of *brownei*; halter dark or pale 21

19. Antennal sensillar pattern 3,(4),5,(6),7,(8),9,(10),11-15; vein R4+5 dark up to the point where it turns abruptly forward to meet costa; mandible with 21-23 teeth ..... *insignis* Lutz
-- Antennal sensillar pattern 3,11-15; vein R4+5 pale or slightly darkened; mandible with 13-18 teeth 20

20. Eyes forming a V-shape where they contact; vein R4+5 with a small, faint, darkish spot behind apex; mandible with 18 teeth; apex of vein Cu1 pale ..... *charrua* Spinelli & Martinez
-- Eyes contiguous by a distance equal to diameter of 1.5 ommatitial facets; vein R4+5 without a darkish spot behind apex; mandible with 13 teeth; apex of vein Cu1 dark ..... *biestroi* Spinelli & Ronderos

21(19). Halter knob pale (sometimes very slightly infuscated in *coutinhoi* and *pseudodiabolicus)* 22
-- Halter knob dark brown 25

22. Large species (wing length 1.40 mm); 3rd palpal segment slender (palpal ratio 4.00), pit irregular; antennal ratio 0.93; proboscis relatively long (P/H ratio 0.99); male 9th tergum with long, slender apicolateral processes ..... *guttatus* (Coquillett)
-- Smaller species (wing length 0.98-1.02 mm); 3rd palpal segment stout (palpal ratio 2.60-2.80), pit irregular or subdivided; antennal ratio 1.09-1.12; proboscis short (P/H ratio 0.61-0.89); male apicolateral processes short 23

23. Eyes broadly contiguous by a distance equal to diameter of 4-5 ommatidial facets; 3rd palpal segment shorter than combined length of segments 4 and 5; P/H ratio 0.61 ..... *franklini* Spinelli, n. sp.
-- Eyes contiguous by a distance equal to diameter of 2-3 ommatidial facets; 3rd palpal segment longer than combined length of segments 4 and 5; P/H ratio 0.85-0.89 24

24. Third palpal segment with irregular pit; male 9th tergum with apicolateral processes closer together; apex of aedeagus with rounded papilla; apex of parameres with fringing hairs ..... *coutinhoi* Barretto
-- Third palpal segment with subdivided pit; male 9th tergum with apicolateral processes widely spaced; apex of aedeagus blunt, without terminal papilla; apices of parameres without fringing hairs ..... *pseudodiabolicus* Fox

25(21). Small species (wing length 1.07 mm); 3rd palpal segment stout (palpal ratio 2.85), nearly without terminal extension; 2nd distal pale spot in cell M1 sometimes faint or absent ..... *brownei* Spinelli, n. sp.
-- Larger species (wing length 1.14-1.53 mm: 3rd palpal segment elongated (palpal ratio 3.25-4.20), with long slender portion beyond pit; 2nd distal pale spot in cell M1 always present 26

26. Vein R4+5 with small darkish spot behind apex 27
-- Vein R4+5 without small darkish spot behind apex 28

27. Antennal sensillar pattern 3,11-15; 3rd palpal segment very elongated (palpal ratio 4.20), pit shallow and rounded; P/H ratio 1.22; vein R4+5 pale; male 9th tergum with somewhat widely-spaced apicolateral processes; apex of aedeagus truncated ..*foxi* Ortiz

-- Antennal sensillar pattern 3,(7),(9),11-15; 3rd palpal segment broad in middle (palpal ratio 3.50), pit irregular; P/H ratio 1.00; male apicolateral processes closer together; aedeagus with terminal papilla ..... *fernandoi* Tavares & Souza

28. Mandible with 13-15 relatively large teeth; P/H ratio 0.86; palpal pit irregular ..... *plaumanni* Spinelli, n. sp.
-- Mandible with 20-23 very small teeth; P/H ratio 1.07-1.09; palpal pit irregular or rounded 29

29. Large species (wing length 1.53 mm); 3rd palpal segment stouter (palpal ratio 3.60), pit irregular; male 9th tergum rounded distally ..... *ignacioi* Forattini
-- Smaller species (wing length 1.14 mm); 3rd palpal segment very slender (palpal ratio 4.05), with clearly-defined, round, small, shallow pit; male 9th tergum subquadrangular distally ..... *paraignacioi* Spinelli, n. sp.

DESCRIPTIONS OF SPECIES

Culicoides batesi Wirth & Blanton
(Figs. 5, 34)

Culicoides batesi Wirth & Blanton, 1973: 426 (female, male; Brazil; figs.); Wirth et al ., 1988: 14 (wing photo atlas; distr.).

Culicoides sanmartini Wirth & Barreto, 1978: 553 (female, male; Colombia; figs.); Wirth et al., 1988: 18 (wing photo atlas; distr.). NEW SYNONYMY.

Diagnosis. A small to medium-sized species, dark brown. Eyes (Fig. 5a) contiguous by a distance equal to diameter of 2-3.5 ommatidial facets. Antenna (Fig. 5 b,e,f) entirely brown, sensillar pattern 3,11-15. Palpus (Fig. 5c) brown; third segment moderately stout, sensory pit irregular. Mandible with 14-16 teeth. Mesonotum dark brown with grayish pollinosity, blackish on anterior margin and on extreme sides, a narrow median and 2 broader sublateral dark brown vittae. Wing (Figs. 5d, 34) dark smoky brown with pattern of rather indistinct pale grayish spots; r-m crossvein in a large pale spot but faintly darkened; vein R4+5 pale, slightly infuscated for a short distance; one transverse distal pale spot in cell R5 broadly meeting wing margin; one distal pale spot in cell Ml (typical form), but a 2nd one developed in many specimens; apices of veins Ml and M2 narrowly pale, apices of veins M3+4 and Cul dark; macrotrichia present on distal 1/3 of wing. Halter deeply infuscated. Legs dark brown; mid femur pale at tip, all tibiae with narrow basal, and hind tibia with narrow apical pale rings. Spermathecae (Fig. 5g) ovoid, slightly unequal. Male ninth tergum (Fig. 5i) with a pair of widely spaced, prominent apicolateral processes; aedeagus with bulbous tip; parameres (Fig. 5h) joined narrowly at extreme bases, main bodies stout, apices with distinct fringing hairs.

Variation (N = 10): WL 1.10 (0.91-1.20); CR 0.68 (0.66-0.69); AR 1.07 (0.97-1.12); ATR 2.40 (2.20-2.60); PR 2.70 (2.40-3.10); P/HR 0.81 (0.77-0.86).

Types. Holotype female, allotype male, Belem, Para, Brazil, vi.1969, T. H. G. Aitken, APEG Forest light trap (in USNM). Paratypes, 2 males, 150 females.

Holotype female and allotype male of *sanmartini*, Rio Raposo, Valle, Colombia, iii and 1.vii.1964, V. H. Lee (in USNM). Parayptes, 133 females, 34 males, many data.

Distribution. Bolivia, Brazil, Colombia, Ecuador.

Specimens Examined. 727 females, 1 male, from the following localities:

BOLIVIA: 60 mi n Santa Cruz (R. B. Cummings)

BRAZIL: Para, Belem, many data (T. H. G. Aitken; type series of *batesi)*,

COLOMBIA: Choco, Rt. 25 (D. G. Young); Curiche, many data (DGY); Teresita (DGY). Dept. Valle, Rio Raposo (V. H. Lee).

Specimens Examined. (labelled "*sanmartini*"): 87 females, 34 males.

BOLIVIA: Yapacani (H. Bermudez).

COLOMBIA: Cauca, Lopez, Rio Micay (M. A. Tidwell); Rio Micay, Casa de Suarez (VHL); Rio Micay, Puerto Lopez (VHL). Valle, Rio Raposo (VHL).

ECUADOR: Pr. Esmeraldas, Rio Gayapas (L. A. Leon). Pastaza, Cononaco (Cohen).

Wing Photo (Fig. 34). paratype: Brazil, Para, Belem (Aitken).

Discussion. This species is very similar to *C. lutzi*, from which it can be distinguished by the faintly darkened r-m crossvein, dark apex of vein M3+4 , and dark halter. Characters for separating *batesi* from *fusipalpis* are found in the discussion under the latter species.

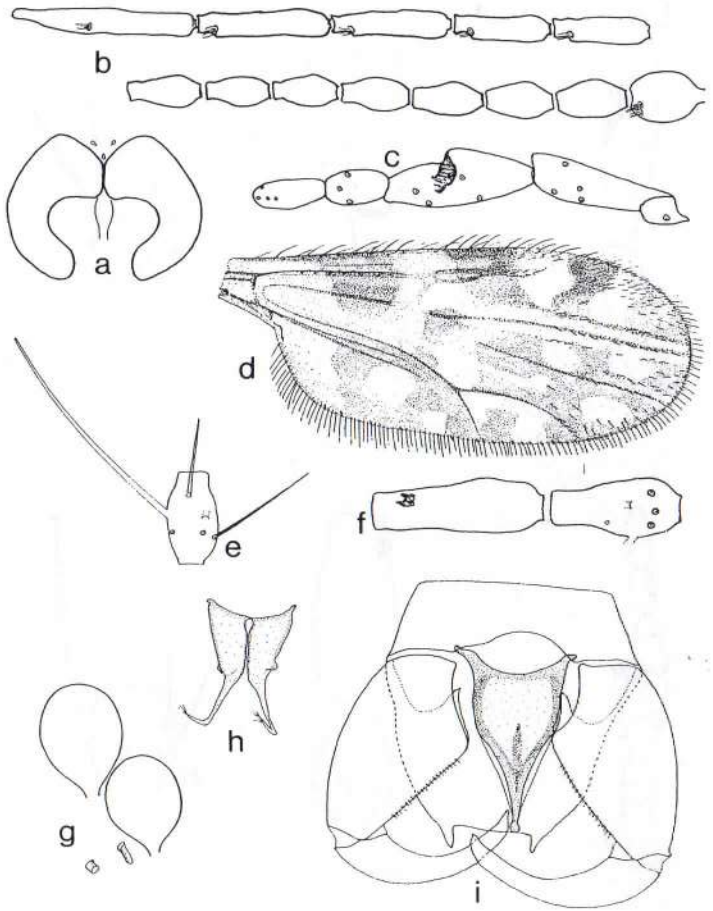


Fig. 5. *Culicoides batesi*; a-g, female; h-i, male: a, eye separation; b, antenna; c, palpus; d, wing; e, antennal segment 6; f, antennal segments 10 and 11; g, spermathecae; h,

Wirth & Barreto (1978) compared and distinguished *C. batesi* from *C. sanmartini*, based on differences in wing length and in the different contrast of the wing pattern. We checked carefully both type-series during the present study and concluded that those differences are not significant to separate species.

Culicoides biestroi Spinelli & Ronderos
(Figs. 6a-c, 35)

Culicoides biestroi Spinelli & Ronderos, 1991: 86 (female, male; Argentina; figs.); Spinelli & Martinez, 1992: 186 (Uruguay record).

Diagnosis. A large-sized, dark brown species. Eyes contiguous by a distance equal to diameter of 1.5 ommatidial facets. Antenna (Fig. 6a,b) brown, bases of flagellar segments 3-10 pale, sensillar pattern 3,11-15. Palpus (Fig. 6c) dark brown; 3rd segment elongated, pit irregular. Mandible with 13 teeth. Mesonotum dark brown, without prominent pattern. Wing (Fig. 35) with very contrasting pattern; r-m crossvein dark; vein R4+5 slightly darkened; one transverse distal pale spot in cell R5, not reaching wing margin; one distal pale spot in cell M1, distal pale spot in cell M2 not reaching wing margin; apices of veins M1, M2 and M3+4 pale, apex of vein Cu1 dark; macrotrichia present on distal 1/3 of wing. Halter dark. Legs brown, fore femur slightly paler; fore and mid knees and base and apex of hind tibia with yellowish rings. Two ovoid, unequal spermathecae. Male unknown.

Variation (N = 2): WL 1.48 (1.46-1.50); CR 0.67; AR 1.20 (1.13-1.27); ATR 1.40; PR 4.00; P/HR 1.06.

Types. Holotype female, 10 km S Monte Caseros (Dest. Pref. "Paniagua"), Prov. Corrientes, Argentina, 22.iv.1987, L. Biestro, CDC trap (in Mus. La Plata). Paratype female, Arroyo Zapata, Prov. Buenos Aires, 27.i.1988, H. Marino, CDC trap.

Distribution. Argentina, Uruguay.

Specimens Examined.

URUGUAY: Dto. Montevideo, Punta Espinillo, 6.x.1987, M. Martinez, in *Eryngium eburneum* Dec., 1 female.

Wing Photo (Fig. 35). Uruguay, Montevideo, Punta Espinillo (Martinez).

Discussion. This species closely resembles *C. insignis* and *C. charrua*. From *insignis* it can be distinguished by the mandible with 13 teeth, vein R4+5 only slightly infuscated, and sensillar pattern 3,11-15. From *charrua* it differs in the eyes more broadly contiguous, number of mandibular teeth (13 vs. 18), distal pale spots in cells R5 and M2 not reaching wing margin, and apex of vein Cu1 dark.

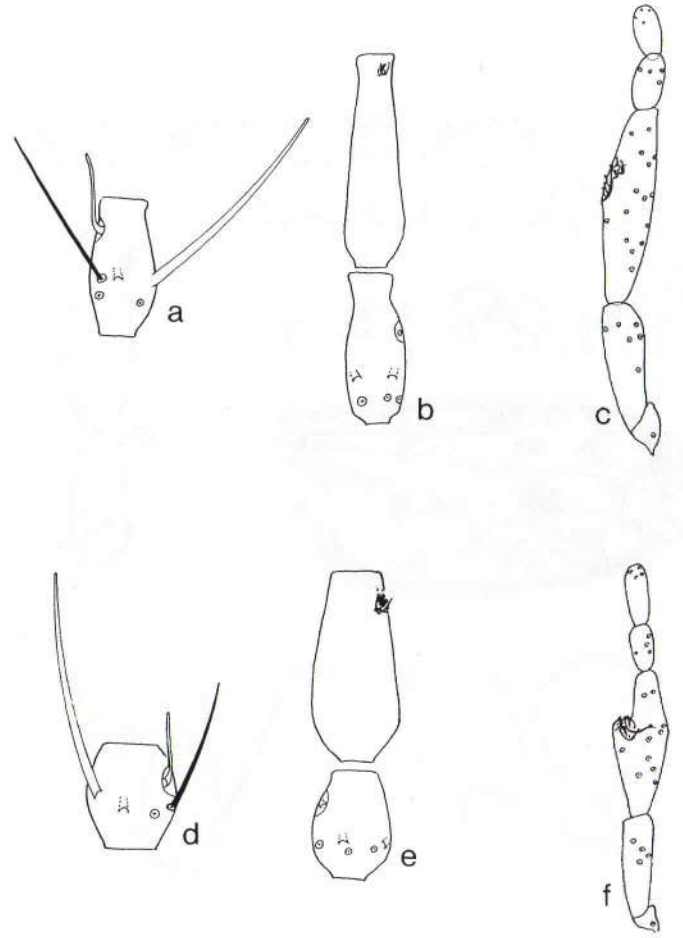


Fig. 6. *Culicoides biestroi* (a-d) and *C. bimaculatus* (d-f) female: a, d, antennal segments 10 and 11; g, spermathecae; h, parameres; i, genitalia, parameres omitted.

(Figs. 6d-f, 36)

Culicoides bimaculatus Floch & Abonnenc, 1942b: 3 (female; Guyane; fig. wing, palpus); Barbosa, 1947: 8 (in key); Fox, 1955: 230 (catalog reference); Forattini, 1957: 239 (synonym of *lutzi* Costa Lima); Wirth, 1974: 24 (catalog reference); Wirth et al., 1988: 14 (wing photo atlas; photo not available); Waller et al., 1990: 362 (Guyane; in key).

Diagnosis. A small, dark brown species. Eyes contiguous by a distance equal to diameter of 2 ommatidial facets. Antenna (Fig. 6d,e) brown, short; sensillar pattern 3,11-15. Palpus (Fig. 6f) brown; 3rd segment stout, with conspicuous, irregular, sensory pit. Mandible with 16-17 teeth. Mesonotum dark brown, without definite pattern. Wing (Fig. 36) with pattern in which pale areas are predominant; r-m crossvein pale; vein R4+5 infuscated on lower margin; a small blackish spot behind apex of 2nd radial cell; one transverse distal pale spot in cell R5 broadly reaching wing margin; 2 distal pale spots in cell M1 (the 2nd one very faint in 2 of the available specimens); apices of veins M1, M2, M3+4 pale, apex of vein Cul dark; scattered macrotrichia present on distal 1/3 of wing. Halter dark brown. Spermathecae small, spherical, subequal with short necks. Male unknown.

Variation (N = 4): WL 0.94 (0.92-0.97); CR 0.66 (0.63-0.67); AR 1.15 (1.13-1.18); ATR 2.00 (1.90-2.10); PR 2.75 (2.65-2.85); P/HR 1.12 (1.08-1.20).

Types. Holotype female "monte en preparation (les ailes a part) et conserve dans les collections de l'I. P. sous le no. 305 D. Les deux autres exemplaires sont classes comme paratypes sous les nos. 306 et 307."

Distribution. Brazil, Guyane.

Specimens Examined.

BRAZIL: Amazonas, Rio Amazon, Faro Grande to Mandii, 26.ix.1969, H. A. Wright, 2 females. Para, Belem, x.1970, T. H. G. Aitken, IPEAN buffalo pasture light trap, 1 female; *idem* except 18.xi.1979, biting man, APEG forest, 1 female.

Wing Photo. (Fig. 36).-- Brazil, Rio Amazon (Wright).

Discussion. This species resembles *C. foxi* by virtue of the presence of a small blackish spot behind the apex of the 2nd radial cell, and by the dark brown halter. Nevertheless, it can easily be distinguished from *foxi* by the stouter 3rd palpal segment with irregular sensory pit, and by the pale r-m crossvein. *Culicoides bimaculatus* also resembles the Nearctic species *C. venustus* Hoffman, especially in the general arrangement of the pale and dark wing spots, but *venustus* is a larger species with very contrasting wing pattern in which the dark areas are predominant.

Culicoides brasilianum Forattini

(Figs. 7, 37)

Culicoides brasilianum Forattini, 1956: 81 (female; Brazil; figs.); Forattini, 1957: 202 (redescribed; figs.; Brazil record); Wirth, 1974: 24 (catalog reference); Spinelli & Wirth, 1986: 51 (in key; wing photo); Wirth et al ., 1988: 15 (wing photo atlas); Ronderos & Spinelli, 1990: 82 (male described; Argentina; fig. wing, genitalia).

Diagnosis. A large-sized, dark brown species. Eyes contiguous by a distance equal to diameter of one ommatidial facet. Antenna (Fig. 7a,b,d) entirely brown; sensillar pattern

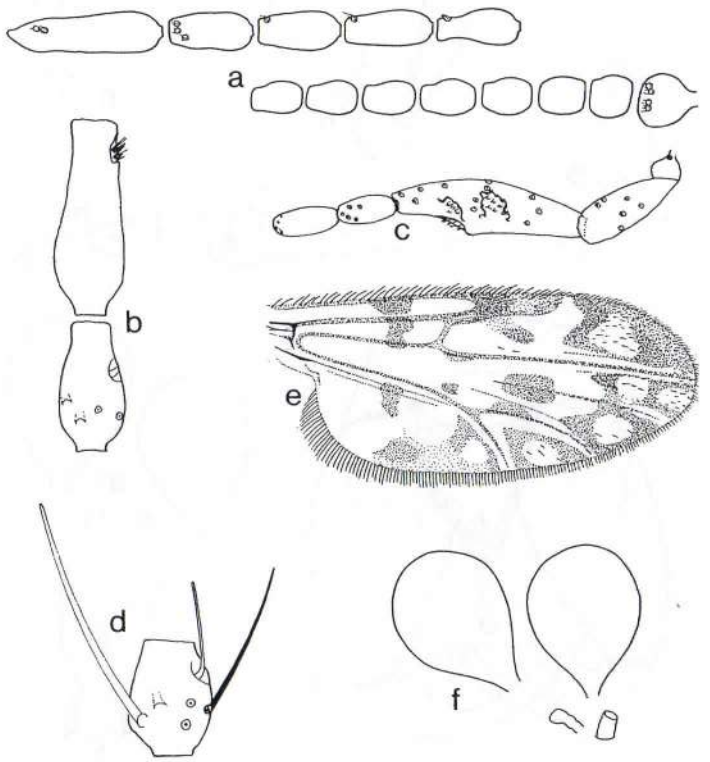


Fig 7. *Culicoides brasilianum*, female: a, antennae; b, antennal segments 10 and 11; c, palpus; d, antennal segment 6, e, wing; f, spermathecae.

3,11-15. Palpus (Fig. 7c) dark brown; 3rd segment slightly broader just beyond middle, pit irregular. Mandible with 14-16 teeth. Mesonotum without definite pattern. Wing pattern (Figs. 7e, 37) with extensive pale areas predominant; r-m crossvein pale; vein R4+5 pale; one transverse distal pale spot in cell R5 broadly meeting wing margin; 2 distal pale spots in cell Ml; apices of veins Ml, M2 and M3+4 pale, apex of vein Cul dark; macrotrichia present on distal 1/2 of wing, a few also in anal cell. Halter knob dark, pedicel pale. Legs brown, mid and hind knees and apex of hind tibia yellowish. Spermathecae pyriform, unequal (Fig. 7f). Male genitalia with apicolateral processes of ninth tergum small and close together; aedeagus with terminal papilla; parameres connected at bases by a short loop, main bodies stout, apex with minute fringing hairs.

Variation (N = 3): WL 1.35 (1.32-1.38); CR 0.67 (0.66-0.68); AR 1.12 (1.10-1.14); ATR 2.05 (1.85-2.25); PR 3.70; P/HR 0.98 (0.94-1.00).

Types. Holotype female and 39 female paratypes, Sao Vicente, Estado Sao Paulo, Brazil, viii-xi.1955, O. P. Forattini & E. X. Rabello (in Fac. Hig. Univ. Saulo Paulo, Brazil). We have examined the holotype through the courtesy of Dr. O. P. Forattini.

Distribution. Argentina, Brazil.

Specimens Examined.

BRAZIL: Sao Paulo, Sao Vicente, 17.x.1955, Forattini & Rabello, 2 females (paratypes).

Wing Photo (Fig. 37). Paratype, Brazil, Sao Paulo, Sao Vicente (Forattini & Rabello).

Discussion. *Culicoides brasilianum* is a large species, easily distinguished from the related species by the wing pattern with extensive pale areas; from *guttatus* it also differs in the pale r-m crossvein and dark halter, and from *ignacioi* 22(which has a very similar palpus) by the pale r-m crossvein and mandible with 14-16 teeth (20-22 in *ignacioi).*

Culicoides brownei Spinelli, new species
(Figs. 8, 38)

Female. Wing length 1.07 (0.99-1.15, n = 10) mm; breadth 0.51 (0.47-0.53, n = 10) mm.

Head: Dark brown. Eyes (Fig. 8a) bare, contiguous by a distance equal to diameter of 2.5-3.0ommatidial facets. Antenna (Fig. 8b,c) entirely brown; lengths of flagellar segments in proportion of 18-14-13-14-14-14-13-15-20-21-23-26-38; antennal ratio 1.14 (1.05-1.22, n = 10); sensillar pattern 3,11-15; ATR ratio 2.55 (2.50-2.60, n = 10). Palpus (Fig. 8d) brown, lengths of segments in proportion of 10-23-26-11-12; palpal ratio 2.85 (2.70-3.00, n = 10); 3rd segment stout, broad in middle, pit irregular. Mandible with 14-16 (n = 10) teeth; P/H ratio 0.87 (0.80-0.92, n = 10).

Thorax: Mesonotum dark brown, with conspicuous yellowish area mesad; pleura yellowish brown. Wing (Fig. 38) with contrasting pattern; r-m crossvein dark on anterior 1/2, included in a large pale spot; 2nd radial cell with broad lumen; vein R4+5 infuscated on lower margin; one large transverse distal pale spot in cell R5 broadly meeting wing margin; cell M1 primarily with 2 distal pale spots, but the distal one sometimes faint or even absent in some specimens; distal pale spot in cell M2 large, usually not attaining wing margin; cell M4 with rounded pale spot that is not connected with the pale area bordering lower margin of vein M3+4; anal cell with 2 distal pale spots; apices of veins M1, M2 and M3+4 pale, apex of vein Cu1 dark; scattered macrotrichia present on distal 1/3 of wing; costal ratio 0.68 (0.67-0.70, n = 10). Halter brown. Legs dark brown; apices of mid femur and hind tibia yellowish; all tibiae with subbasal yellowish rings; hind tibial comb with 5 bristles.

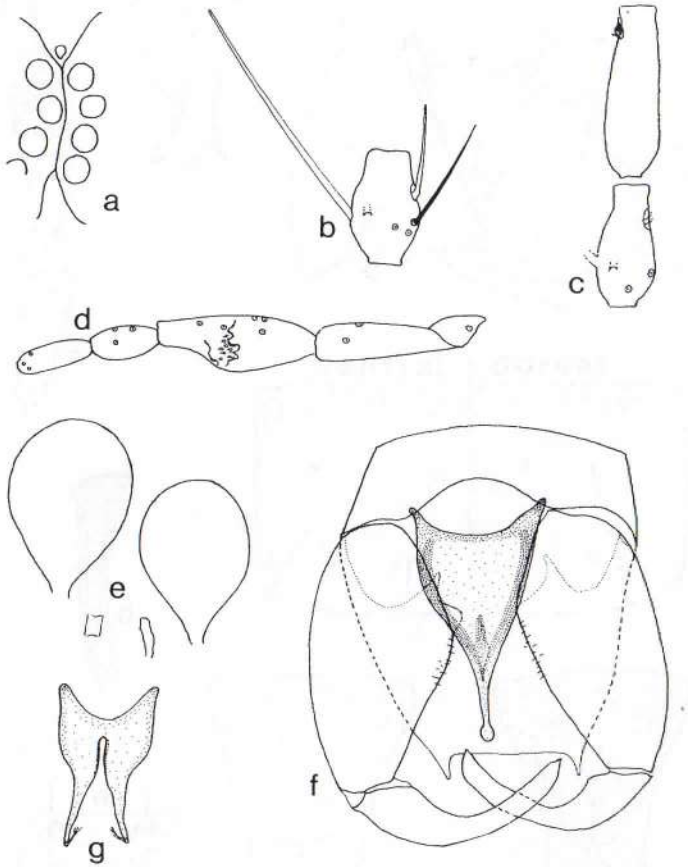


Fig. 8. *Culicoides brownei*; a-e, female; f-g, male: a, eye separation; b, antennal segment 6; c, antennal segments 10 and 11; d, palpus; e, spermathecae; f, genitalia, parameres omitted; g, parameres.

Abdomen: Dark brown. Spermathecae ovoid, unequal (Fig. 8e); measuring 0.054 x 0.037 mm, and 0.048 x 0.033 mm.

Male. Wing length 0.91 mm; breadth 0.36 mm; costal ratio 0.69.

Similar to female with usual sexual differences. Genitalia (Fig. 8f): Ninth sternum with rather deep caudomedian excavation, membrane not spiculate; 9th tergum with caudal cleft, and a pair of short, widely spaced, apicolateral processes. Gonocoxite stout, gonostylus strongly curved with pointed tip. Aedeagus with low basal arch; lateral arms strongly sclerotized anteriorly, distal portion slender with apical papilla; distinct internal sclerotized peg present. Parameres (Fig. 8g) fused on basal 1/4; main bodies relatively stout, apices with minute fringing hairs.

Distribution. Colombia.

Types. Holotype female, Colombia, Valle, Rio Raposo, ii.1964, V. H. Lee, light trap; allotype male, same data except iii.1964 (in USNM). Paratypes, 125 females, 6 males, as follows: Same data as holotype, 18 females, 1 male; same data as allotype, 9 females, 1 male; same data except iii.1963, 1 female; iv.1963, 13 females, 2 males; v.1963, 9 females; vii.1963, 7 females; viii.1963, 5 females; xii.1963, 3 females; i.1964, 9 females; iv.1964, 1 male; v.1964, 3 females; vi.1964, 14 females; vii.1964, 1 female, 1 male; viii.1964, 3 females; xii.1964, 1 female; ii.1965, 5 females; iii.1965, 9 females; v.1965, 6 females; vii.1965, 1 female; viii.1965, 1 female. Colombia, Palagua, Pto. Boyaca, 25.iii.1973, M. F. Suarez, 1 female.

Wing Photo (Fig. 38). Holotype: Colombia, Valle, Rio Raposo (Lee).

Discussion. This species is dedicated to Joseph E. Browne of Old Dominion University in recognition of his important studies on the systematics of Colombian *Culicoides*.

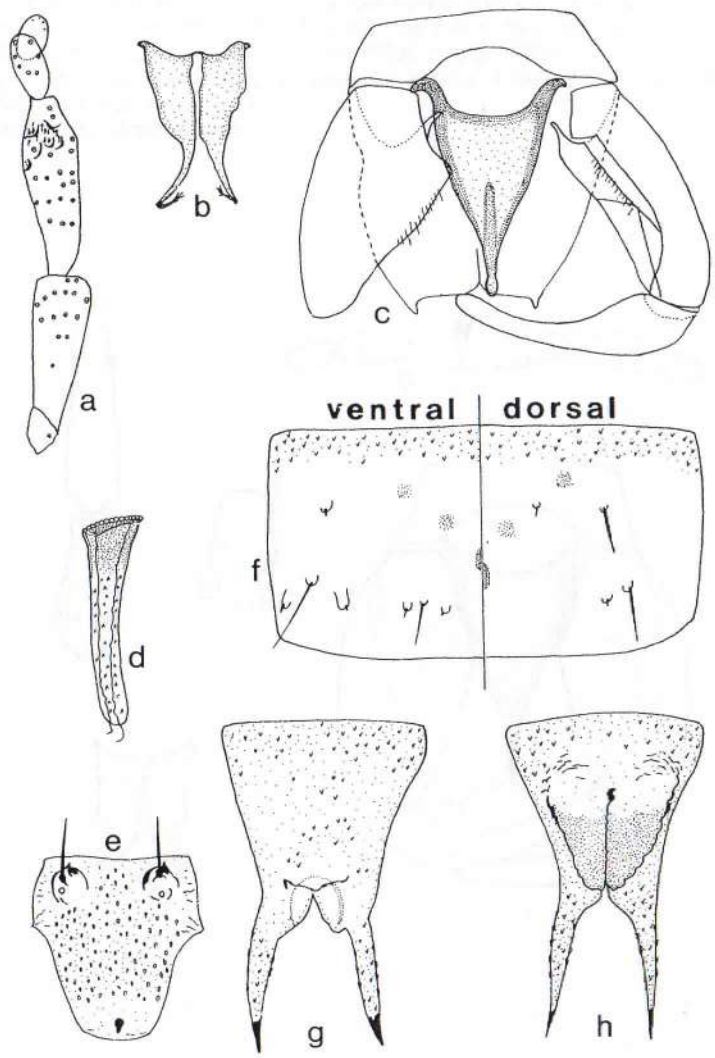
Culicoides brownei is very simiilar to *C. franklini* n. sp., from which it can be distinguished by the stouter 3rd palpal segment with irregular pit, eyes contiguous for 2.5-3.0 ommatidial facets (by 4-5 facets in *franklini*), and by its dark halter.

Culicoides charrua Spinelli & Martinez
(Figs. 9, 39)

Culicoides charrua Spinelli & Martinez, 1992:176 (male, female, pupa; Uruguay).

Diagnosis. A large-sized brownish species. Eyes forming a V-shape where they contact. Antenna pale brown, sensillar pattern 3,11-15. Palpus (Fig. 9a) brown; 3rd segment with irregular pit. Mandible with 18 teeth. Mesonotum brownish, without definite pattern. Wing (Fig. 39) with contrasting pattern; r-m crossvein entirely dark; vein R4+5 pale, with a small, faint, darkish spot behind apex; one distal transverse pale spot in cell R5 broadly reaching wing margin; one distal pale spot in cell M1; apices of veins M1 M2, M3+4 and Cu1 pale; macrotrichia sparse on distal 1/2 of wing and in anal cell. Halter brown. Femora pale brown except distal 1/5 dark brown; tibiae brown, pale rings on fore and mid knees and base and apex of hind tibia. Spermathecae ovoid, subequal. Male 9th tergum (Fig. 9c) with widely spaced, small apicolateral processes; aedeagus with terminal papilla; parameres (Fig. 9b) joined at bases by a short sclerotized loop, main bodies stout, tips with fine fringing hairs.

Fig. 9. *Culicoides charrua*; a, female; b-c, male; d-h, pupa: a, palpus; b, parameres; c, genitalia, parameres and one gonostylus omitted; d, prothoracic respiratory horn; e, operculum; f, abdominal tubercles; g, last abdominal segment of female; h, same, of male.



Pupal respiratory horn (Fig. 9d) yellowish, distal 1/3 brown, with 12-15 apical spiracular openings; operculum as in Fig. 9e; tubercles of abdominal segments (Fig. 9f) not strongly developed; 2 dpm, the outer bearing a long hair, the inner a minute spine; 2 dasm, the outer bearing a fine seta, the inner a short spine; 3 vpm, the middle one bearing a hair, the others 2 short spines; 1 lasm, with a minute spine; 3 lpm tuberles, the outer bearing a short spine, the middle a long hair, and the inner one a minute spine. Terminal abdominal processes of female as in Fig. 9g; male as in Fig. 9h.

Numerical Values (N = 1): WL 1.73; CR 0.68; AR 0.95; ATR 1.60; PR 3.50; PH/R 1.12.

Types. Holotype female, allotype male, Playa Pascual, Dto. San Jose, Argentina, 6.x.1987, M. Martinez (in Mus. La Plata).

Distribution. Uruguay.

Specimens Examined. Holotype female, allotype male. URUGUAY: Dto. San Jose, Playa Pascual, 6.x.1987,N. Martinez, in *Eryngium serra.*

Wing Photo (Fig. 39). Holotype: Uruguay, Dto. San Jose (Martinez).

Discussion. The adult of this species is similar to *C. insignis*, from which it can be distinguished by the antennal sensory pattern and by the vein R4+5 pale with a small, faint, darkish spot behind apex. On the other hand, the pupa differs from *insignis* pupa in many aspects, such as lacking lateral spiracular openings on the respiratory horn, and the poor development of the dpm tubercles.

Culicoides biestroi is also similar to *C. charrua*. Characters for separating the two species are given in the discussion under *C. biestroi*.

Two female specimens from Brazil, Santa Catarina, Ponta Grossa, i.1956 (USNM) fit very well with *C. charrua*. They differ from the holotype of *charrua* only in the antennal sensillar pattern 3,(4),5,7,9,(10),11-15,and in the infuscation of the lower margin of vein R4+5. Since we have observed considerable variation of these characters in several species of the *gutttatus* group, it is quite possible that the above mentioned specimens belong to *C. charrua*.

Culicoides coutinhoi Barretto
(Figs. 10, 40)

Culicoides coutinhoi Barretto, 1944: 96 (male; Brazil; figs.); Barbosa, 1947: 13 (notes from Barretto's paper); Ortiz, 1950a: 449 (notes); Fox, 1955: 24 (catalog reference); Wirth & Blanton, 1956: 314 (female, male; French Guiana; figs.); Forattini, 1957: 239 (synonym of *lutzi);* Wirth, 1974: 24 (catalog reference); Spinelli & Wirth, 1986: 52 (in key; wing photo); Wirth et al., 1988: 14 (in wing photo atlas).

Diagnosis. A medium-sized, brown species. Eyes contiguous by a distance equal to diameter of 3 ommatidial facets. Antenna (Fig. 10a,b) brown, bases of flagellar segments 3-10 paler; sensillar pattern 3,11-15. Palpus (Fig. 10c) brown; 3rd segment stout, with irregular sensory pit. Mandible with 15-17 teeth. Mesonotum dark brown, with pair of submedian yellowish bands. Wing (Fig. 40) with contrasting pattern; r-m crossvein infuscated on anterior 1/2; vein R4+5 pale; one distal transverse pale spot in cell R5 broadly meeting wing margin; 2 distal pale spots in cell Ml; apices of veins Ml, M2 and M3+4 pale, apex of vein Cul dark; a few macrotrichia present at extreme tips of cells R5, Ml and M2. Halter knob pale, sometimes slightly infuscated in females. Legs brown, fore and mid knees and base and apex of hind tibia yellowish. Spermathecae subspherical to

ovoid, subequal. Male 9th tergum (Fig. 10e) with caudal cleft, apicolateral processes close together; aedeagus with terminal papilla. Parameres (Fig. 10d) connected basally by a short sclerotized loop, main bodies elongated, apices slender with a few fine hairs.

Variation. (N = 9): WL 0.98 (0.89-1.10); CR 0.66 (0.65-0.68); AR 1.09 (1.03-1.18); ATR 2.20 (2.00-2.60); PR 2.80 (2.40-3.05); P/HR 0.85 (0.78-0.89).

Types. Holotype male, Juquia, Municipio de Prainha, Estado de Sao Paulo, Brazil (in Fac. Med. Univ. Sao Paulo coll.).

Distribution. Brazil, Guyane.

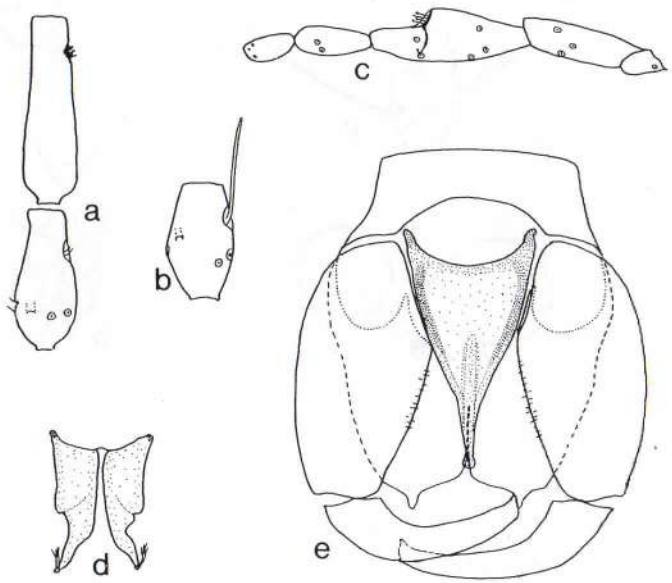


Fig. 10. *Culicoides coutinhoi*; a-c, female; d-e, male: a, antennal segments 10 and 11; b, antennal segment 6; c, palpus; d, parameres; e, genitalia, parameres omitted.

Specimens Examined.

BRAZIL: Manaus, 19.ix.1969, H. A. Wright, 2 females, 1 male, idem except 21.ix.1969, 2 females, 1 male; Amazon River, Patucho light, Ilha Parintus, 11.ix.1963,HAW, 2 females, 2 males. Para, Belem, APEG Forest, many data, T. H. G. Aitken, 2 females, 5 males.

GUYANE: Macouria, v.1953, E. Abonnenc, 1 female, 1 male.

Wing Photo (Fig. 40). Brazil, Amazonas, Manaus (Wright).

Discussion. Although Barretto's original description states that the r-m crossvein is not darkend on the anterior 1/2, his photograph of the wing shows the crossvein to be distinctly infuscated. *Culicoides coutinhoi* is very similar to *C. pseudodiabolicus* (especially the females), from which it can be distinguished by the stout palpus with irregular pit (subdivided in *pseudodiabolicus),* by the small apicolateral processes closer together, and by the terminal papilla of the aedeagus.

Culicoides davidi Spinelli, new species
(Figs. 11, 41)

Female. Wing length 1.06 (1.02-1.10, n = 2) mm; breadth 0.50 (0.49-0.51, n = 2) mm.

Head: Dark brown. Eyes (Fig. 11d) bare, contiguous for a distance equal to diameter of 2.5 ommatidial facets. Antenna (Fig. 11a,c) entirely dark brown (slightly paler in paratype); lengths of flagellar segments in proportion of 18-13-13-14-14-14-14-16-24-25-26-30-37; antennal ratio 1.19 (1.16-1.22, n = 3); sensillar pattern 3,11-15; ATR ratio 1.90 (1.85-1.95, n = 2). Palpus (Fig. 11b) dark brown; lengths of segments in proportion of 10-25-30-11-10; 3rd segment slightly broad in middle, with subdivided pit; palpal ratio 3.50 (n = 2). Mandible with 16 (n = 2) teeth; P/H ratio 0.95 (n = 2).

Thorax: Dark brown; mesonotum without pattern. Wing (Fig. 41) grayish brown, with inconspicuous pattern of diffuse pale spots; r-m crossvein slightly darkened, the pale area in which it is included large, reaching costa; vein R4+5 pale, infuscated a short distance; one small distal pale spot in cell R5; 2 diffuse distal pale spots in cell M1; distal pale spot in cell M2 small; pale spot in cell M4 not connected with the pale line bordering lower margin of vein M3+4; anal cell with only one visible distal spot; apex of vein M1 pale, apices of veins M2, M3+4 and Cul dark (apex of vein M2 slightly pale in paratype); scattered macrotrichia present on distal 1/2 of wing; costal ratio 0.67 (n = 2). Halter dark brown. Legs dark brown, narrow yellowish rings subbasally on tibiae, hind tibia broadly yellowish apically; hind tibial comb with 5 bristles.

Abdomen: Dark brown. Spermathecae pyriform, unequal (Fig. 11e), measuring 0.046 x 0.035 mm and 0.038 x 0.032 mm.

Male. Unknown.

Distribution. Colombia, Trinidad.

Types. Holotype female, Colombia, Dept. Choco, Rt. 25, 13.xii.1967, D. G. Young (in USNM). Paratype female, Trinidad, Dookie's Stable, Vega de Oropouche, 16.xii.1960, T. H. G. Aitken.

Wing Photo (Fig. 41). Holotype: Colombia, Dept. Choco, Rt. 25 (Young).

Discussion. This species is named for David G. Young in appreciation of his interest in, and collection of long series of *Culicoides* midges from the proposed route of the sea-level canal in Choco, Colombia.

Culicoides davidi is very similar to *C. diffusus* n. sp. Characters for separation are found in the key and in the discussion under the latter species.

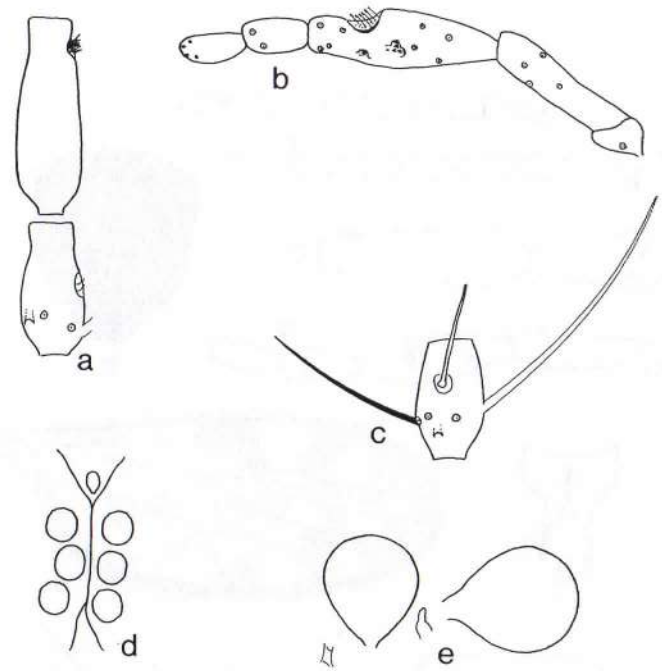


Fig. 11. *Culicoides davidi*, female: a, antennal segments 10 and 11; b, palpus; c, antennal segment 6; d, eye separation; e, spermathecae.

Culicoides diabolicus Hoffman
(Figs. 1, 12, 42)

Culicoides diabolicus Hoffman, 1925: 294 (female; Cabima, Panama; fig. wing, thoracic pattern); Macfie, 1932: 487 (Colombia); Macfie, 1937: 7 (in part; male, female; Trinidad); Costa Lima, 1937: 416 (fig. female palpus; Brazil); Adamson, 1939: 81 (Trinidad records); Kumm et al., 1940: 420 (Costa Rica); Barbosa, 1947: 17 (in part; Nicaragua, Guatemala, Panama, Trinidad, Brazil); Fox, 1948: 24 (Panama; notes; fig. palpus, male aedeagus, parameres; synonyms: *filariferus*, *pseudodiabolicus*); Ortiz, 1950a: 446 (redescribed; notes); Macfie, 1935: 102 (Costa Rica); Fox, 1955: 235 (catalog); Wirth, 1955: 109 (Guatemala); Wirth & Blanton, 1956: 316 (redescribed; figs.; synonyms: *bimaculatus*, *ocumarensis);* Fox, 1958: 138 (notes on synonymy); Wirth & Blanton, 1959: 280 (redescribed; figs.;synonyms: *filariferus,pseudodiabolicus, ocumarensis);* Wirth, 1974: 24 (catalog); Ramirez Perez, 1984: 62 (Venezuela); Wirth et al., 1988: 14 (wing photo atlas; photo misident, = *tidwelli;* distribution). *Culicoides guttatus* (Coquillett) of authors, in part; Barbosa, 1947: 17 (erroneous synonymy); Barbosa, 1952: 15 (erroneous synonymy); Woke, 1954: 68 (Panama records).

Diagnosis. A medium-sized species, brown. Eyes contiguous by a distance equal to diameter of 1.5-2.5 ommatidial facets. Antenna (Fig. 12a,b,f) brown, bases of flagellar segments 3-10 pale, sensillar pattern 3,11-15. Palpus (Fig. 12c) brown; 3rd segment slender, slightly broad in middle, pit irregular. Mandible with 14-17 teeth. Mesonotum (Fig. 12d) yellowish in center with a pair of prominent blackish sublateral vittae. Wing (Figs. 12e, 42) with contrasting pattern; r-m crossvein pale (faintly darkened in some topotypic specimens); vein R4+5 pale; one large, transverse, distal pale spot in cell R5 broadly meeting wing margin; 2 distal pale spots in cell Ml, the distal one smaller; apices of veins Ml and M2 pale, apices of veins M3+4 and Cul dark. Halter pale. Legs brown, fore and mid knees broadly yellow on femora and tibiae, hind femur dark to apex, hind tibia with broad basal and apical yellowish bands. Spermathecae subspherical to ovoid, unequal (Fig. 12g). Male 9th tergum (Fig. 12i) with widely spaced apicolateral processes; aedeagus with terminal papilla; parameres (Fig. 12h) connected by a short loop at extreme bases, the apices with minute fringing hairs.

Variation (N = 10): WL 1.00 (0.90-1.12); CR 0.68 (0.66-0.69); AR 1.10 ((1.07-1.15); ATR 2.20 (2.00-2.40); PR 3.20 (3.00-3.40); P/HR 0.96 (0.91-1.00).

Types. Syntypes: 8 females, Cabima, Panama, 19.v.1911, August Busck, "bites like the devil," (in USNM)(cited as "Type and 7 paratypes" by Wirth & Blanton (1956), after examination.

Distribution. Mexico to Venezuela and Ecuador (no records in West Indies).

Specimens Examined.

COLOMBIA: Dept. Cauca, Lopez, Rio Micay, 18.v.1977, M. A. Tidwell, 2 females, 1 male. Dept. Choco, Rt. 25, 18.xi.1967, D. G. Young, 3 females; Curiche, 12.xi.1967, DGY, 9 females. Meta, Puerto Lopez, 7.ix.1971, C. J. Marinkelle, 1 female; Pto Boyaca, 16.viii.1971, CJM, 1 female.

ECUADOR: Pichincha, 6 mi W Santo Domingo de los Colorados, 23.ii.1956, E. Schlinger & E. S. Ross, 1 female.

GUATEMALA: Acatenango, 8.viii.1951, Gibson & Ascoli, 1 male.

HONDURAS: Cortez Beach, 4.vi.1964, collector ?, 1 female. Guanaja Island, 3.i.1983, J. R. Wood, 1 male 15 females. Isla Barbareta, 23.iv.1989, G. Magnon, 1 male, 1 female.

PANAMA: Canal Zone, Cabima, 19.v.1911, 5 females (topotypes); Balboa, 2 vii.1942, P. Woke, 2 females; Fort Sherman, Mojinga Swamp, i.1953, FSB, 3 females; Gamboa,

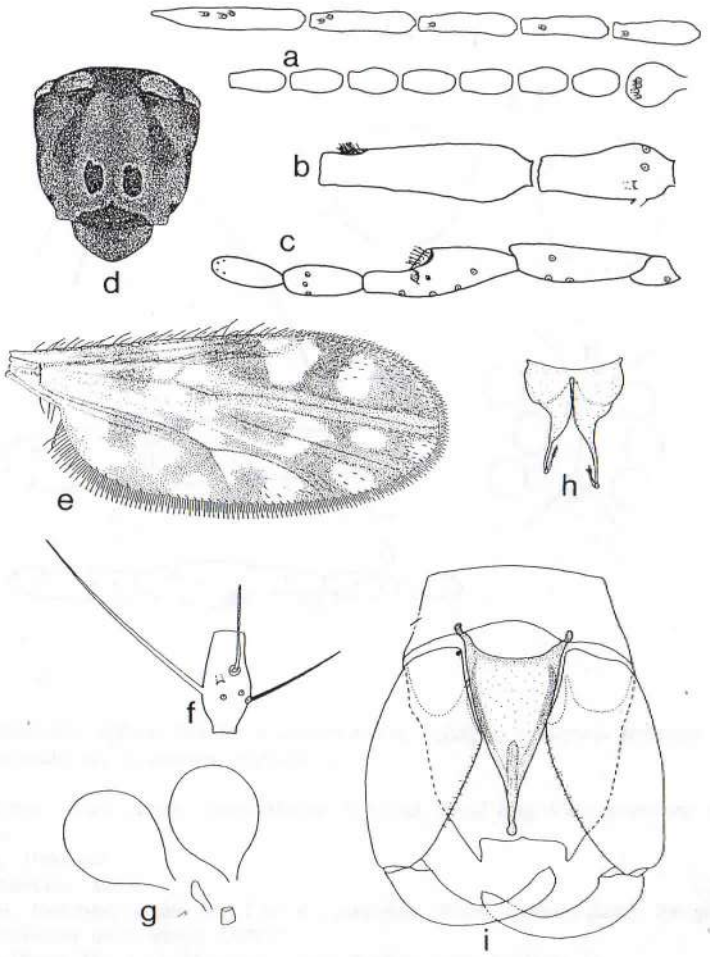


Fig. 12. *Culicoides diabolicus*; a-g, female; h-i, male: a, antenna; b, antennal segments 10 and 11; c, palpus; d, dorsal thoracic pattern; e, wing; f, antennal segment 6; g, spermathecae; h, parameres; i, genitalia, parameres omitted.

Pipeline Road, vii.1967,W. W. Wirth, 2 females; Gamboa, Rio Agua Salud, vii.1967,WWW, 1 female; Coco Solo, 23.x.1958, S. Breeland, 1 male. Chiriqui, El Pueblo Stream, vi.1964, A. Broce, 2 males; Potrerillos, 25.vii.196,Broce, 1 female, 2 males; idem except 27.vii.1964, 1 female; Rovira, Elvira Farm, 11.viii.1964, F. S. Blanton, 1 female, idem except 7.vii.1964, 1 male. Darien, Garachine, ii.1953, FSB, 1 female, 1 male.

Wing Photo (Fig. 42).-- Paratype, Panama, Cabima (Busck).

Discussion. Despite the fact that *C. diabolicus* is one of the earliest described species in the *guttatus* Group, it is not abundant in the large collection we studied. For many years previous authors (Wirth & Blanton 1973, Aitken et al. 1975) confused *diabolicus* with *tidwelli*, new species here described, and Wirth & Blanton (1959) made a wrong sex association, illustrating the male of *pseudodiabolicus*. On the other hand, the description and figures of Wirth & Blanton (1956), based primarily on type material, fit very well with the above diagnosis of *diabolicus*.

Culicoides diabolicus can readily be distinguished from *tidwelli* by the slender 3rd palpal segment with definite extension behind tip, elongated, slender palpal segments 4-5 (short and rounded in *tidwelli*), antennal sensillar pattern 3,ll-15 (additional sensilla sometimes present on 3,7,9 in *tidwelli*), and widely spaced apicolateral processes of the male 9th tergum.

Culicoides diffusus Spinelli, new species
(Figs. 13, 43)

Culicoides flavivenula Costa Lima; Wirth & Blanton, 1956: 318 (in part, misident.).

Female. Wing length 1.10 (1.08-1.12, n = 3) mm; breadth 0.49 (0.48-0.49, n = 3) mm.

Head: Dark brown. Eyes (Fig. 13a) bare, contiguous for a distance equal to diameter of 1.5 ommatidial facets. Antenna (Fig. 13c,e) entirely brown; lengths of flagellar segments in proportion of 18-14-14-14-14-13-14-15-21-23-25-28-35; antennal ratio 1.20 (1.14-1.25, n = 3); sensillar pattern 3,11-15; ATR ratio 1.90 (1.80-2.00, n = 3). Palpus (Fig. 13b) brown; lengths of segments in proportion of 9-26-38-15-14; 3rd segment elongated, with round, shallow sensory pit; palpal ratio 4.35 (4.25-4.55, n = 3). Mandible with 22-23 very small teeth; P/H ratio 1.19 (1.15-1.21, n = 3).

Thorax: Dark brown; mesonotum without pattern. Wing (Fig. 43) grayish brown, with inconspicuous pattern of diffuse pale spots; r-m crossvein slightly darkened, the pale area in which it is included small, rounded; vein R4+5 pale, slightly infuscated a short distance; 2nd radial cell with narrow lumen; one transverse distal pale spot in cell R5 not reaching wing margin; only one distal pale spot in cell M1; distal pale spot in cell M2 rounded; pale spot in cell M4 not connected with pale area bordering lower margin of vein M3+4; anal cell with 2 faint distal pale spots; apex of vein M1 slightly pale; apices of veins M2, M3+4 and Cul dark; macrotrichia present on distal 1/2 of wing, also many in anal cell; costal ratio 0.67 (0.66-0.68, n = 3). Halter brown. Legs dark brown, narrow yellowish rings subbasally on tibiae; hind tibia broadly yellowish at apex; hind tibial comb with 5 bristles.

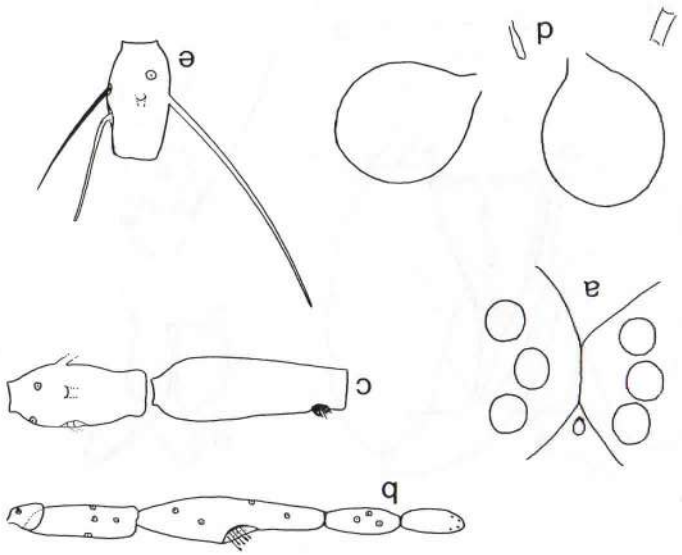


Fig. 13. *Culicoides diffusus*, female: a, eye separation; b, palpus; c, antennal segments 10 and 11; d, spermathecae; e, antennal segment 6.

Abdomen: Dark brown. Spermathecae subequal, ovoid (Fig. 13d); measuring 0.051 x 0.041 mm.

Male. Unknown.

Distribution. Brazil.

Types. Holotype female and 2 female paratypes: Brazil, Espirito Santo, Piragueassia (date & collector unknown)(in USNM).

Wing Photo (Fig. 43).-- Holotype, Brazil, Espirito Santo (collector ?).

Discussion. The presence of a sensory pit on the third palpal segment readily distinguishes *C. diffusus* from the related species *C. maruim*, *paramaruim*, and *trinidadensis*, which also have a grayish brown wing with an inconspicuous pattern of diffuse pale spots.

Culicoides diffusus is also very similar to *C. davidi*, from which it can be distinguished by the more elongate 3rd palpal segment with definite round pit (subdivided in *C. davidi*), eyes more narrowly contiguous, mandible with 22-23 very small teeth (16 in *davidi*), and smaller pale spot on the r-m crossvein.

Culicoides fernandoi Tavares & Souza
(Figs. 14, 44)

Culicoides fernandoi Tavares & Souza, 1979: 611 (male, female; Brazil; figs.); Spinelli & Wirth, 1986: 60 (in key; Argentine records; wing photo); Wirth et al., 1988: 16 (wing photo atlas; distribution). Spinelli & Ronderos, 1991: 88 (Argentina, Uruguay records).

Culicoides foxi Ortiz, misident.; Forattini, 1957: 205 (Argentina record); Cavalieri & Chiossone, 1966: 148 (Argentina records).

Diagnosis. A large-sized dark brown species. Eyes contiguous by a distance equal to diameter of 1.5 ommatidial facets. Antenna (Fig. 14b,c) brown, bases of flagellar segments 3-10 pale; sensillar pattern 3,(7),(9),11-15. Palpus (Fig. 14a) brown; 3rd segment broad in middle, pit irregular. Mandible with 14-15 teeth. Mesonotum dark brown, without prominent pattern. Wing (Fig. 44) with contrasting pattern; r-m crossvein dark on anterior 1/2; vein R4+5 dark on lower margin, with a small darkish spot behind apex; one crescent-shaped (usually divided) distal pale spot in cell R5; 2 distal pale spots in cell M1, the distal one small, not reaching wing margin (very faint in some specimens); apices of veins M1, M2 and M3+4 pale, apex of vein Cu1 dark; scattered macrotrichia present on distal 1/3 of wing. Halter dark brown. Legs dark brown; narrow apex of mid femur, bases of all tibiae and apex of hind femur with yellowish bands. Spermathecae ovoid, unequal. Male 9th tergum (Fig. 14e) with mesal cleft, apicolateral processes very small and close together; aedeagus with terminal papilla; parameres (Fig. 14d) joined at bases by a short loop; main bodies stout, apices with minute fringing hairs.

Variation (N = 5): WL 1.36 (1.24-1.47); CR 0.66; AR 1.14 (1.10-1.16); ATR 2.40 (2.20-2.60); PR 3.50 (3.30-3.90); P/HR 1.00 (0.92-1.06).

Types. Holotype male, 3 female paratypes, Sitio Peri-Ceci, Sumiduoro, Rio de Janeiro, Brazil, iii.1978, Tavares & Souza (in Instituto Oswaldo Cruz, Rio de Janeiro).

Distribution. Argentina, Brazil, Colombia, Uruguay.

Specimens Examined.

BRAZIL: Espirito Santo, Reserva Florestal Cia. Vale do Rio Doce, BR 101 km 120, Aragao-Tavares-Luna, 1 female. Rio de Janeiro, Sumidouro, Sitio Peri-Ceci, iii.1978, Tavares & Souza, 1 female (paratype). Santa Catarina, Nova Teutonia, viii.1945, xi.1962, ix.1965, F. Plaumann, 2 females, 1 male.

COLOMBIA: Meta, Finca Barbascal, 27-30.ix.1964, V. H. Lee, 1 female, 1 male.

Wing Photo (Fig. 44).-- Paratype, Brazil, Rio de Janeiro (Tavares & Souza).

Discussion. Characters for separating *C. fernandoi* from *C. ignacioi* are given in the discussion under the latter species, while characters for separating it from *C. foxi* are given in the key.

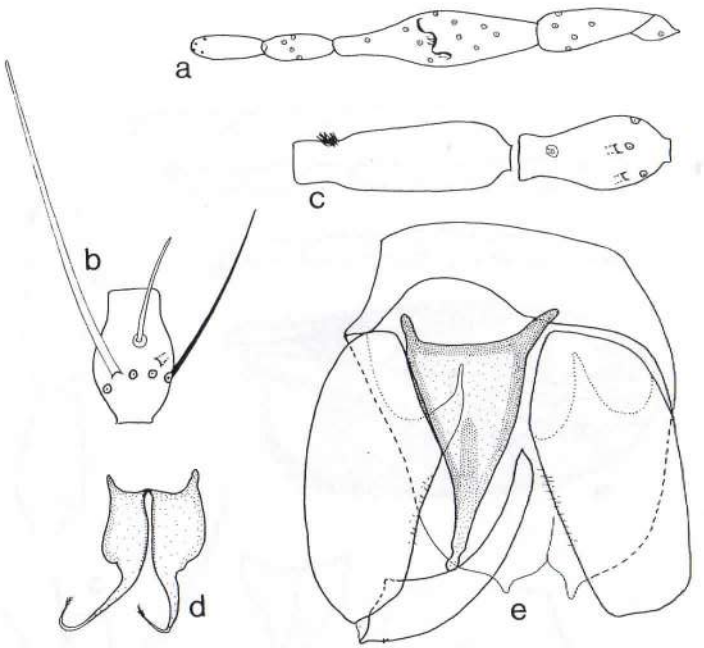


Fig. 14. *Culicoides fernandoi*; a-c, female; d-e, male: a, palpus; b, antennal segment 6; c, antennal segments 10 and 11; d, parameres; e, genitalia, parameres and one gonostylus omitted.

Culicoides filarifer Hoffman
(Figs. 15, 45)

Culicoides filariferus Hoffman, 1939: 172 (female; Chiapas, Mexico; fig. mesonotum, wing, palpus); Greiner et al., 1989: 103 (Trinidad, Tobago records); Waller et al., 1990: 357 (redescribed; Guyane; wing photo).

Culicoides filarifer Hoffman; Wirth, 1974: 24 (catalog); Wirth et al., 1988: 16 (wing photo atlas; distribution). *Culicoides* sp. "El Vergel"; Dampf, 1936: 277 (Mexico; filaria host).

Culicoides guttatus (Coquillett) of authors, in part; Barbosa, 1947: 17 (erroneous synonymy); Macfie, 1948: 74 (Chiapas, Mexico; notes); Barbosa, 1952: 16 (erroneous synonymy); Gibson & Ascoli, 1952: 318 (Guatemala; with microfilaria; feeding habits); Woke, 1954: 71 (Panama records).

Diagnosis. A medium-sized, dark brown species. Eyes contiguous by a distance equal to diameter of 1.5-2.0 ommatidial facets. Antenna (Fig. 15a,b,c) brown, broad bases of flagellar segments 3-10 pale; sensillar pattern 3,11-15. Palpus (Fig. 15d) brown; 3rd segment slightly broader in middle, with a conspicuous distal extension, pit irregular. Mandible with 14-17 teeth. Mesonotum yellowish brown with 2 longitudinal, sublateral, dark brown vittae. Wing (Figs. 15e, 45) with contrasting pattern; r-m crossvein pale (a faint darkish line, but not a definite dark spot, sometimes present on anterior 1/2); vein R4+5 pale; one distal transverse pale spot in cell R5 broadly meeting wing margin; 2 distal pale spots in cell M1 (the 2nd one faint or absent in some specimens); apices of veins M1 and M2 pale, apices of veins M3+4 and Cu1 dark (a few specimens with a faint pale area at apex of vein Cu1); scattered macrotrichia on distal 1/4. Halter dark brown. Legs dark brown, fore and mid knees and broad apex of hind tibia yellowish. Spermathecae pyriform to subspherical, unequal (Fig. 15f). Male 9th tergum (Fig. 15h) with a pair of widely spaced, short, apicolateral processes; aedeagus with terminal papilla; parameres (Fig. 15g) fused at base a short distance, main bodies stout, apices with minute fringing hairs.

Variation (N = 10): WL 1.14 (1.00-1.24); CR 0.64 (0.63-0.66); AR 1.11 (1.03-1.21); ATR 2.20 (2.05-2.30); PR 3.45 (2.95-3.70); P/HR 1.02 (0.95-1.12).

Types. "Series of females collected by Dr. Alfons Dampf at El Vergel, near Huixtla, State of Chiapas, Mexico (700 meters), June 1935. The specimens, preserved in alcohol, were dehydrated in the higher alcohols, cleared in toluol, then mounted after drying, a technique devised by Mr. H. S. Barber of the United States National Museum . . . Type and paratypes in the United States National Mueum; paratypes also returned to Dr. Dampf." (Hoffman, 1939).

Distribution. From Mexico south to northern Brazil

Specimens Examined. 2,055 females, 52 males, from the following localities (collector):

BRAZIL: Amazonas, Rio Preto, Tiririca (E. J. Fittkau); Amazonas, Rio Negro, Igarape da Bica (EJF); Rio Branquinho (EJF); Rio Solimoes, Igarape Amataura (EJF); Rio Solimoes, Igarape St. Rita (EJF); Rio Cueiras (EJF); Rio Madeira, Sao Geraldo (EJF). Para, Rio Paru (EJF); Rio Paru de Oeste, Mission Tiriyos (EJF).

COSTA RICA: Birri de Heredia, 1,600 m (J. Homan).

EL SALVADOR: Sonsonata, Armenia (F. S. Blanton). Morazan, Sociedad (FSB); Morazan, nr. San Carlos (FSB); La Libertad, Sta. Tecla (FSB); San Vicente, Santo Domingo (J. F. Matta); La Libertad, Sta. Tecla, Finca La Pena (FSB); Cuscatlan, San Pedro Perulapan (JFM); San Miguel, San Jorge (FSB); Usulutan, Sta. Elena (JFM).

HONDURAS: Atlantida, San Aleto Farm (FSB); Atlantida, Lancetillo (FSB).

MEXICO: Chiapas, El Vergel (A. Dampf, holotype and paratypes). Veracruz, Fortin de las Flores (FSB).

PANAMA: Chiriqui, Potrerillos (A. Broce).

Wing Photo (Fig. 45).– Paratype: Mexico, Chiapas, El Vergel (Dampf).

Discussion. For many years after this species was described (Hoffman, 1939) various authors considered it as a junior synonym of *diabolicus* (Wirth & Blanton 1956, 1959), *lutzi* (Forattini 1957), or *guttatus* (Ortiz 1950a). Wirth & Blanton (1973) and Aitken et al. (1975) resurrected the species *filarifer* and pointed out the characters for separating it from other species belonging to the *guttatus* Group, such as *pseudodiabolicus* and *guttatus*. Nevertheless, they considered as the male of *filarifer* those specimens here recorded as males of *ocumarensis*. The Trinidad records of *filarifer* published by Aitken et al. (1975) refer to *ocumarensis*.

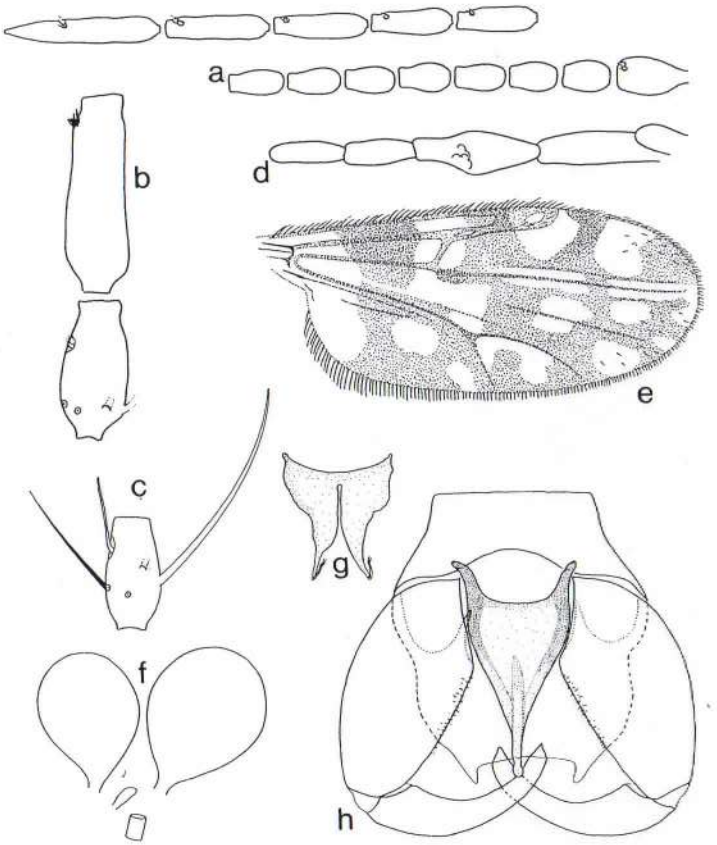


Fig. 15. *Culicoides filarifer*; la-f, female; g-h, male: a, antenna; b, antennal segments 10 and 11; c, antennal segment 6; d, palpus; e, wing; f, spermathecae; g, parameres; h, genitalia,

Diagnosis. A medium-sized, dark brown species. Eyes contiguous by a distance equal to diameter of 1.5-2.0 ommatidial facets. Antenna (Fig. 15a,b,c) brown, broad bases of flagellar segments 3-10 pale; sensillar pattern 3,11-15. Palpus (Fig. 15d) brown; 3rd segment slightly broader in middle, with a conspicuous distal extension, pit irregular. Mandible with 14-17 teeth. Mesonotum yellowish brown with 2 longitudinal, sublateral, dark brown vittae. Wing (Figs. 15e, 45) with contrasting pattern; r-m crossvein pale (a faint darkish line, but not a definite dark spot, sometimes present on anterior 1/2); vein R4+5 pale; one distal transverse pale spot in cell R5 broadly meeting wing margin; 2 distal pale spots in cell M1 (the 2nd one faint or absent in some specimens); apices of veins M1 and M2 pale, apices of veins M3+4 and Cu1 dark (a few specimens with a faint pale area at apex of vein Cu1); scattered macrotrichia on distal 1/4. Halter dark brown. Legs dark brown, fore and mid knees and broad apex of hind tibia yellowish. Spermathecae pyriform to subspherical, unequal (Fig. 15f). Male 9th tergum (Fig. 15h) with a pair of widely spaced, short, apicolateral processes; aedeagus with terminal papilla; parameres (Fig. 15g) fused at base a short distance, main bodies stout, apices with minute fringing hairs.

Variation (N = 10): WL 1.14 (1.00-1.24); CR 0.64 (0.63-0.66); AR 1.11 (1.03-1.21); ATR 2.20 (2.05-2.30); PR 3.45 (2.95-3.70); P/HR 1.02 (0.95-1.12).

Types. "Series of females collected by Dr. Alfons Dampf at El Vergel, near Huixtla, State of Chiapas, Mexico (700 meters), June 1935. The specimens, preserved in alcohol, were dehydrated in the higher alcohols, cleared in toluol, then mounted after drying, a technique devised by Mr. H. S. Barber of the United States National Museum . . . Type and paratypes in the United States National Mueum; paratypes also returned to Dr. Dampf." (Hoffman, 1939).

Distribution. From Mexico south to northern Brazil

Specimens Examined. 2,055 females, 52 males, from the following localities (collector):

BRAZIL: Amazonas, Rio Preto, Tiririca (E. J. Fittkau); Amazonas, Rio Negro, Igarape da Bica (EJF); Rio Branquinho (EJF); Rio Solimoes, Igarape Amataura (EJF); Rio Solimoes, Igarape St. Rita (EJF); Rio Cueiras (EJF); Rio Madeira, Sao Geraldo (EJF). Para, Rio Paru (EJF); Rio Paru de Oeste, Mission Tiriyos (EJF).

COSTA RICA: Birri de Heredia, 1,600 m (J. Homan).

EL SALVADOR: Sonsonata, Armenia (F. S. Blanton). Morazan, Sociedad (FSB); Morazan, nr. San Carlos (FSB); La Libertad, Sta. Tecla (FSB); San Vicente, Santo Domingo (J. F. Matta); La Libertad, Sta. Tecla, Finca La Pena (FSB); Cuscatlan, San Pedro Perulapan (JFM); San Miguel, San Jorge (FSB); Usulutan, Sta. Elena (JFM).

HONDURAS: Atlantida, San Aleto Farm (FSB); Atlantida, Lancetillo (FSB).

MEXICO: Chiapas, El Vergel (A. Dampf, holotype and paratypes). Veracruz, Fortin de las Flores (FSB).

PANAMA: Chiriqui, Potrerillos (A. Broce).

Wing Photo (Fig. 45).– Paratype: Mexico, Chiapas, El Vergel (Dampf).

Discussion. For many years after this species was described (Hoffman, 1939) various authors considered it as a junior synonym of *diabolicus* (Wirth & Blanton 1956, 1959), *lutzi* (Forattini 1957), or *guttatus* (Ortiz 1950a). Wirth & Blanton (1973) and Aitken et al. (1975) resurrected the species *filarifer* and pointed out the characters for separating it from other species belonging to the *guttatus* Group, such as *pseudodiabolicus* and *guttatus*. Nevertheless, they considered as the male of *filarifer* those specimens here recorded as males of *ocumarensis*. The Trinidad records of *filarifer* published by Aitken et al. (1975) refer to *ocumarensis*.

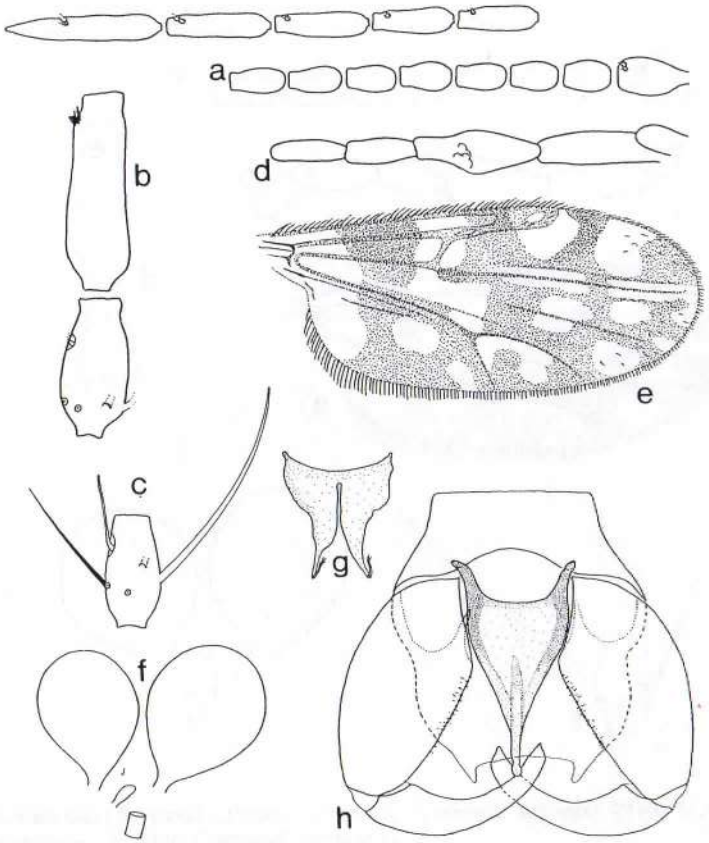


Fig. 15. *Culicoides filarifer*; la-f, female; g-h, male: a, antenna; b, antennal segments 10 and 11; c, antennal segment 6; d, palpus; e, wing; f, spermathecae; g, parameres; h, genitalia,

Habits. Gibson & Ascoli (1952: 317) gave notes on the feeding habits in Guatemala (as *guttatus*). "This species bites only during or immediately after a light rain. It has not been taken on sunny or overcast days. Its feeding time is much longer than that of the other species, averaging about ten minutes, and it does not engorge as fully as do the others. It is the only species of the four which will not resume feeding once it has been disturbed. *C. guttatus* is of particular interest in connection with the transmission of onchocerciasis, since Macfie (1948) believes that it is identical with *C. filariferus*, in which Dampf (1936) found developmental forms of filarid larvae, presumably *Onchocerca volvulus* and *O. cervicalis*, in Chiapas, Mexico . . . No evidence of a natural infection [with filaria] was found in any of the four species."

Culicoides flavivenula Costa Lima
(Figs. 16, 46)

Culicoides flavivenula Costa Lima, 1937: 418 (as "*flavivenula* Lutz, n. sp.;" female; Brazil; fig. palpus); Floch & Abonnenc, 1942a: 3 (Guyane); Barbosa, 1947: 15 (Brazil; fig. palpus); Ortiz, 1950a: 448 (notes; as *flavenula*); Forattini, 1954b: 135 (male, female; Brazil; figs.; Ortiz & Leon, 1955: 572 (notes); Wirth & Blanton, 1956: 318 (redescribed; Brazil; figs.; Forattini, 1957: 235 (redescribed; Brazil; figs.); Wirth & Blanton, 1973: 433 (Amazon records, Brazil); Wirth, 1974: 24 (catalog); Aitken, et al, 1975: 122 (Trinidad records; notes; wing photo); Spinelli & Wirth, 1986: 52 (in key; wing photo); Wirth et al., 1988: 16 (wing photo atlas; distribution); Waller et al., 1990: 357 (redescribed; Guyane; wing photo).

Diagnosis. A medium-sized brown species. Eyes contiguous by a distance equal to diameter of 1-2 ommatidial facets. Antenna (Fig. 16a,b,f) entirely brown; sensillar pattern 3,11-15. Palpus (Fig. 16c) brown; 3rd segment with small, round, well-defined, shallow pit. Mandible with 19-20 teeth. Mesonotum brown, with median area indistinctly paler. Wing (Figs. 16e, 46) with a somewhat diffuse pattern; r-m crossvein pale; vein R4+5 pale; one transverse distal pale spot in cell R5 reaching wing margin; only one distal pale spot in cell Ml; vein Ml slightly pale at apex; apices of veins M2, M3+4 and Cul dark; macrotrichia present on distal 1/2 and also in anal cell. Halter pale. Legs brown, apex of mid femur, bases of mid and hind tibiae and apex of hind tibia, indistinctly paler yellowish. Spermathecae subspherical to pyriform, subequal (Fig. 16d).

According to Forattini (1954a, 1957) the male genitalia are characterized by the 9th tergum with small, separated, apicolateral processes; aedeagus with terminal papilla, and parameres fused mesally for about 1/2 the total length and with bare tip.

Variation (N = 10): WL 0.95 (0.90-1.02); CR 0.66 (0.63-0.68); AR 1.09 (1.04-1.14); ATR 2.45 (2.20-2.90); PR 3.20 (2.95-3.55); P/HR 1.00 (0.95-1.03).

Types. Two female syntypes, Japuhyba, Angra dos Reis, Est. Rio de Janeiro, Brazil, xii.1913, D. L. Travassos (no. 3008 coll. Inst. Oswaldo Cruz).

Distribution. Brazil, Guyane, Trinidad.

Specimens Examined.

BRAZIL: Pará, Belem, APEG Forest, many data, T. H. G. Aitken, light trap, 38 females.

Wing Photo (Fig. 46).-- Brazil, Para, Belem (Aitken).

Discussion. This species is very similar to *C. lutzi*, from which it can be distinguished by the 3rd palpal segment with a well-defined, round pit (irregular in *lutzi);* apices of veins

M2 and M3+4 dark (broadly pale in *lutzi*): macrotrichia more abundant, also present in anal cell; and parameres broadly fused at bases.

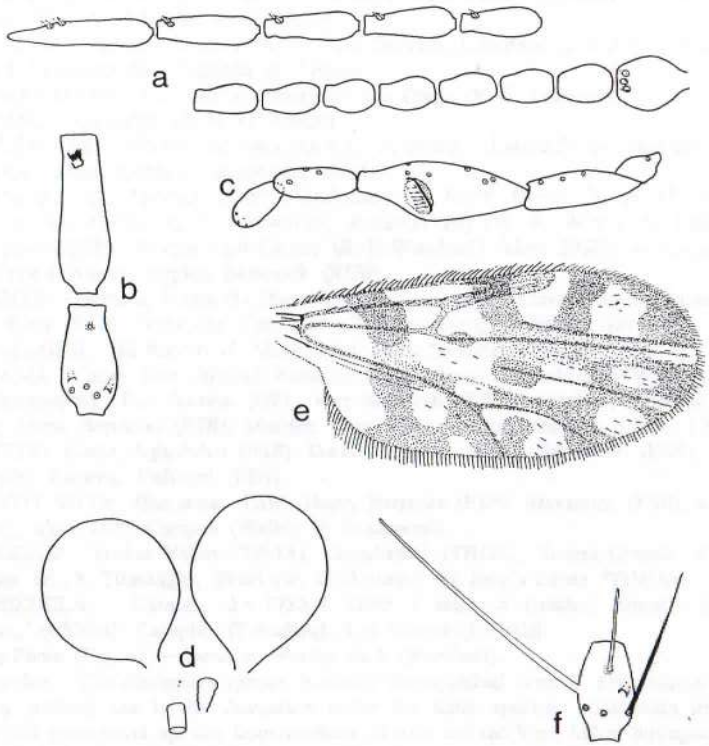


Fig. 16. *Culicoides flavivenula*, female: a, antenna; b, antennal segments 10 and 11; c, palpus; d, spermathecae; e, wing; f, antennal segment 6.

Culicoides foxi Ortiz
(Figs. 17, 47)

Culicoides foxi Ortiz, 1950b: 461 (male; Puerto Rico); figs.); Ortiz, 1951: 4 male, female; Venezuela; figs.); Fox, 1953: 888 (Puerto Rico; notes); Wirth & Blanton, 1956: 309 (male,female; figs.; distribution); Forattini, 1957: 205 (redescribed; figs.; Brazil distribution); Wirth & Blanton, 1959: 283 (redescribed; figs.; Panama distribution); Fox & Garcia-Moll, 1961: 120 (notes; Puerto Rico); Williams, 1964: 463 (larval habitats; Trinidad); Aitken et al., 1968: 165 (habits; Trinidad); Tikasingh, 1972: 447 (habits); Wirth, 1973: 24 (catalog); Wirth & Blanton, 1973: 434 (Amazon records); Aitken et al,

1975: 124 (Trinidad records; wing photo); Ramirez Perez, 1984: 62 (Venezuela records); Greiner et al., 1984: 389 (Caribbean records); Spinelli & Wirth, 1986: 51 (in key); Greiner & Rawlins, 1987: 153(Jamaica records); Lien & Lu, 1987: 93 (redescribed; Bolivia; wing photo); Wirth et al., 1988: 16 (wing photo atlas; distribution); Greiner et al., 1989: 101 (Trinidad & Tobago records); Waller et al., 1990: 357 (notes; Guyane; wing photo); Spinelli & Ronderos, 1991: 88 (record Corrientes Prov., Argentina; notes).

Culicoides diabolicus Hoffman, of authors, misident.; Floch & Abonnenc, 1942a (French Guiana; notes; figs.).

Culicoides guttatus (Coquillett) of authors, misident; Fox, 1948: 23 (female; Venezuela); Fox, 1949: 31 (male, female; Puerto Rico); Fox & Kohler, 1950: 342 (Puerto Rico; biology).

Diagnosis. A large-sized, dark brown species. Eyes contiguous for a distance equal to diamater of one ommatidial facet. Antenna (Fig. 17a,b,c) brown, bases of flagellar segments 3-10 pale; sensillar pattern 3, 11-15. Palpus (Fig. 17d) dark brown; 3rd segment elongated, pit rounded and shallow, the extension beyond the pit slender. Mandible with 15-17 teeth. Mesonotum (Fig. 17f) with prominent pattern, heavily light gray pollinose in center, with 2 distinct, sublateral, blackish, irregular, longitudinal vittae. Wing (Fig. 17e, 47) with contrasting pattern; r-m crossvein entirely and deeply infuscated; vein R4+5 pale but with small blackish spot behind apex; one large, transverse, distal pale spot in cell R5 broadly meeting wing margin; 2 distal pale spots in cell M1; apices of veins M1, M2 and M3+4 broadly pale; apex of vein Cu1 dark; macrotrichia sparse near wing margin. Halter knob deeply infuscated, pedicel pale. Legs brown with distinct pale bands at midlength and narrow blackish rings before apices of fore and mid femora, fore and mid knees narrowly pale; hind tibial comb with 6 spines. Spermathecae subspherical to ovoid, unequal (Fig. 17i). Male 9th tergum (Fig. 17h) with small, somewhat widely spaced, apicolateral processes; aedeagus elongate, sides convexly swollen, apex truncated rather than with papilliform tip; parameres (Fig. 17g) fused on proximal 1/4, apices with minute fringing hairs.

Variation (N = 10): WL 1.28 (1.12-1.51); CR 0.68 (0.66-0.70); AR 1.10 (1.00-1.22); ATR 1.80 (1.65-2.00); PR 4.20 (3.80-4.50); P/HR 1.22 (1.14-1.30).

Types. Holotype male, Camp Tortuguero, 6.viii.1948 (as allotype of *Culicoides guttatus* (Coquillett) in Fox 1949: 31), misident.; designated by Ortiz (1950b: 461) (in Univ. Puerto Rico School of Tropical Medicine, San Juan).

Distribution. Mexico through Central and South America to Bolivia and Argentina; West Indies.

Specimens Examined. 170 females, 33 males, from the following localities (collector):

BOLIVIA: 60 mi N Santa Cruz (R. B. Cummings).

BRAZIL: Amazonas, Rio Marauia (E. J. Fittkau); Rio Aripuana (EJF); Igarape Kumadueni (EJF); Rio Solimoes, 15 km below Coari (EJF); Rio Solimoes, Ilha Jucara (EJF); Rio Solimoes, Igarape Amataura (EJF); Rio Solimoes, Igarape Okueima (EJF); km 50 BR 174, 11.5 m. N Manaus (J. Arias). Bahia, Ilheus (Davis & Shannon); Itabuna (J. A.Winder); Piraja (Davis & Shannon). Para, Belem, many data (T. H. G. Aitken); Rio Paru (EJF); Maraba (D. R. Roberts, biting man); Altamira (? collector). Minas Gerais, Caratinga, Barracao (R. Lane); Rio Amazon, Prainha, Floresta light, (H. A. Wright).

COLOMBIA: Cauca, Tambo, Finca Carpenteria (V. H. Lee); Oleoducto de Pacific, 10 km NW Dagua (R. E. Woodruff). Choco, Teresita (D. G. Young). Valle, Pance (M. Tidwell); Rio Raposo (VHL). Meta, Finca Barbascal (VHL); Puerto Lopez (C. J. Marinkelle). Huila, San Agustin (D. H. Messersmith).

COSTA RICA: Guanacaste, 2 mi W Liberia (REW). Limon, Hacienda Theobroma (L. G. Saunders). Puntarenas, Sabalito (F. S. Blanton); Palmar Sur (FSB). San Jose, San Isidro del General (FSB); San Isidro, Perez Zeledon (FSB).

DOMINICAN REPUBLIC: Puerto Plata, Long Beach Hotel (Woodruff & Drummond). MTS Prov., Rincon Molinillos (C. Mitchell).

ECUADOR: Pastaza, 25 km N Puyo (W. E. Steiner); Cononaco (J. Cohen). Pichincha, 47 km S S. Domingo, Rio Palenque (J. Cohen).

EL SALVADOR: La Libertad, Hacienda San Diego (S. G. Breeland).

GUYANE: Cabassou (T. H. G. Aitken).

HONDDURAS: Cortez, El Agua Azul (J. F. Matta). Lancetilla (P. Galindo); Lago Yojoa (PG). Santa Barbara, Chumbagua (JFM).

JAMAICA: St. Thomas, Baths (Maldonado & Farr); Devey (T. H. G. Aitken). Manchester, Mandeville (E. G. Farnworth); Runaway Bay (W. W. Wirth); St. Catherine, Spanish Town (EGF); Worthy Park Estates (R. E. Woodruff); idem (EGF); Westmoreland, Negril, Crystal Waters, tropical hammock (REW).

MEXICO: Guerrero, Ixtapa (D. Pletsch); Zihuatanejo (DP). Oaxaca, Isth. Tehuantepec, Jaltepec River (FSB). Veracruz, Catemaco (P. J. Spangler); Cuitlahuac (PJS).

NICARAGUA: El Recreo (J. Maldonado). Villa Somoza (FSB).

PANAMA: Canal Zone, Albrook Field (G. Field); Barro Colorado I. (WWW); *idem* (S. & W. Duckworth); Fort Kobbe (GF); Fort Sherman (FSB); Gamboa, Pipeline Road (WWW); Loma Borracho (FSB); Madden Dam (FSB); Summit Gardens (FSB). Chiriqui, Volcan (FSB). Cocle, Aguadulce (FSB). Darien, El Real (FSB); Garachine (FSB); Patino Point (FSB). Panama, Pedregal (FSB).

PUERTO RICO: Guajataca (FSB). Henry Barracks (FSB). Mayaguez (FSB); *idem* (J. Edmiston); *idem*, UPR Campus (Walker & Drummond).

TRINIDAD: Tucker Valley (THGA); Grandwood (THGA); Sangre Grande, Vega de Oropouche (E., S. Tikasingh); Simla (W. Duckworth); St. John's Estate (THGA).

VENEZUELA: Caracas, 3.v.1930, I. Ortiz, 1 male, 4 females, pinned, labelled "Paratypes," (USNM). Carapito (P.Anduze). Los Choros (I. Ortiz).

Wing Photo (Fig. 47).-- Jamaica, Worthy Park (Woodruff).

Discussion. This distinctive species is readily distinguished from *C. bimaculatus* by the characters pointed out in the discussion under the latter species. *Culicoides foxi* is a common and widespread species from southern Mexico and the West Indies throughout the Amazon Basin, but is not found in large numbers in any one collection compared with *C. insignis*, *C. filarifer*, or *C. pseudodiabolicus*.

Habits. Aitken et al. (1975: 114) gave the following notes on the habits of *C. foxi* in Trinidad: "*Culicoides foxi* is a common forest and plantation species; we have records (more than 40 collections) for every month. Most of the 1955-70 collections were made with light traps, but the species will bite man and has been taken thus between 5:30 and 7:30 pm. The species has been reared by Williams from cocoa pods at Sangre Grande (in association with *C. glabellus*, *C. paraensis*, *C. poikilonotus* and *C. pusillus*) and taken in cocoa plantation drainage ditches at Las Cuevas, Maracas and Sangre Grande. Tikasingh (1972) reported numerous females of *foxi* biting man at Vega de Oropouche, with lowest densities in months (April-June) just prior to the rainy season and the peak month in March with a rate of 100 per man hour."

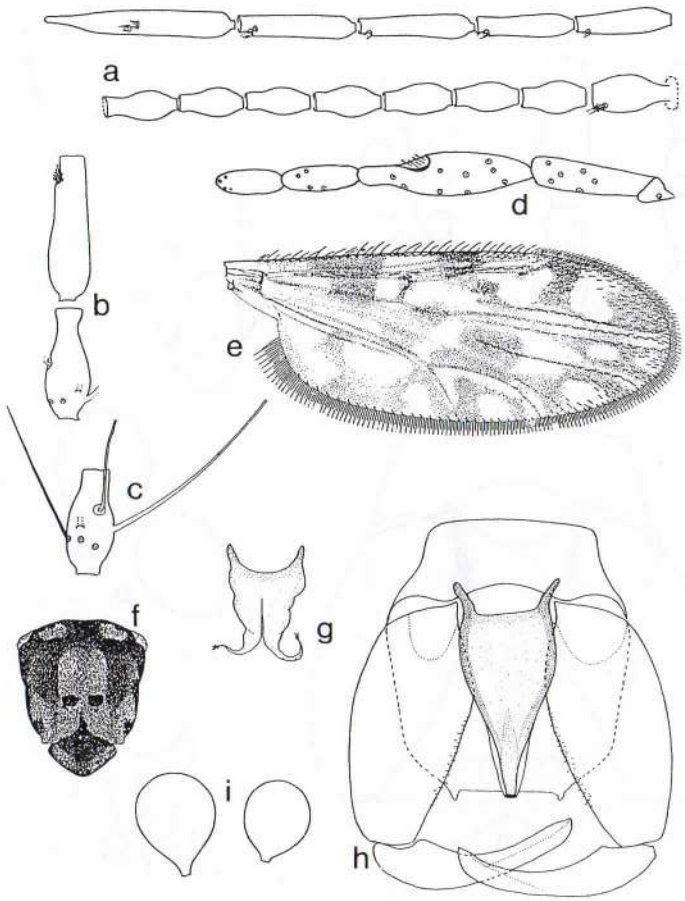


Fig. 17. *Culicoides foxi*; a-f, i, female; g-h, male: a, antenna; b, antennal segments 10 and 11; c, antennal segment 6; d, palpus; e, wing; f, dorsal thoracic pattern; g, parameres; h, genitalia, parameres omitted; i, spermathecae.

Culicoides franklini Spinelli, new species
(Figs. 18, 48)

Female. Wing length 1.02 (0.89-1.15, n = 10) mm; breadth 0.48 (0.46-0.53, n = 10) mm.

Head: Dark brown. Eyes (Fig. 18b) bare, contiguous by a distance equal to diameter of 4-5 ommatidial facets. Antenna (Fig. 18a,c) brown, narrow bases of segments 3-10 pale; lengths of flagellar segments in proportion of 18-13-14-14-14-14-13-14-20-21-24-26-41; antennal ratio 1.12 (1.10-1,18, n = 10); sensillar pattern 3,11-15; ATR ratio 2.95 (2.30-3.15, n - 10). Palpus (Fig. 18d) brownish, short; lengths of segments in proportion of 6-16-18-11-9 (in the entire type-series the combined lengths of segments 4 and 5 larger than length of segment 3); 3d segment relatively stout, with shallow, irregular pit; palpal ratio 2.60 (2.45-2.80, n = 10). Mandible with 13-17 (n = 10) small teeth. Proboscis short, P/H ratio 0.61 (0.58-0.65, n = 10).

Thorax: Dark brown; mesonotum with pale humeral areas, but apparently without prominent pattern. Wing (Fig. 48) with contrasting pattern; r-m crossvein dark on anterior 1/2; vein R4+5 pale; 2nd radial cell with broad lumen; one large transverse, distal pale spot in cell R5 broadly reaching wing margin; 2 distal pale spots in cell M1; distal pale spot in cell M2 large, broadly connected with wing margin; pale spot in cell M4 broadly connected with pale line bordering lower margin of vein M3+4; anal cell with 2 large distal pale spots; apices of veins M1, M2 and M3+4 pale, apex of vein Cu1 dark; scattered macrotrichia at extreme apices of cells R5 and M1; costal ratio 0.68 (0.67-0.70, n = 10). Halter pale. Legs dark brown; apices of mid ratio 0.68 (0.67-0.70, n = 10). Halter pale. Legs dark brown; apices of mid tibia and hind femur yellowish, all tibiae with subbasal yellowish rings; hind tibial comb with 5 bristles.

Abdomen: Dark brown. Spermathecae ovoid, unequal (Fig. 18e), measuring 0.046 x 0.038 mm and 0.041 x 0.035 mm, necks 0.005 mm long.

Male. Wing length 0.86 mm; breadth 0.35 mm; costal ratio 0.65.

Similar to female with usual sexual differences. Genitalia (Fig. 18g): Ninth sternum with deep caudomedian excavation, membrane not spiculate; 9th tergum broad caudally, truncated; apicolateral processes widely spaced. Gonocoxite moderately stout, gonostylus slightly curved. Aedeagus elongated; basal arch very low; lateral arms nearly straight; distal portion slender with terminal papilla; internal sclerotized peg present. Parameres (Fig. 18f) fused on basal 1/4, apices with minute fringing hairs.

Distribution. Bolivia, Brazil, Colombia, El Salvador, Honduras, Mexico, Panama.

Types. Holotype female, allotype male, Panama, Canal Zone, Summit Gardens, vii.1967, F. S. Blanton, light trap (in USNM). Paratypes, 53 females, 10 males, as follows:

BOLIVIA: Yapacani, Luna Nueva, 28.vii.1981, H. Bermudez, 4 females.

BRAZIL: Para, Belem, APEG Forest, ix.1969, T. H. G. Aitken, 2 females.

COLOMBIA: Valle, Rio Raposo, xii.1963, V. H. Lee, light trap, 1 female; same data except iii.1964, 3 females. Choco, Teresita, 25.vi.1967, D. G. Young, 6 females, 2 males; same data except 31.vi.1967, 1 female; 5.vii.1967, 1 female, 1 male; 30.vii.1967, 3 females, 2 males; 7.x.1967, 2 females.

EL SALVADOR: Morazan, Sociedad, viii.1964, F. S. Blanton, 2 females.

HONDURAS: Atlantida, Lancetilla, 4.vi.1964, FSB, 4 females. La Lima, 3.vii.1964, 1 female.

MEXICO: Guerrero, Ixtapa, 27.i.1977, D. Pletsch, ex mangrove, 1 female.

PANAMA: Canal Zone, same data as type, 12 females, 3 males; Barro Colorado Island, vii.1967, W. W. Wirth, light trap, 7 females, 2 males. Darien, Santa Fe, 11.ix.1967, A. Broce, 1 female. San Blas, Rio Carti Grande, 2 km W Nusagandi, 5.iii.1985, O. Flint & J. Louton, 1 female.

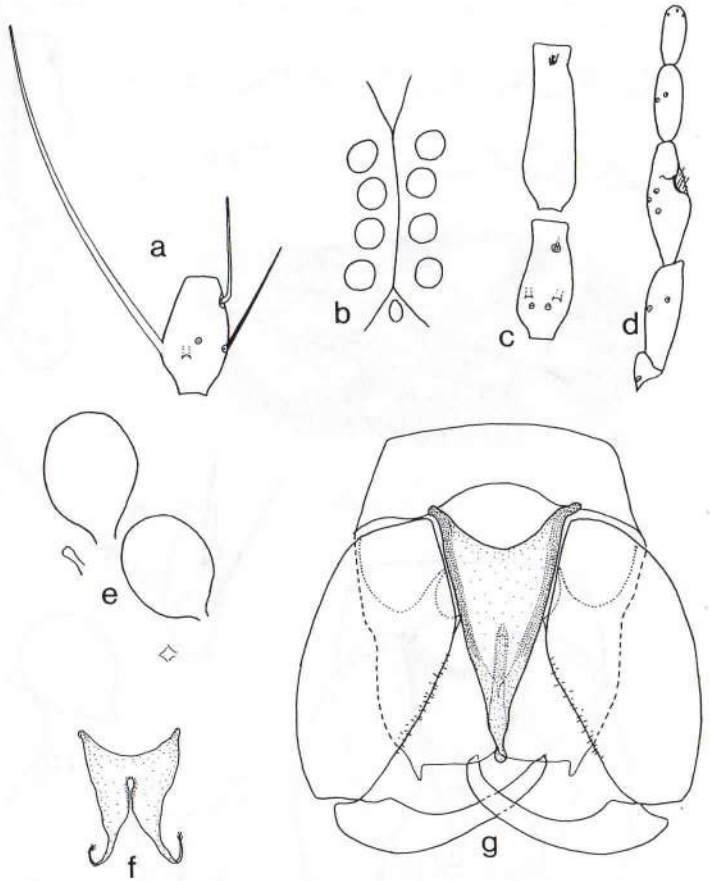


Fig. 18. *Culicoides franklini*; a-e, female; f-g, male: a, antennal segment 6; b, eye separation; c, antennal segments 10 and 11; d, palpus;; e, spermathecae; f, parameres; g, genitalia, parameres omitted.

Wing Photo (Fig. 48). Holotype, Panama, Canal Zone, Summit Gardens (Blanton).

Discussion. This species is dedicated to Franklin S. Blanton, retired from the University of Florida, in recognition of his long and active interest in the collection and study of Ceratopogonidae, and in tribute to his leadership in the guidance of a remarkable cadre of graduate students in the study of ceratopogonid taxonomy. Professor Blanton developed a taxonomic collection of biting midges at the Florida State Collection of Arthropods that is one of the most extensive in the world.

Culicoides franklini is a widespread species; easily distinguished from its closest congeners *C. pseudodiabolicus*, *coutinhoi* and *brownei* by the broadly contiguous eyes, very short proboscis, and 3rd palpal segment shorter than combined lengths of segments 4 and 5.

Culicoides fusipalpis Wirth & Blanton
(Figs. 19, 49)

Culicoides fusipalpis Wirth & Blanton, 1973: 435 (male, female; Brazil; figs.); Aitken et al., 1975: 125 (Trinidad record; notes); Spinelli & Wirth, 1986: 52 (in key; wing photo); Wirth et al., 1988: 16 (wing photo atlas; distribution); Waller et al., 1990: 358 (notes; Guyane; wing photo).

Diagnosis. A small brown species. Eyes contiguous by a distance equal to diameter of 2-2.5 ommatidial facets. Antenna (Fig. 19a,b,c) brown, bases of segments 3-10 pale; sensillar pattern 3,11-15. Palpus (Fig. 19d) brown; 3rd segment fusiform, slightly swollen in midportion only, with scattered surface sensilla. Mandible with 14-15 teeth. Mesonotum brown, without prominent pattern. Wing pattern (Figs. 19e, 49) contrasting; r-m crossvein in a large pale spot, but vein slightly darkened; vein R4+5 pale; one large transverse distal pale spot in cell R5, broadly meeting wing margin; one distal pale spot in cell M1 (a 2nd one developed in many specimens, even in the type series); apices of veins M1 and M2 narrowly pale, apices of veins M3+4 and Cu1 dark (in a few specimens apex of vein M3+4 narrowly pale); scattered macrotrichia on distal 1/4 of wing. Halter pale. Legs brown; mid femur narrowly yellowish at apex; all tibiae with basal, and hind tibia with apical, broad yellowish bands. Spermathecae (Fig. 19f) subequal, subspherical with short sclerotized necks. Male 9th tergum (Fig. 19h) with widely spaced, small, slender apicolateral processes; aedeagus with terminal papilla; parameres (Fig. 19g) fused a short distance at bases, main bodies stout, tips with distinct fringing hairs.

Variation (N = 10): WL 1.03 (0.91-1.16); CR 0.67 (0.66-0.70); AR 1.10 (1.04-1.16); ATR 2.15 (2.00-2.30); PR 3.50 (3.30-3.90); P/HR (0.93 (0.89-1.05).

Types. Holotype, female, allotype, male, Belem, Para, Brazil, viii.1969, T. H. G. Aitken, light trap in APEG Forest (in USNM). Paratypes, 16 males, 198 females.

Distribution. Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guyana, Guyane, Panama.

Specimens Examined. 334 females, 19 males, from the following localities (collector):

BOLIVIA: San Esteban, Santa Cruz, Muyurina (R. Cummings).

BRAZIL: Amazonas, Rio Branquinho, mouth Rio Cueiras (E. J. Fittkau); Rio Marauia (EJF); Rio Paru (EJF); Rio Solimoes (EJF); Rio Toototobi (R. Pinger); km 50 BR 174 N Manaus (J. Arias); Rio Negro, Ilha Marara (EJF). Bahia, Itabuna (J. A. Winder). Para, Rio Paru de Oeste, Malloca Apico (EJF); Rio Paru de Oeste, Mission Tiriyos (EJF); Maraba (D. R. Roberts); Belem, many data (T. H. G. Aitken); Altamira (? collector). Rio de Janeiro, Sumidouro (J. Conceicao); idem (Ruiz).

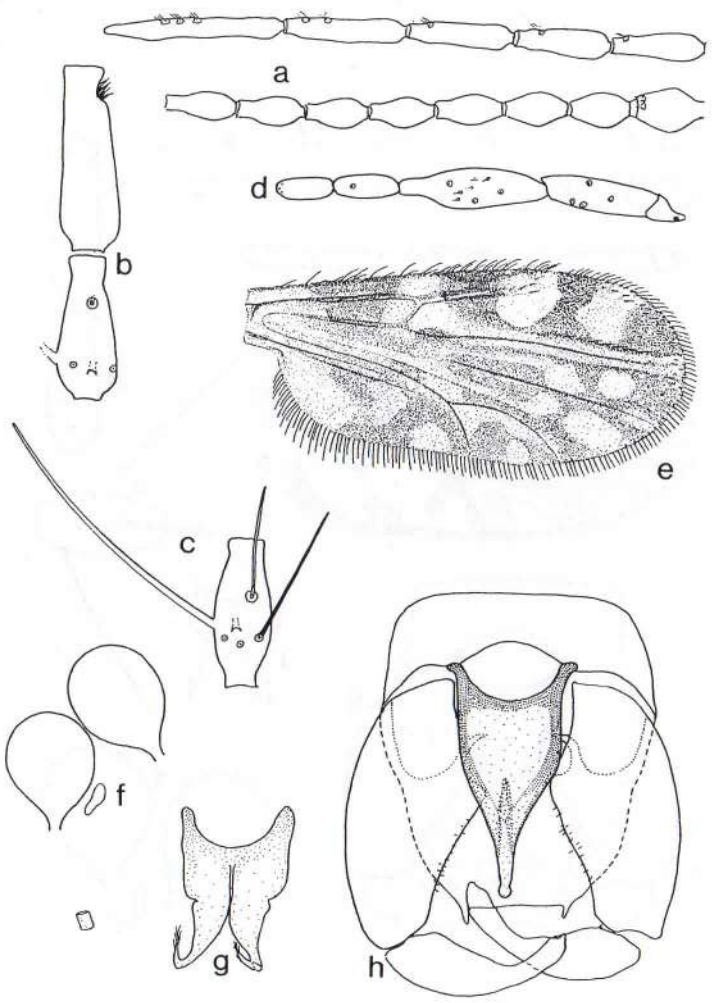


Fig. 19. *Culicoides fusipalpis*; a-f, female; g-h, male: a, antenna; b, antennal segments 10 and 11; c, antennal segament 6; d, palpus; e, wing; f, spermathecae; g, parameres; h, genitalia, parameres omitted.

Culicoides guttatus (Coquillett)
(Figs. 20. 50)

Ceratopogon guttatus Coquillett, 1904: 35 (female; Sao Paulo, Brazil).
Culicoides guttatus (Coquillett); Kieffer, 1906: 54 (combination); Lutz, 1912: 16 (Brazil); Lutz (in part), 1913: 58 (notes; Sao Paulo, Brazil); Costa Lima, 1937: 416 (female; Brazil; figs. wing; compare *diabolicus);* Macfie, 1939: 199 (Brazil record); Barretto, 1944: 91 (male; figs.; Brazil); Barbosa (in part), 1947: 17 (discussion; Brazil records; synonyms: *diabolicus, filariferus*); Fox, 1948: 23 (discussion; fig. female palpus); Lane, 1950: 115 (extensive synonymy); Ortiz, 1950a: 440 (in part; taxonomy; redescription; Venezuela record, misident.); Fox, 1955: 239 (catalog; discussion of synonymy); Forattini, 1955: 103 (redescribed; Brazil; synonymy); Wirth & Blanton, 1956: 312 (notes on type; fig. wing); Spinelli & Wirth, 1986: 52 (in key; wing photo); Wirth et al., 1988: 16 (wing photo atlas; distribution).

Diagnosis. A large dark brown species. Eyes contiguous by a distance equal to diameter of 2.5 ommatidial facets. Antenna (Fig. 20a,b,c) brown, bases of segments 3-10 pale; sensillar pattern 3,11-15. Palpus (Fig. 20d) slender; 3rd segment slightly widest just beyond middle, pit subdivided. Mandible with 18-20 small teeth. Mesonotum and scutellum brown, dark grayish pollinose. Mesonotum with an inconspicuous pair of broad, dark brown, sublateral vittae, anterior and lateral margins blackish. Wing pattern (Figs. 20e, 50) contrasting; r-m crossvein infuscated on anterior 1/2; vein R4+5 pale; one large pale spot in cell R5; 2 distal pale spots in cell M1; apices of veins M1, M2 and M3+4 broadly pale, apex of vein Cu1 dark; macrotrichia sparse on distal 1/4 of wing. Halter whitish, small area at base of knob dark. Legs brown, fore and mid knees and base and apex of hind tibia yellowish. Spermathecae ovoid, subequal (Fig. 20h). Male 9th tergum (Fig. 20g) with large, slender, widely separated apicolateral processes; aedeagus ending in terminal papilla; parameres (Fig. 20f) connected at bases by a short loop, apices with short hairs.

Variation (N = 10): WL 1.40 (1.31-1.53); CR 0.67 (0.65-0.69); AR 0.93 (0.88-1.00); ATR 2.30 (2.00-2.50); PR 4.00 (3.60-5.35); P/HR 0.99 (0.92-1.04).

Types. Syntypes: 3 females, Sao Paulo, Brazil, A. Lutz, collector (in USNM). Lectotype designated by Wirth & Blanton (1956: 314).

Distribution. Southeastern Brazil, Paraguay.

Specimens Examined.

BRAZIL: Rio de Janeiro, Itatiaia, 800 m, vii.1954, Travassos & Rego Barros, 1 female, 1 male. Santa Catarina, Nova Teutonia, many data, F. Plaumann, 86 females, 8 males. Sao Paulo, Salesopolis, 23.iii.1963, N. Marston, 4 females; Estacao Biologica de Boraceia, 850 m, 27.ii.1967, M. E. Irwin, 3 females, 1 male.

PARAGUAY: Dept. Central, Caacupe Agr. Exp. Sta., 9.ii.1968, R. E. Woodruff, 3 males.

Wing Photo (Fig. 50). Brazil, Santa Catarina, Nova Teutonia (Plaumann).

Discussion. This species is very similar to *C. ignacioi*, from which it can be distinguished by the pale halter, slender 3rd palpal segment, aedeagus with terminal papilla, and parameres connected by only a short loop.

Culicoides guttatus is a large species that appears to be restricted to southeastern Brazil and Paraguay. Forattini (1957) gave numerous records of *guttatus* for northern South America and Central America, but in our opinion he misidentified many specimens, confusing them with *diabolicus* and *pseudodiabolicus*, species that he considered synonymous with *guttatus*.

The species that Fox (1949) described as *C. guttatus* from Puerto Rico was described as *C. foxi* by Ortiz (1950a).

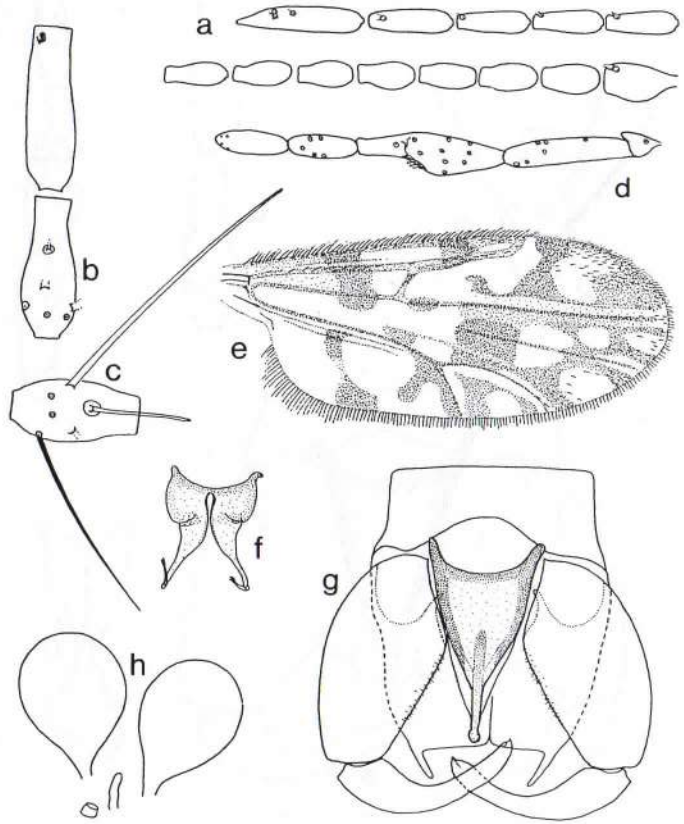


Fig. 20. *Culicoides guttatus*; a-e, h, female; f-g, male: a, antenna; b, antennal segments 10 and 11; c, antennal segment 6; d, palpus; e, wing; f, parameres; g, genitalia, parameres omitted; h, spermathecae.

Culicoides ignacioi Forattini
(Figs. 21, 51)

Culicoides ignacioi Forattini, 1957: 215 (male, female; Brazil; figs.); Spinelli & Wirth, 1986: 61 (in key; notes; wing photo); Wirth et al., 1988: 16 (wing photo atlas; distribution); Waller et al., 1990: 358 (notes; Guyane; wing photo).

Culicoides trinidadensis Forattini (not Hoffman); 1953: 123 (misident.; male, female; Brazil; figs.).

Culicoides saintjusti Tavares & Ruiz, 1980: 27 (male, female; Brazil; figs.). NEW SYNONYMY.

Diagnosis. A large blackish species. Eyes contiguous by a distance equal to diameter of 1.5 ommatidial facets. Antenna (Fig. 21b,c) brown, bases of segments 3-10 pale; sensillar pattern 3,11-15. Palpus (Fig. 221a) dark brown; 3rd segment broad in middle, with conspicuous irregular pit. Mandible with 20-22 small teeth. Mesonotum brown, blackish anterolaterally, with 2 mesal dark brown vittae on anterior 1/2. Wing (Fig. 51) with very contrasting pattern; r-m crossvein dark on anterior 1/2; vein R4+5 pale; one transverse distal pale spot in cell R5 reaching wing margin; 2 distal pale spots in cell M1, the distal one small but reaching wing margin; apices of veins M1, M2 and M3+4 broadly pale, apex of vein Cu1 dark; macrotrichia present on distal third of wing, a few also in anal cell. Halter knob dark brown, pedicel pale. Legs dark brown, fore and mid knees yellowish, base and apex of hind tibia yellowish. Spermathecae ovoid, small, slightly unequal. Male 9th tergum (Fig. 21e) rounded distally, with short caudal cleft and widely spaced, short apicolateal processes; aedeagus with truncate apex; parameres (Fig. 21d) broadly fused at base, apices with minute fringing hairs.

Variation (N = 3): WL 1.53 (1.38-1.61); CR 0.69 (0.68-0.70); AR 0.95 (0.93-1.00); ATR 2.05 (1.90-2.15); PR 3.60 (3.50-3.70); P/HR 1.09 (1.07-1.11).

Types. Holotype of *ignacioi*, male, Boracea, M. Salesopolis, E. S. Paulo, Brazil, v.1947, L. Travassos-F. & P. E. Vanzolini coll. Allotype and 6 female paratypes (in Fac. Hig. S. Publ. Univ. Sao Paulo) (holotype examined through courtesy of Dr. O. P. Forattini).

Holotype of *saintjusti*, male, Paru da Fome, Jacarepagua, Rio de Janeiro, Brazil, same data for female allotype and 2 female and 2 male paratypes, iii,iv,v.1973,O. Tavares & R. Ruiz (in Museum Nacional do Rio de Janeiro).

Distribution. Brazil.

Specimens Examined.

BRAZIL: Minas Gerais, Caratinga, Barracao, 17.ix.1976,R. Lane, 2 females, 1 male. Rio de Janeiro, Jacarepagua, Pau da Fome, iii.1973 and vi.1973,Tavares & Ruiz, 1 female, 1 male (paratypes of *saintjusti*).

Wing Photo (Fig. 51). Brazil, Minas Gerais, Barracao (Lane).

Discussion. This species is very similar to *C. fernandoi*, from which it can be distinguished by the mandible with 20-22 teeth (14-15 in *fernandoi*), vein R4+5 pale (infuscated on lower portion with a very small dark spot behind apex in *fernandoi*), distal pale spot in cell R5 large, transverse (crescent-shaped or subdivided in *fernandoi*) and by the male genitalia with widely spaced apicolateral processes, aedeagus with truncate apex and parameres broadly fused at bases.

Tavares & Ruiz (1980) compared and distinguished *C. saintjusti* from *C. ignacioi*, but the characters they used for separating the species (poststigmatic dark spot and the shape of the aedeagus) are identical in the two species.

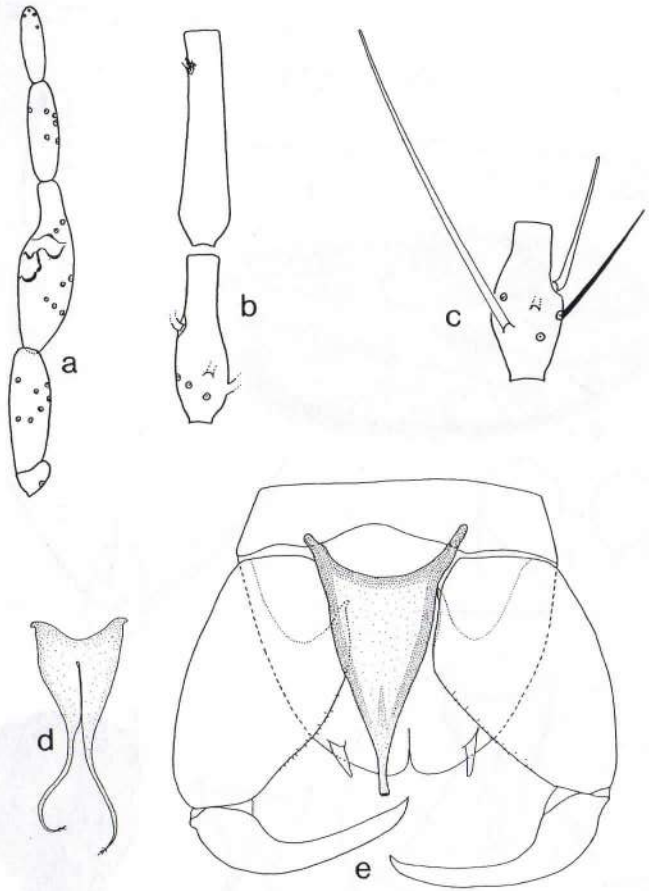


Fig. 21. *Culicoides ignacioi*; a-c, female; d-e, male: a, palpus; b, antennal segments 10 and 11; c, antennal segment 6; d, parameres; 3, genitalia, parameres omitted).

Culicoides insignis Lutz
(Figs. 22, 23, 52)

Culicoides insignis Lutz, 1913: 51 (male, female, pupa; Brazil; fig. wing); Costa Lima, 1937: 415 (notes on Lutz collection; Brazil; fig. palpus); Barbosa, 1947: 20 (notes on genitalia of male in Lutz's collection; fig. male genitalia from Brazil); Macfie, 1948: 75 (Chiapas, Mexico; notes); Fox, 1948: 25 (notes on female characters); Ortiz, 1950a: 441 (redescribed; discussion; Venezuela records); Ortiz, 1950b: 463 (synonyms: *recifei*, *inamollae*, *oliveri*,*trinidadensis*); Iriarte, 1950: 389 (notes; Venezuela); Barbosa, 1952: 16 (Brazil; notes on Lutz's collection); Fox, 1953: 888 (habits; Puerto Rico); Forattini, 1955: 107 (redescribed; Brazil; figs.); Wirth & Blanton, 1956: 318 (redescribed; Lutz's syntypes restudied, male lectotype designated; distribution; figs.; synonyms: *inamollae*, *painteri*); Forattini et al., 1956: 195 (larva, pupa; Brazil); Forattini, Rabello & Pattoli, 1957: 312 (larval habitat; Brazil); Forattini, 1957: 223 (redescribed; Brazil; figs; larva, pupa); Wirth & Blanton, 1959: 285 (redescribed; figs.; Panama records); Williams, 1964: 463 (larval habitats; Trinidad); Linley, 1965: 57 (pupa; Jamaica; figs.); Cavalieri & Chiossone, 1966: 148 (Argentina records); Davies, 1967: 39 (Jamaica; larval habitat; habits); Gutsevich et al., 1969: 4 (Cuba); Wirth & Blanton, 1973: 440 (Amazon records); Wirth, 1974: 25 (catalog; synonyms: *inamollae*, *painteri*); Wirth & Blanton, 1974: 57 (redescribed; figs.; West Indies records); Aitken et al., 1975: 130 (Trinidad records); Davies & Giglioli, 1977: 414 (Cayman Is.; breeding sites); Blanton & Wirth, 1979: 106 (all stages; figs.; Florida records); Davies & Giglioli, 1979: 593 (Cayman Is.; biol. notes); Ramirez Perez, 1984: 62 (Venezuela); Greiner, et al., 1984: 389 (Caribbean records); Spinelli & Wirth, 1986: 52 (in key; wing photo); Greiner & Rawlins, 1987:153 (Jamaica records); Lien & Lu, 1987: 94 (redescribed; Bolivia; wing photo); Wirth et al., 1988: 16 (wing photo atlas; distribution); Gibbs et al., 1989: 141 (Bivens Arm virus isolated in Florida); Greiner et al., 1989: 101 (Trinidad, Tobago survey); Greiner et al., 1990: 1072 (St.Croix records); Waller et al., 1990: 358 (notes; Guyane; wing photo); Homan et al., 1990: 1089 (potential bluetongue vector in Caribbean and Central America); Spinelli & Ronderos, 1991: 85 (Uruguay record); Tanya et al.,1992:1 (experimental infection with bluetongue virus).

Culicoides inamollae Fox & Hoffman, 1944: 110 (male, female; Puerto Rico; fig. wing); Barbosa, 1947: 9 (in key); Fox, 1948: 25 (Florida; fig. palpus, male genitalia); Fox & Kohler, 1950: 341 (biology; Puerto Rico); Fox, 1953: 888 (Puerto Rico; biol. notes); Foote & Pratt, 1954: 25 (Florida; figs.); Beck, 1958: 9 (Florida records; seasonal incidence); Fox & Garcia-Moll, 1961: 120 (notes; Puerto Rico).

Culicoides oliveri Fox & Hoffman, 1944: 108 (in part, male only; Haiti; fig. aedeagus, parameres).

Culicoides painteri Fox, 1946: 257 (female; Honduras; fig. wing); Barbosa, 1947: 9 (in key); Fox, 1948: 26 (discussion; fig. female palpus, male aedeagus, parameres); Ortiz, 1950a: 451 (notes).

Diagnosis. A medium to large-sized, dark brown species. Eyes contiguous from just a point on lower portion to a distance equal to diameter of 1.5 ommatidial facets. Antenna (Fig. 22a,b,c) brown, bases of flagellar segments 3-10 pale; sensillar pattern 3,(4),5,(6),7,(8),9,(10),11-15. Palpus (Fig. 22d) dark brown, elongated; 3rd segment slightly broader in middle, with characteristic irregular pit. Mandible with 21-23 teeth. Mesonotum (Fig. 22i) with pattern of yellowish center and 2 prominent dark sublateral vittae. Wing (Figs. 22e, 52) with distinctive pattern; r-m crossvein dark; vein R4+5 dark up to the point where it turns abruptly forward to meet costa; one transverse distal pale spot in cell R5

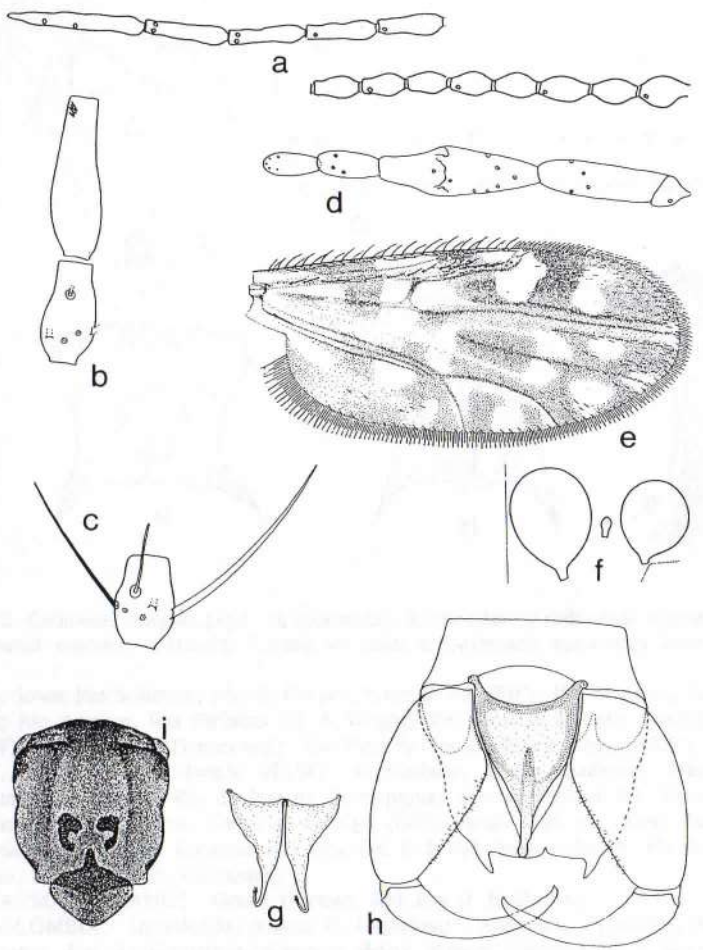


Fig. 22. *Culicoides insignis*; a-f, i, female; g-h, male: a, antenna; b, antennal segments 10 and 11; c, antennal segment 6; d, palpus; e, wing; f, spermathecae; g, parameres; h, genitalia, parameres omitted; i, dorsal thoracic pattern.

reaching wing margin; only one distal pale spot in cell M1 (a second one at wing margin frequently present in male); apices of veins M1, M2, and M3+4 pale, apex of vein Cu1 dark. Halter dark brown. Legs dark brown, with pale spots on fore and mid knees and at base and apex of hind tibia. Spermathecae subspherical to pyriform, slightly unequal (Fig. 22f). Male 9th tergum (Fig. 22h) with slender, widely separated apicolateral processes; apex of aedeagus slender with rounded papilla; parameres (Fig. 22g) connected at bases by a short sclerotized loop, each with short, stout main body and slender, ventrally directed, filiform tip with apex bare (Florida, West Indies and South America) or with minute fringing hairs (Central America)

Variation (N= 10): WL 1.22 (1.09-1.39); CR 0.64 (0.62-0.66); AR 1.27 (1.19-1.38); ATR 2.20 (2.00-2.40); PR 3.40 (3.00-3.55); P/HR 1.02 (0.98-1.08).

Pupa (from Florida specimens). Exuviae yelllowish brown. Operculum (Fig. 23a) dark brown; posterior end with large, fingerlike process projecting backward; surface of midportion covered by pointed, posteriorly directed tubercles; 2 am tubercles, each with a strong seta. Respiratory horn (Fig. 23e) amber colored, surface of anterior 1/2 with scattered pointed tubercles, becoming dark brown at tip; with 1-3 lateral and 6-10 apical spiracular openings. Anterodorsal (ad) tubercles with a pair of long subequal setae; dl tubercles with a pair of thin, very unequal hairs; dm tubercles almost black, with a strong pointed spine; vl tubercles with a pair of thin subequal setae. Fourth abdominal segment (Fig. 23b) with the following tubercles: 5 dpm (1 with a thin hair, 2 with a strong spine, 3-4 bare, 5 with a minute spine); 3 vpm (1 with a minute spine, 2 with a fine hair, 3 with a medium-sized spine); 3 lpm (the central with a fine hair, the laterals with a short spine); 2 dasm, the inner with a sharp spine, the outer with a long haire; 1 lasm, with a single small spine. Terminal segments of abdomen as in Fig. 23c (female) and 23d (male).

Types. Types of *insignis*: Females, male, and pupae were described by Lutz, but locality data were not given; only: "Ocorrem no Rio de Janeiro e na Bahia, onde pareciam mais asbundantes." Forattini (1955: 111) listed from the Lutz collection "Japuhyba, Angra dos Reis, E. do Rio de Janeiro, xii.1913 (Travassos col. 1, 8 female cotypes." Wirth & Blanton (1956: 322) designated as lectotype of *insignis* a male mounted on a slide together with a female from the Lutz collection in the Instituto Oswaldo Cruz (locality not given on the slide).

Types of *inamollae:* Holotype female, allotype male, 2 female paratypes, from light traps at Mayaguez, Puerto Rico, 7.x.1935, G. S. Tulloch (in School of Tropical Medicine, San Juan, Puerto Rico) (examined by Wirth & Blanton, 1956).

Types of *painteri*: Holotype female (slide), paratype female (pinned), Puerta Castilla, Honduras, 20, 29.iv.1926, R. H. Painter (in STMUPR) (examined by Wirth & Blanton, 1956).

Distribution. Widely distributed, from Florida to 35^{0} S in Argentina.

Specimens Examined. 1,032 females, 618 males, from the following localities (collector).

ARGENTINA: Buenos Aires, Berisso (G. R. Spinelli); Arroyo Zapata (GRS). Chaco, Resistencia (R. C. Shannon). Entre Rios, Arroyo P. Verne (O. Flint); Gualeguaychu (GRS); Santa Ana (GRS). Formosa, Parque Nac. Rio Pilcomayo (GRC). Misiones, Campo Viera (GRS).

BARBADOS: No locality (E. C. Greiner).

BELIZE: Cayo Dist., Western Highway (W. Hasse). Nattieville (WH).

BOLIVIA: Santa Cruz, 2 mi N Santa Rosa (R. E. Woodruff); 60 mi N Santa Cruz, Sasavedra Agr. Exp. Sta. (REW).

BRAZIL: Amazonas, Rio Cururu, Mission Cururu (E. J. Fittkau); Rio Madeira, Guajara-Mirim (R.C.Shannon); Rio Preto, Tiririca (EJF); Rio Negro, Igarape da Bica

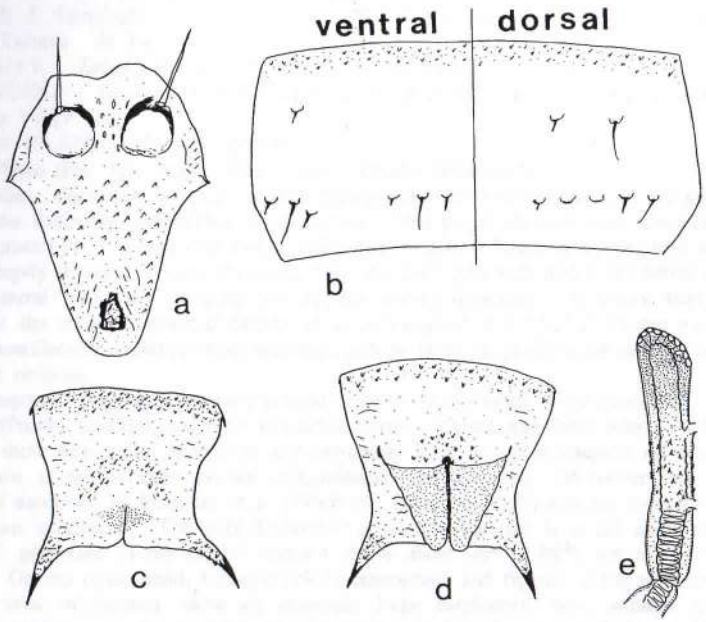


Fig. 23. *Culicoides insignis*, pupa: a, operculum; b, tubercles of abdominal segments; c, last abdominal segment of female; d, same for male; e, prothoracic respiratory horn.

(EJF); lower Rio Solimoes, Ilha do Careiro, Lago do Rei (EJF); Rio Madeira, Sao Geraldo (EJF); Rio Amazon, Ilha Parintins (H. A. Wright); Rio Amazon, Prainha (HAW); Manaus (HAW). Para, Belem (Damasceno); Rio Paru de Oeste, Mission Tiriyos (EJF); Belem (T. H. G. Aitken); Belem Harbor (HAW). Pernambuco, Recife (Barbosa). Minas Gerais, Caratinga (R. Lane). Rio de Janeiro, Jacarepagua, Pau de Fomme (O. Tavares). R. S. Pelotas (Bienko); Quarai, Sanga da Restiga (GRS). Santa Catarina, Nova Teutonia (F. Plaumann). Sao Paulo, Boraceia Biol. Sta. (M. E. Irwin); Salesopolis (N. Marston). Mato Grosso, Cuiaba (W. H. Whitcomb).

CAYMAN ISLANDS: Grand Cayman, Red Bay (J. E. Davies).

COLOMBIA: Intendencia Arauca (J. Jorgenson). Antioquia, El Hatillo, Barbosa (E. J. Homan); Hac. La Candelaria, Caucasia (EJH). Boyaca, Calderon (C. J. Marinkelle). El Cesar, San Alberto, 120 km N Bucaramanga (CJM). Huila, San Agustin (D. Messersmith). Cauca, 11 km N Santander de Quilchao (M. A. Tidwell). Magdalena, La Gloria (F. S. Blanton). Meta, Refugio Macarena (CJM); Fincac Barbascal (V. H. Lee); Opogoda (E. J. Pampana). Palagua, Pto. Boyaca (M. F. Suarez). Amazonas, Sofia (CJM). Valle, Cali (MAT); Valle del Cauca (J. Cruz); Rio Micay, Pto. Lopes (VHL); Rio Raposo (VHL).

COSTA RICA: Cartago, El Alto (FSB); Navarro (FSB); Turrialba (FSB); idem (R. E. Woodruff). Limon, La Lola, vic. Matina (W. D. Duckworth); Hacienda Theobroma (L. G. Saunders); Los Diamantes (REW). Puntarenas, Palmar Sur (FSB); Villa Neilly (Broce & Woodruff); Boca del Barranco (REW). San Jose, Desamparados (FSB); San Isidro del

General (FSB); Zapote (REW); San Isidro, Perez Zeledon (FSB). Guanacaste, 2 mi W Liberia (REW).

CUBA: Guantanamo (E. R. Turner). Camaguey, La Victoria (J. U. McGuire).

DOMINICA: Cabrit Swamp (W. W. Wirth). Clarke Hall (T. J. Spilman, W. W. Wirth). Mouth Layou R. (WWW).

DOMINICAN REPUBLIC: M.T.S.Prov., Rincon Molinillos (C. Mitchell). Rio Camu, 19 km NE Jarabacoa (Flint & Gomez). Puerto Plata, Long Beach Hotel (Woodruff & Drummond).

ECUADOR: Guare, Los Rios (R. Levi-Castillo). Napo, Limoncocha (L. J. Pinto). Pichincha, San Miguel de Caigona (L. A. Leon).

EL SALVADOR: Cuscatlan, San Pedro Perulapan (FSB). La Libertad, Hacienda San Diego (S. G. Breeland); San Andres (FSB); Santa Tecla (FSB). San Miguel, San Jorge (FSB). Santa Ana, Chalchuapa (FSB). San Vicente, Santo Domingo (FSB); *idem* (J. F. Matta). Sonsonate, Armenia (JFM); Metalio (SGB).

FLORIDA: Alachua Co., Pine Acres, 20 mi S. Gainesville (GRS). Highlands Co., Lake Placid, Archbold Biological Sta. (WWW).

GRENADA: St. Andrews Parish, Mirabeau Agr. Sta. (Telesford).

GUYANA: Demerara Co. (G. I. Burton).

GUYANE: Macouria (E. Abonnenc).

HAITI: Bayeux (R. C. Lowrie). Novion (Raccurt & Lowrie). Chou Chou Baie (Raccurt & Lowrie).

HONDURAS: Lago Yojoa (P. Galindo). Comayagua, Comayagua (FSB); *idem* (JFM); Siguatepeque (FSB); *idem* (JFM). Copan, Santa Rosa (FSB). Cortes, El Agua Azul (JFM); La Lima (FSB). Distrito Central, Santa Rosa (JFM). Guanaja Island (J. R. Wood). Puerto Castilla (R. H. Painter). Valle, Nacaome (FSB). Zamorano, Francisco Morazan (FSB).

JAMAICA: Montego Bay (REW). Kingston (Chapin & Blackwelder). Runaway Bay (WWW). Santa Cruz (C. & B.). St. Catherine, Spanish Town (E. G. Farnworth); same C. & B.); Twickerham Park (EGF). Westmoreland, Negril, Crystal Waters, tropical hammock (REW); Beau Cottage (EJF); Bluefield, Caldar Est. (EGF).

MEXICO: Morelos, E. Salto Falls (W. & D. Hasse). Nayarit, Tepec (FSB). Oaxaca, Tuxtepec, 20 km S. Bethania, Arroyo Chopan (P. J. Spangler); Isth. Tehuantepec, Jaltepec River (FSB). Tabasco, Villahermosa (PJS). Veracruz, Fortin de Las Flores (FSB); Cuitlahuac (PJS); El Enero (Flint & Ortiz); Los Tuxtlas, Rio Palma, vic. La Palma (C. & O. Flint); Catemaco (PJS). Tamaulipas, C. Monte (B. Brookman).

NICARAGUA: El Recreo (J. Maldonado). Villa Somoza (P. Galindo).

PANAMA: Canal Zone, Fort Sherman, Mojinga Swamp (FSB). Chiriqui, Elvira Farm (FSB); Gualaca (FSB); La Concepcion, Rio Caimito (PJS); Volcan (FSB). Cocle, Aguadulce (FSB); El Valle (FSB). Darien, Santa Fe (A. Broce); Garachine (FSB); Jaque (FSB); El Real (FSB). Herrera, Pto. Chitre (FSB). Los Santos, Pan de Azucar (FSB). Panama, Isla Taboga (FSB); Pacora (FSB); Tocumen (FSB). Veraguas, Divisa (FSB); El Maria (FSB).

PARAGUAY: Dept. Central, Caacupe Agr. Exp. Sta. (REW). Cordillera, 2 km E Valenzuela (REW).

PUERTO RICO: Anasco (J. F. Edmiston). Bosque de Luquillo (Walker & Drummond). Camp Tortuguero (FSB). Carolina (H. D. Pratt). Gurabo (HDP); *idem* (ECG). Laguna Tortaguero (HDP). Mayaguez, UPR Campus (Walker & Drummond). Rio Piedras (Flint & Spangler).

ST. LUCIA: Union Agr. Sta. (O. S. Flint).

TRINIDAD: U.S. Naval Sta. (THGA). Las Cuevas Bay, tidal area (R. W. Williams). Ft. Read (E. S. Tikasingh). La Paille Village, Port of Spain (Aitken & Downes). Carlsen Field (M. Yaseen). St. Pats, Arima (W. G. Downes). Tucker Valley (THGA).

URUGUAY: Artigas, Bella Union (GRS). Tacuarembo (A. Dyce).

VENEZUELA: Guarico, 12 km S Calabozo (P. & P. Spangler). Ocumare del Tuy (I. Ortiz). San Felipe (IO).

VIRGIN ISLANDS: St. John (RWW).

Wing Photo (Fig. 52). Brazil, Mato Grosso, Cuiaba (Whitcomb).

Discussion. *Culicoides insignis* is readily distinguished from other species of the *guttatus* Group by the following combination of characters: third palpal segment with conspicuous, irregular sensory pit; r-m crossvein deeply infuscated; vein R4+5 dark up to the point where it turns abruptly forward to meet the costa; only one distal pale spot in cell Ml; halter dark, and apicolateral processes of male 9th tergum widely separated. In many keys and descriptions the antennal sensillar pattern of *insignis* is given as 3,5,7,9,11-15, but we have observed considerable variation from this basic pattern in the large series we studied during the present revision.

With respect to the pupae, we have studied material from Florida (here described), from Honduras (Puerto Castilla), and from Argentina (Arroyo Zapata and Santa Ana). All these specimens show very similar operculum and respiratory horn, as well as identical distribution and armature of the tubercles on the cephalothorax and abdomen. Moreover, the pupa from Brazil described by Forattini et al. (1956) and Forattini (1957) appears to agree very well with our specimens. The only difference in all this material is in the angle of the apicolateral processes of the caudal segment (from about 70^0 to 90^0), not a significant difference. On the other hand, Linley's (1965) description and figures of pupae from the mangrove area of Jamaica show an unusually large respiratory horn without lateral spiracular openings, and the caudal segment with very wide angle of spread (about 185^0).

Habits. During the present study field work was also undertaken to find the most important breeding places of *C. insignis* in Florida, and the relationship of this species with different livestock. We selected the Pine Acres Research Station of IFAS, University of Florida, located 20 miles south of Gainesville. We found larvae of *C. insignis* breeding in mud at the edge of a large shallow pond, located about 0.1 mi from a cattle pen. These larvae were reared in the laboratory and the adults that emerged were determined as *C. insignis*. We also collected several adults of *insignis* in emergence traps places on the pond margin. Finally, we also collected *C. insignis* in emergence traps placed on cattle dung in this pasture.

Williams (1964: 463) and Aitken et al. (1975: 130) listed the following larval habitats for *C. insignis* in Trinidad: Brazil Village (Las Hermanas Estate), from wet cow manure and a pasture spring outcrop; Maracas (Beach area), from edge of tidal drainage ditch, short grass, open to sky; Cocorite, from tidal swamp; Valsayn, edge of *Tilapia* fish ponds, short grass, open to sky, water level fluctuates; Vega de Oropouche, from grassy stream margin; from coconut swamp, brackish water, shaded, water level fluctuates; river edge, tidal, salt-marsh grass, open to sky; edge of shaded stream, sandy soil with decomposing leaves, no growing vegetation; and edge of a partially shaded stream, tall grass.

Davies & Giglioli (1979) reported from Grand Cayman that "This species was more widespread than the previous species [*furens*] but was never trapped in large numbers. It did however occur in emergence traps and seemed to favor non-saline breeding sites, which were a minor part of available habitats though widely spread over the Island (Davies & Giglioli 1977). The species was also recorded in Cayman Brac. Peak densities appeared to occur after the rainy season when ground water levels were falling, usually in December and January. Later in the dry season numbers were reduced possibly because non-saline habitats then became too dry. This species was never taken at human bait but almost 10% of the *Culicoides* attracted to a goat bait near a non-saline site were *C. insignis*."

Culicoides lutzi Costa Lima
(Figs. 24, 53)

Culicoides lutzi Costa Lima, 1937: 419 (female; Para, Brazil, fig. palpus);
Barbosa, 1947: 81 (in key); Ortiz, 1950a: 448 (notes); Wirth & Blanton, 1956: 318 (notes; fig. wing); Forattini, 1957: 237 (redescribed; figs.; distribution); Wirth & Blanton, 1973: 442 (Amazon, Colombia records); Wirth, 1974: 25 (catalog); Ramirez Perez, 1984: 63 (Venezuela); Spinelli & Wirth, 1986: 52 (in key; wing photo); Wirth et al., 1988: 16 (wing photo atlas; distribution); Waller et al., 1990: 358 (notes; Guyane; wing photo).

Diagnosis. A medium-sized brown species. Eyes contiguous by a distance equal to diameter of 2-3 ommatidial facets. Antenna (Fig. 24a,b,c) brown, bases of segments 3-10 slightly paler; sensillar pattern 3,11-15. Palpus (Fig. 24d) brown; 3rd segment stout, with shallow irregular sensory pit. Mandible with 17-19 teeth. Mesonotum with prominent pair of blackish sublateral vittae. Wing (Fig. 24e, 53) with contrasting pattern; r-m crossvein pale; vein R4+5 pale; one transverse distal pale spot in cell R5 reaching wing margin; only one distal pale spot in cell M1; apices of veins M1, M2 and M3+4 broadly pale, apex of vein Cu1 dark; macrotrichia sparse in apices of cells R5, M1 and M2. Halter pale. Legs brown, apex of mid femur, bases of tibiae and apex of hind tibia narrowly yellowish. Spermathecae subspherical, unequal (Fig. 24f), with very short necks. Male 9th tergum (Fig. 24h) with apicolateral processes moderately separated; aedeagus with terminal papilla; parameres (Fig. 24g) connected by a short loop, each with stout main portion, apex with minute hairs.

Variation (N = 10): WL 1.10 (0.98-1.18); CR 0.66 (0.64-0.68); AR 1.22 (1.16-1.26); ATR 2.80 (2.55-2.90); PR 2.40 (2.25-2.55); P/HR 0.76 (0.71-0.83).

Types. Two syntypes, Abaete, Para, Brazil, E. Chagas coll. (no. 1408, Inst. Oswaldo Cruz).

Distribution. Brazil, Colombia, Guyana, Guyane, Venezuela.

Specimens Examined. 244 females, 12 males, from the following localities (collector):

BRAZIL: Amazonas, Rio Marauia, many data (E. J. Fittkau); Rio Madeira, Porto Velho (R. C. Shannon); Rio Madeira (EJF); Parana Madeirinha (EJF); lower Rio Madeira (EJF); Rio Madeira, Sao Geraldo (EJF); San Antonio, Manaus (EJF);Rio Tocantins, Villa Nova (EJF); Rio Solimoes (EJF); Rio Solimoes, Ponte Periquitos (EJF); Rio Solimoes, Igarape Catua (EJF); Rio Solimoes, mouth Ipixuna (EJF); lower Rio Solimoes, Ilha do Careiro, Lago do Rei (EJF); Rio Solimoes, Igarape Uarini (EJF); Rio Solimoes, Igarape Amataura (EJF); Rio Solimoes, S. Antonio do Ica (EJF), Rio Solimoes, 15 km below Coari (EJF); Rio Solimoes, Ilha Jucara (EJF); Rio Solimoes, at mouth Rio Takana (EJF); Rio Negro (EJF); Rio Negro, Igarape da Bica (EJF); Rio Tootototobi (R. Pinger); Rio Cueiras (EJF); Rio Cueiras, Rio Branquinho (EJF). Mato Grosso, Cuiaba (W. H. Whitcomb). Para (N. C. Davis); Para, Rio Paru de Oeste, Mission Tiriyos (EJF); Belem (T. H. G. Aitken). Roraima, Rio Auris (R. Pinger).

COLOMBIA: Meta, Finca Barbascal (V. H. Lee); Refugio Macarena (C. J. Marinkelle). Pto. Boyaca (CJM). Amazonas, Sofia (CJM).

ECUADOR: Napo, 20 km W Cuyabena (J. Cohen).

VENEZUELA: TFA Base Camp, 140 m, Cerro de la Neblina (O. Flint & J. Louton).

Wing Photo (Fig. 53). Brazil, Amazonas, Rio Solimoes (Fittkau).

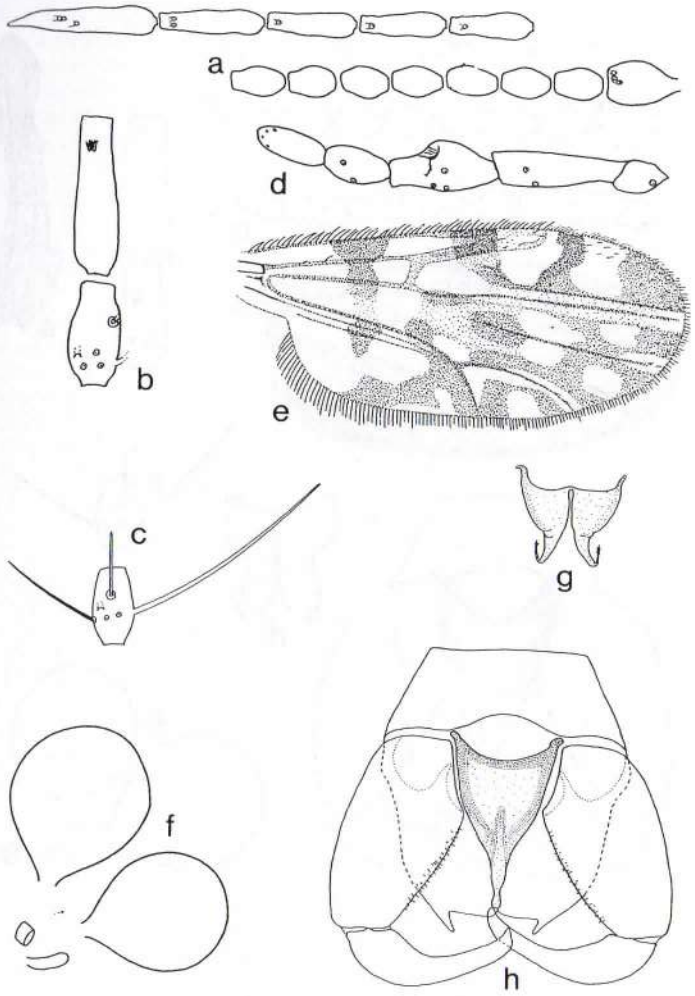


Fig. 24. *Culicoides lutzi*; a-f, female; g-h, male: a, antenna; b, antennal segments 10 and 11; c, antennal segment 6; d, palpus; e, wing; f, spermathecae; g, parameres; h, genitalia, parameres omitted.

Discussion. Characters for separating *C. lutzi* from the related species *C. flavivenula* are given in the key and in the discussion under the latter species. Forattini (1957) pointed out that the parameres of *C. lutzi* are fused at the base a short distance, but in the specimens we studied they are connected by only a short loop.

Culicoides maruim Lutz
(Figs. 25, 54)

Culicoides maruim Lutz, 1913: 48 (female; Brazil; mangrove swamps); Costa Lima, 1937: 412 (in key); Barbosa, 1947: 10 (in key); Fox, 1948: 22 (male, female; Bahia, Brazil; fig. male genitalia); Briceno-Iragorry, 1949: 318 (notes; Venezuela); Ortiz, 1950a: 444 (redescription; discussion); Iriarte, 1950: 394 (notes; Venezuela); Barbosa, 1952: 18 (Brazil record; fig. pupa ex Lutz coll.); Forattini & Galvao, 1955: 225 (redescribed from types; figs.; Brazil); Wirth & Blanton, 1956: 323 (redescribed; figs.; Brazil; synonym: *recifei* Forattini, 1957: 218 (redescribed; figs.; distribution); Forrattini et al., 1957: 312 (larval habitat; Brazil); Williams, 1964: 402 (larval habitats; Trinidad); Aitken et al., 1975: 133 (Trinidad records; wing photo); Ramirez Perez, 1984: 63 (Venezuela); Spinelli & Wirth, 1986: 52 (in key; wing photo); Wirth et al,, 1988: 16 (wing photo atlas; distribution).

Culicoides lutzi Costa Lima of authors, misident.; Floch & Abonnenc, 1942a: 2 (female; Guyane; figs.).

Culicoides insignis Lutz, of authors, misident.; Floch & Abonnenc, 1942b: 2 (male; Guyane; figs.); Barbosa, 1944: 259 (Recife, Brazil; figs.).

Culicoides recife Barbosa, 1947:25 (Recife, Brazil; n. sp. for *insignis* Lutz of Barbosa 1944); Barbosa, 1952: 20 (valid species).

Diagnosis. A medium-sized species. Eyes contiguous by a distance equal to diameter of 1 ommatidial facet. Antenna (Fig. 25b,c,e) entirely brown; sensillar pattern 3,11-15. Palpus (Fig. 25d) brown; 3rd segment elongated, without pit, sensilla scattered on surface. Mandible with 16-18 teeth. Mesonotum without pattern, uniformly pruinose gray. Wing (Figs. 25f, 54) with poorly defined gray pattern; r-m crossvein dark on anterior end; vein R4+5 pale (or slightly darkened on lower margin in some specimens); one distal pale spot in cell R5 not meeting wing margin; one small distal pale spot in cell M1; veins M1, M2, M3+4 and Cul dark at apices; macrotrichia abundant, including anal cell (typical form), but frequently restricted to distal 1/3. Halter dark. Legs brown, fore and mid knees with paler spots, hind tibia with faint basal and apical pale bands. Spermathecae pyriform, slightly unequal (Fig. 25g). Male 9th tergum (Fig. 25i) with mesal cleft and widely separated apicolateral processes; apex of aedeagus stout with ball-like tip; parameres fused a short distance at extreme bases, main bodies stout and gradually tapering to relatively stout, bare, pointed tips. Pupal exuviae yellowish. Operculum dark brown, mid portion with pointed, anteriorly directed tubercles; respiratory horn (Fig. 25a) with 3 lateral (2 basal, 1 beyond middle) and 7 distal spiracular openings.

Variation (N = 10): WL 1.08 (0.91-1.20); CR 0.67 (0.66-0.69); AR 1.12 (1.08-1.17); ATR 1.65 (1.50-2.00); PR 4.25 (4.05-4.60); P/HR 1.14 (1.07-1.22).

Types. Of *maruim:* Lutz (1913) merely stated occurrence of *maruim* in the states of Rio de Janeiro, Sao Paulo, and Bahia, Brazil, in the mangrove zone. Forattini & Galvao (1955) studied 2 males and 10 females from the Lutz collection in the Instituto Oswaldo Cruz and designated a holotype male and allotype female, but gave no specimen data.

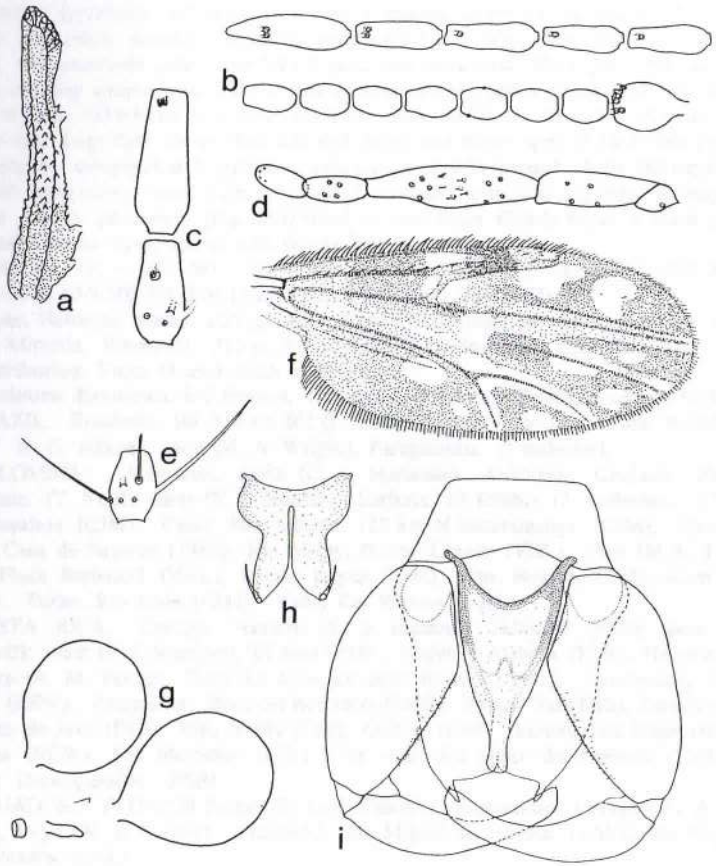


Fig. 25. *Culicoides maruim*; a, pupa; c-g, female; h-i, male: a, prothoracic respiratory horn; b, antenna; c, antennal segments 10 and 11; d, palpus; e, antennal segment 6; f, wing; g, spermathecae; h, parameres; i, genitalia, parameres omitted.

Types of *recifei*: Types were not designted; only numerous females and males from Recife, Olinda, anad Paulista (Pernambuco) were mentioned.

Distribution. Coastal; Brazil, Carriacou, Guyana, Guyane, Trinidad, Venezuela.

Specimens Examined.

BRAZIL: Bahia, Salvador, 16-18.viii.1932, N. C. Davies, 1 male. Recife, 1956, F. S. Barbosa, 7 females, 4 males. Rio de Janeiro, Mangaratiba, vii.1976, O. Tavares, 1 female. Sao Paulo, Bertioga, vii.1955, Forattini & Rabello, 1 females.

CARRIACOU, W. I.: Harvey Vale, 9.xii.1968, P. Bacon, biting in mangroves, 3 females.

GUYANA: Corentyne, Berbice Village, 10.viii.1962, T. H. G. Aitken, on man, 1 female.

TRINIDAD: Caroni Swamp, 18.x.1956, 7.iv.1958 (THGA), 5 females, biting man. Manganiella, 13.ix.1955, biting man, mangrove swamp (THGA). Grandwood USNS, 25.iv.1958, light trap (THGA), 1 female. Cocal, 26.iii.1960, biting man (THGA), 1 female. Chaguaramas USNS, 22.i.1960, (THGA), 1 female. Bush Bush Forest, Nariva Swamp, 2.i.1961, (THGA), 3 females. Cocorite Swamp, 13.viii.1963, R. W. Williams, emergence trap, 1 male; 15.i.1970, J. B. Davies, em. trap, 1 male. Ft. Read, 3.xii.1965, E. S. Tikasingh, *ex* man, 2 females. Sangre Grande, 7.ii.1966, S. Webb, 1 female. Cocorite, 15.viii.1969, M. Yaseen, biting on sand beach, 3 females. Oropouche, 7.x.1969, M. Yaseen, biting on sand beach, 1 female. Roussillae, 7.x.1969, M. Yaseen, biting on sand beach, 1 female. No data, Hogue & Bright, 1 female, with pupal exuviae.

Wing Photo (Fig. 54). Brazil, Rio de Janeiro, Mangaratiba (Tavares).

Discussion. This species differs from *paramaruim* in having the 3rd palpal segment much longer and more slender, the male 9th tergum with a mesal cleft, and the aedeagus with stouter tip; from *trinidadensis* in the antennal sensillar pattern, and the aedeagus without subapical projections; and from *diffusus* and *davidi* in the 3rd palpal segment without sensory pit.

Forattini (1957) described and illustrated the pupa of *maruim*, but did not mention the lateral spiracular openings of the respiratory horn.

Habits. Aitken et al. (1975) gave the following records from larval habitats in Trinidad: Port of Spain (Cocorite), collected by emergence trap from tidal swamp; Vega de Oropouche (Toco Road), by emergence trap from grassy drainage ditch edge.

Culicoides ocumarensis Ortiz
(Figs. 26, 55)

Culicoides ocumarensis Ortiz, 1950a: 455 (male, female; Venezuela; figs.); Ortiz & Leon, 1955: 571 (Ecuador; notes; figs.); Wirth, 1974: 25 (catalog); Lien & Lu, 1987: 93 (notes; Bolivia; wing photo); Wirth et al., 1988: 18 (wing photo atlas; distribution).

Culicoides diabolicus Hoffman, of authors, misident.; Macfie, 1932: 488 (notes; Colombia record; "biting at night in houses"); Wirth & Blanton, 1956: 316 (synonym: *ocumarensis);* Wirth & Blanton, 1959: 280 (synonymy).

Culicoides lutzi Costa Lima, of authors, in part; Forattini, 1957: 238 (synonym: *ocumarensis*).

Culicoides insignis Lutz, of authors, misident.; Floch & Abonnenc, 1942b: 2 (male; Guyane; figs.); Barbosa, 1944: 259 (male, female; Peixinhos, Recife, Brazil; figs.).

Culicoides recifei Barbosa, 1947: 25 (Recife, Brazil; n. sp. for *insignis* Lutz of Barbosa 1944); Barbosa, 1952: 20 (valid species).

Culicoides filariferus Hoffman, of authors, in part; Aitken et al., 1975: 121 (synonym: *ocumarensis*; Trinidad records; wing photo).

Diagnosis. A medium-sized dark brown species. Eyes contiguous by a distance equal to diameter of 1.5-2.0 ommatidial facets. Antenna (Fig. 26a,b) brown, bases of antennal segments 3-10 pale; sensillar pattern 3,11-15. Palpus (Fig. 26c) brown; 3rd segment slightly broader in middle, pit irregular. Mandible with 13-17 teeth. Mesonotum dark brown; prescutellar depression yellowish, this area extending anteriorly in middle; 2 sublateral, anterior, somewhat rounded, yellowish brown patches. Wing (Fig. 55) with contrasting pattern; r-m crossvein pale; vein R4+5 pale; one transverse distal pale spot in cell R5 broadly meeting wing margin; 2 distal pale spots in cell M1; apices of veins M1 and M2 pale, apices of veins M3+4 and Cu1 dark; scattered macrotrichia on distal 1/4 of wing. Halter dark brown. Legs dark brown, fore and mid knees and broad apex of hind tibia yellowish. Spermathecae subspherical to pyriform, subequal or slightly unequal. Male 9th tergum (Fig. 26e) with conspicuous mesal cleft, apicolateral processes very close together; aedeagus with terminal papilla; parameres (Fig. 26d) fused at base (from slightly fused to fused on basal 1/4), main bodies stout, apices with minute fringing hairs.

Variation. (N = 10): WL 1.05 (0.95-1.20); CR 0.67 (0.65-0.68); AR 1.12 (1.00-1.20); ATR 2.20 (2.10-2.30); PR 3.55 (3.25-3.80); P/HR 0.97 (0.95-1.03).

Types. Holotype female, allotype male, 5 male, 102 female paratypes, Ocumare del Tuy, Estado Miranda, Venezuela, 210 m, 3-5-50, I. Ortiz (in Inst. Nac. Hig. Caracas).

Distribution. From Mexico south to Brazil.

Specimens Examined. 842 females, 166 males, from the following localities (collector):

BRAZIL: Rondonia, BR 319 km 861 (J. Arias); Puerto Velho (JA). Para, Belem, many data (T. H. G. Aitken); *idem* (H. A. Wright); Paragaminas (? collector).

COLOMBIA: Amazonas, Sofia (C. J. Marikelle). Antioquia, Caucasia, Finca La Candelaria (T. Yuill); *idem* (E. J. Homan); Barbosa, El Establo (? collector). Caqueta, Tres Esquinas (CJM). Cesar, San Alberto, 120 km N Bucaramanga (CJM). Cauca, Rio Micay, Casa de Suyarez (VHL); Rio Micay, Puerto Lopeez (VHL); *idem* (M.A. Tidwell); Meta, Finca Barbascal (VHL); Puerto Lopez (CJM). Pto. Boyaca (CJM); *idem* (M. F. Suarez). Turbo, Rio Leon (CJM). Valle, Rio Raposo (VHL).

COSTA RICA: Cartago, Navarro (F. S. Blanton); Turrialba (FSB); idem (R. E. Woodruff); idem (P. J. Spangler); El Alto (FSB). Alajuela, Alajuela (FSB). Heredia, Finca La Tigra (A. M. Young); Finca La Lola, *ex* cacao flowers (AMY). Guanacaste, 2 mi W Liberia (REW). Puntarenas, Boca del Barranco (REW); Palmar Sur (FSB); Sabalito (FSB); San Vito de Java (FSB); Villa Neilly (FSB); Golfito (FSB). Limon, Los Diamantes near Guadiles (REW); Las Mercedes (FSB). San Jose, San Isidro del General (FSB); *idem* (REW); Desamparados (FSB).

ECUADOR: El Oro, El Pasaje (R. Levi- Castillo). Esmeraldas, Cayapas (L. A. Leon). Pastaza, Puyo (W. E. Steiner). Pichincha, San Miguel de Caigona (LAL); San Miguel de los Colorados (LAL).

EL SALVADOR: La Libertad, San Andres (FSB). Santa Ana, L. Coatepeque (FSB); Santa Ana (FSB); Chalchuapa (FSB). La Paz, San Juan Talpa (FSB).

GRENADA: St. Andrews Parish, Mirabeau Agr. Sta. (J. Telesford).

GUATEMALA: Suchitepequez, Finca Moca (Flint & Ortiz).

HONDURAS: Comayagua, Comayagua (FSB). Cortes, Agua Azul, Rancho Lake Yojoa (FSB); Lago Yojoa (P. Galindo).

MEXICO: Oaxaca, Isth. Tehuantepec, Rio Jaltepec (FSB). Tabasco, Villhermosa (P. J. Spangler).

PANAMA: Chiriqui, El Pueblo Stream (A. Broce); David (AB); El Volcan (FSB). Cocle, El Valle (FSB). Herrera, Pto. Chitre (FSB). Los Santos, La Palma (FSB). Veraguas, Divisa (FSB).

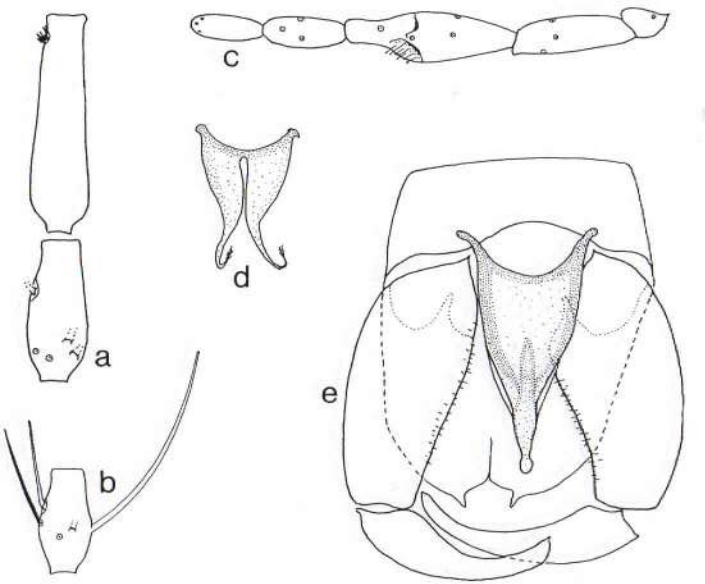


Fig. 26. *Culicoides ocumarensis*; a-c, female; d-e, male: a, antennal segments 10 and 11; b, antennal segment 6; c, palpus; d, parameres; e, genitalia, parameres omitted.

TRINIDAD: St. John's Estate, Dookie's Cow Pen (T. H. G. Aitken). No data (E. C. Greiner); no locality, reared from cocoa pods (no. 35) and in emergence trap, edge of grassy drain ditch (no. 66) (R. W. Williams). Macqueripe (THGA). Vega de Oropouche (E. Tikasingh). Ft. Read (THGA). Port of Spain (H. A. Wright). Chaguaramas USNS (THGA).

VENEZUELA: Ocumare del Tuy, 5.v.1950,I. Ortiz, 2 males (paratypes).

Wing Photo (Fig. 55).-- Ecuador, El Oro, Pasaje (Levi-Castillo).

Discussion This species is very similar to *C. filarifer*, especially the females. Male genital characters for separating the two species, as well as comments about their relationships, are given in the discussion under *C. filarifer*.

Diagnosis. A medium-sized dark brown species. Eyes contiguous by a distance equal to diameter of 1.5-2.0 ommatidial facets. Antenna (Fig. 26a,b) brown, bases of antennal segments 3-10 pale; sensillar pattern 3,11-15. Palpus (Fig. 26c) brown; 3rd segment slightly broader in middle, pit irregular. Mandible with 13-17 teeth. Mesonotum dark brown; prescutellar depression yellowish, this area extending anteriorly in middle; 2 sublateral, anterior, somewhat rounded, yellowish brown patches. Wing (Fig. 55) with contrasting pattern; r-m crossvein pale; vein R4+5 pale; one transverse distal pale spot in cell R5 broadly meeting wing margin; 2 distal pale spots in cell M1; apices of veins M1 and M2 pale, apices of veins M3+4 and Cu1 dark; scattered macrotrichia on distal 1/4 of wing. Halter dark brown. Legs dark brown, fore and mid knees and broad apex of hind tibia yellowish. Spermathecae subspherical to pyriform, subequal or slightly unequal. Male 9th tergum (Fig. 26e) with conspicuous mesal cleft, apicolateral processes very close together; aedeagus with terminal papilla; parameres (Fig. 26d) fused at base (from slightly fused to fused on basal 1/4), main bodies stout, apices with minute fringing hairs.

Variation. (N = 10): WL 1.05 (0.95-1.20); CR 0.67 (0.65-0.68); AR 1.12 (1.00-1.20); ATR 2.20 (2.10-2.30); PR 3.55 (3.25-3.80); P/HR 0.97 (0.95-1.03).

Types. Holotype female, allotype male, 5 male, 102 female paratypes, Ocumare del Tuy, Estado Miranda, Venezuela, 210 m, 3-5-50, I. Ortiz (in Inst. Nac. Hig. Caracas).

Distribution. From Mexico south to Brazil.

Specimens Examined. 842 females, 166 males, from the following localities (collector):

BRAZIL: Rondonia, BR 319 km 861 (J. Arias); Puerto Velho (JA). Para, Belem, many data (T. H. G. Aitken); *idem* (H. A. Wright); Paragaminas (? collector).

COLOMBIA: Amazonas, Sofia (C. J. Marikelle). Antioquia, Caucasia, Finca La Candelaria (T. Yuill); *idem* (E. J. Homan); Barbosa, El Establo (? collector). Caqueta, Tres Esquinas (CJM). Cesar, San Alberto, 120 km N Bucaramanga (CJM). Cauca, Rio Micay, Casa de Suyarez (VHL); Rio Micay, Puerto Lopeez (VHL); *idem* (M.A. Tidwell); Meta, Finca Barbascal (VHL); Puerto Lopez (CJM). Pto. Boyaca (CJM); *idem* (M. F. Suarez). Turbo, Rio Leon (CJM). Valle, Rio Raposo (VHL).

COSTA RICA: Cartago, Navarro (F. S. Blanton); Turrialba (FSB); idem (R. E. Woodruff); idem (P. J. Spangler); El Alto (FSB). Alajuela, Alajuela (FSB). Heredia, Finca La Tigra (A. M. Young); Finca La Lola, *ex* cacao flowers (AMY). Guanacaste, 2 mi W Liberia (REW). Puntarenas, Boca del Barranco (REW); Palmar Sur (FSB); Sabalito (FSB); San Vito de Java (FSB); Villa Neilly (FSB); Golfito (FSB). Limon, Los Diamantes near Guadiles (REW); Las Mercedes (FSB). San Jose, San Isidro del General (FSB); *idem* (REW); Desamparados (FSB).

ECUADOR: El Oro, El Pasaje (R. Levi- Castillo). Esmeraldas, Cayapas (L. A. Leon). Pastaza, Puyo (W. E. Steiner). Pichincha, San Miguel de Caigona (LAL); San Miguel de los Colorados (LAL).

EL SALVADOR: La Libertad, San Andres (FSB). Santa Ana, L. Coatepeque (FSB); Santa Ana (FSB); Chalchuapa (FSB). La Paz, San Juan Talpa (FSB).

GRENADA: St. Andrews Parish, Mirabeau Agr. Sta. (J. Telesford).

GUATEMALA: Suchitepequez, Finca Moca (Flint & Ortiz).

HONDURAS: Comayagua, Comayagua (FSB). Cortes, Agua Azul, Rancho Lake Yojoa (FSB); Lago Yojoa (P. Galindo).

MEXICO: Oaxaca, Isth. Tehuantepec, Rio Jaltepec (FSB). Tabasco, Villhermosa (P. J. Spangler).

PANAMA: Chiriqui, El Pueblo Stream (A. Broce); David (AB); El Volcan (FSB). Cocle, El Valle (FSB). Herrera, Pto. Chitre (FSB). Los Santos, La Palma (FSB). Veraguas, Divisa (FSB).

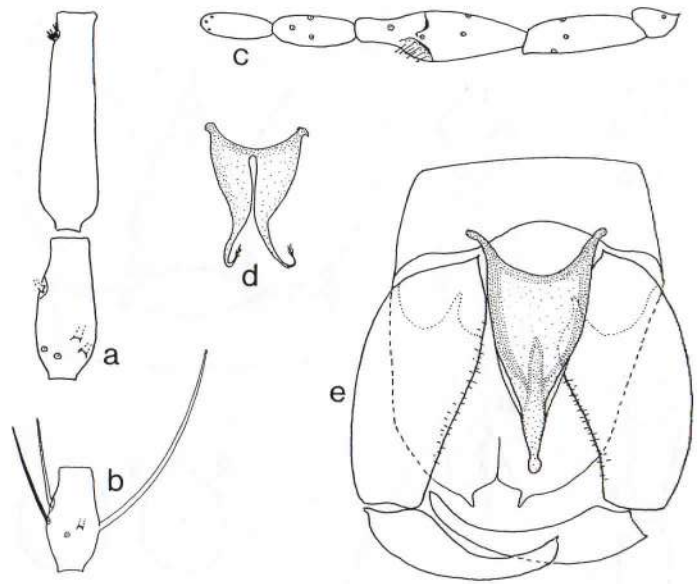


Fig. 26. *Culicoides ocumarensis*; a-c, female; d-e, male: a, antennal segments 10 and 11; b, antennal segment 6; c, palpus; d, parameres; e, genitalia, parameres omitted.

TRINIDAD: St. John's Estate, Dookie's Cow Pen (T. H. G. Aitken). No data (E. C. Greiner); no locality, reared from cocoa pods (no. 35) and in emergence trap, edge of grassy drain ditch (no. 66) (R. W. Williams). Macqueripe (THGA). Vega de Oropouche (E. Tikasingh). Ft. Read (THGA). Port of Spain (H. A. Wright). Chaguaramas USNS (THGA).

VENEZUELA: Ocumare del Tuy, 5.v.1950,I. Ortiz, 2 males (paratypes).

Wing Photo (Fig. 55).-- Ecuador, El Oro, Pasaje (Levi-Castillo).

Discussion This species is very similar to *C. filarifer*, especially the females. Male genital characters for separating the two species, as well as comments about their relationships, are given in the discussion under *C. filarifer*.

Culicoides paraignacioi Spinelli, new species
(Figs. 27, 56)

Female. Wing length 1.14 (1.03-1.27, n = 10 mm; breadth 0.53 (0.49-0.57, n = 10) mm.

Head: Dark brown. Eyes (Fig. 27e) bare; contiguous for a distance equal to diameter of 1.5 ommatidial facets. Antenna (Fig. 27a,b) brown, bases of segments 3-10 pale; lengths of flagellar segments in proportion of 20-16-17-18-18-17-17-17-21-22-24-27-44; antennal ratio 0.99 (0.95-1.04, n = 10); sensillar pattern 3,11-15; ATR ratio 2.00 (1.90-2.15, n = 10). Palpus (Fig. 27c) brown; lengths of segments in proportion of 8-25-33-18-12; 3rd segment slender, with definite, rounded, shallow sensory pit; long slender portion beyond pit; palpal ratio 4.05 (3.55-4.55, n = 10). Mandible with 21-23 (n = 10) very small teeth; P/H ratio 1.07 (1.00-1.19, n = 10).

Thorax: Dark brown; mesonotum without prominent pattern. Wing (Fig. 56) with contrasting pattern; r-m crossvein dark on anterior 1/2; vein R4+5 pale (very slightly infuscated in some specimens); 2nd radial cell with broad lumen; one large, transverse, distal pale spot in cell R5 broadly reaching wing magin; 2 distal pale spots in cell M1; distal pale spot in cell M2 large, rounded; distal pale spot in cell M4 connected with the pale line bordering lower margin of vein M3+4; anal cell with 2 distal pale spots; apices of veins M1, M2 and M3+4 pale, apex of vein Cu1 dark; scattered macrotrichia present on distal 1/4 of wing, a few very close to wing margin in cells M4 and anal cell; costal ratio 0.68 (0.67-0.70, n = 10). Halter dark brown. Legs dark brown; apices of mid tibia and hind femur yellowish; all tibiae with subbasal yellowish rings; hind tibial comb with 5 bristles.

Abdomen: Dark brown. Spermathecae ovoid, unequal (Fig. 27d), measuring 0.054 x 0.039 mm and 0.048 x 0.038 mm.

Male. Wing length 0.92 mm; breadth 0.36 mm; costal ratio 0.69.

Similar to female with usual sexual differences. Genitalia (Fig. 27g): Ninth sternum with very shallow caudomedian excavation, membrane not spiculate; 9th tergum subquadrangular, apicolateral processes slender, widely separated. Gonocoxite moderately stout; gonostylus curved, apex pointed. Aedeagus with low basal arch; lateral arms slightly convex; distal portion short, apex truncated. Parameres (Fig. 27f) broadly fused at base (this fusion somewhat incomplete in the allotype); apices with minute fringing hairs.

Distribution. Belize, Brazil, Colombia, Costa Rica; Guyane.

Types. Holotype female, allotype male, Colombia, Antioquia Dept, near Rio Anori, tropic rain forest, ix.1970, D. G. Young, blacklight trap (in USNM). Paratypes, 157 females, 2 males, as follows:

BELIZE: Chiquibel Rd., 13 km from San Diego, 4.i.1966, R. H. L. Disney, 3 females.

BRAZIL: Amazonas, Rio Cueiras, iv.1961, E. J. Fittkau, 1 female; Igarape Barro Branco, 8.v.1961, EJF, 1 female; Rio Branquinho at Cachoeira, 21.vii.1961, EJF, 1 female; Rio Marauia, ii.1963, EJF, 3 females; *idem* except i.1963, near foothills, 2 females; km 50 BR-174, 11.5 mi N Manaus, J. Arias, 2 females; Rio Jurua Arati, 8.xii.1980, JA, 2 females. Para, Altamira, no date, 4 females; Belem, i.1969, T. H. G. Aitken, 32 females; same data except iv.1969, 2 females; v.1969, 3 females; vii.1969, 9 females; ix.1969, 1 female; i.1970, 1 female; ii.1970, 1 female; iii.1970, 4 females; Maraba, 17.ii.1976, ? collector, 1 female.

COLOMBIA: Dept. Antioquia, same data as type, 18 females. Choco, Curiche, 12.vi.1967, D. G. Young, 35 females; same data except 14.ix.1967, 4 females; Rt. 25, no date, 2 females; Teresita, 25.vi.1967, DGY, 1 female; same data except 14.xi.1967, 7 females, biting man. Caqueta, Los Alicangaras, iv.1970, C. J. Marinkelle, 2 females. Putumayo, Puerto Leguizamo, 25.vi.1968, CJM, 1 female. Guaviare, San Jose del Guaviare, Trocha Oriental, 10.viii.1978, M. F. Suarez, 1 female. Valle, Rio Raposo, v.1963, V. H. Lee, 1 female; same data except xii.1963, 2 females; i.1964, 3 females, 1 male; ii.1964, 3 females; iii.1964, 2 females; vii.1964, 2 females, 1 male; viii.1964, 1 female; iv.1965, 4 females; viii.1965, 1 female.

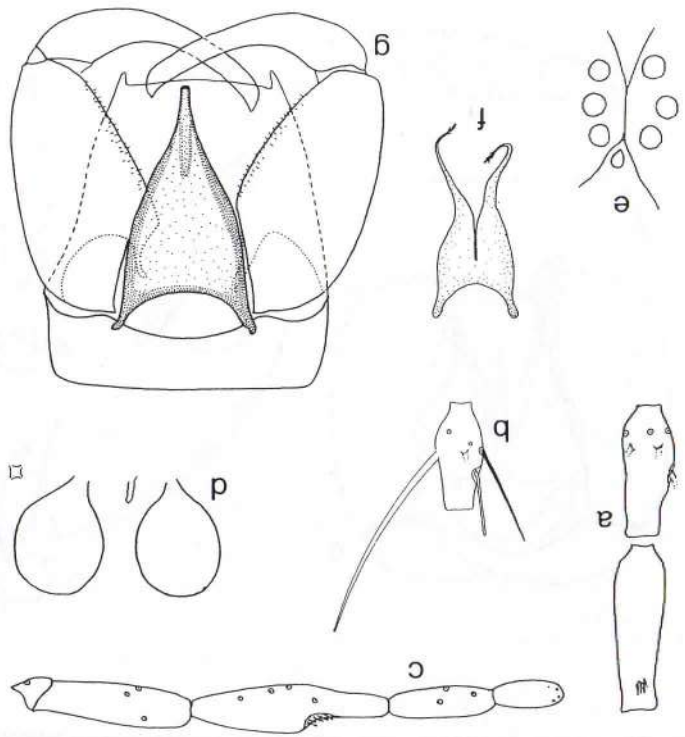


Fig. 27. *Culicoides paraignacioi*; a-e, female; f-g, male: a, antennal segments 10 and 11; b, antennal segment 6; c, palpus; d, spermathecae; e, eye separation; f, parameres; g, genitalia, parameres omitted.

COSTA RICA: Cartago, Turrialba, 17-20.viii.1964, R. E. Woodruff, 1 female. Heredia, Sarapiqui, 24-26.xi.1961, F. S. Blanton, 1 female, 1 male. Limon, Los Diamantes Exp. Sta., 16-17.vii.1964, REW, 1 female. Puntarenas, Villa Neilly, 21.vi.1964, REW, 10 females; same data except 21.vii.1964, 3 females. San Jose, San Isidro del General, 20.vi.1964, REW, 3 females.

Wing Photo (Fig. 56). Holotype, Colombia, Antioquia, Rio Anori (Young).

Discussion. This species is very similar to *C. ignacioi*. The females of *ignacioi* differ from the females of *paraignacioi* in their significantly larger size (wing length 1.53 mm), and in the stouter 3rd palpal segment with conspicuous irregular sensory pit. *Culicoides paraignacioi* is smaller (wing length 1.14 mm) and has a slender 3rd palpal segment, with a

clearly-defined, rounded, small, shallow pit. The male genitalia of both species are also very similar, with apicolateral processes widely separated, apex of aedeagus truncated, and parameres broadly fused at base, but they differ in the shape of the 9th tergum, which is rounded distally in *ignacioi* and subquadrangular in *paraignacioi*.

Culicoides paramaruim Wirth & Blanton
(Figs. 28, 57)

Culicoides paramaruim Wirth & Blanton, 1973: 443 (male, female; Brazil; figs.); Wirth et al.,1988: 18 (wing photo atlas; distribution).

Diagnosis. A medium-sized dark brown species. Eyes contiguous by a distance equal to diameter of 1.5 ommatidial facets. Antenna (Fig. 28a,b) entirely dark brown; sensillar pattern 3,11-15. Palpus (Fig. 28c) relatively short; 3rd segment stout, without pit, sensilla scattered on surface. Mandible with 13-15 relatively stout teeth. Mesonotum dark brown, without prominent pattern. Wing (Fig. 57) grayish brown, with inconspicuous pattern of diffuse pale spots; r-m crossvein darkened, especially so on anterior 1/2; vein R4+5 infuscated; one transverse distal pale spot in cell R5 not reaching wing margin; only one distal pale spot in cell M1; apices of veins M1, M2, M3+4 and Cu1 dark; macrotrichia present on distal 1/3 of wing. Halter dark brown. Legs brown, fore and mid knees with paler spots, hind tibia with faint basal and apical pale bands. Spermathecae subspherical, subequal. Male (Fig. 28e) 9th sternum with caudal margin not distinct; 9th tergum without caudal cleft, with small, widely separated apicolateral processes; apex of aedeagus with small bulbous tip; parameres (Fig. 28d) joined at bases with a short loop, main bodies stout, tapering abruptly at midportion to slender filiform distal process bearing minute fringing distal hairs.

Variation (N = 10): WL 1.04 (0.98-1.15); CR 0.66 (0.66-0.68); AR 1.07 (1.05-1.09); ATR 2.00 (1.80-2.20); PR 2.70 (2.40-2.90); P/HR 0.86 (0.82-0.95).

Types. Holotype, female, Belem, Para, Brazil, May 1969, T. H. G. Aitken, light trap. Allotype male, 1 male, 9 female paratypes, same but various dates (in USNM).

Distribution. Northeastern Brazil.

Specimens Examined.

BRAZIL: Para, Belem, many data, T. H. G. Aitken, 17 females (paratypes), 1 male (allotype); Belem, 15.ix.1969,H. A. Wright, 1 female.

Wing Photo (Fig. 57). Holotype, Brazil, Para, Belem (Aitken).

Discussion. Characters for separating *C. paramaruim* from the related species, *C. maruim* are given in the key and in the discussion under the latter species.

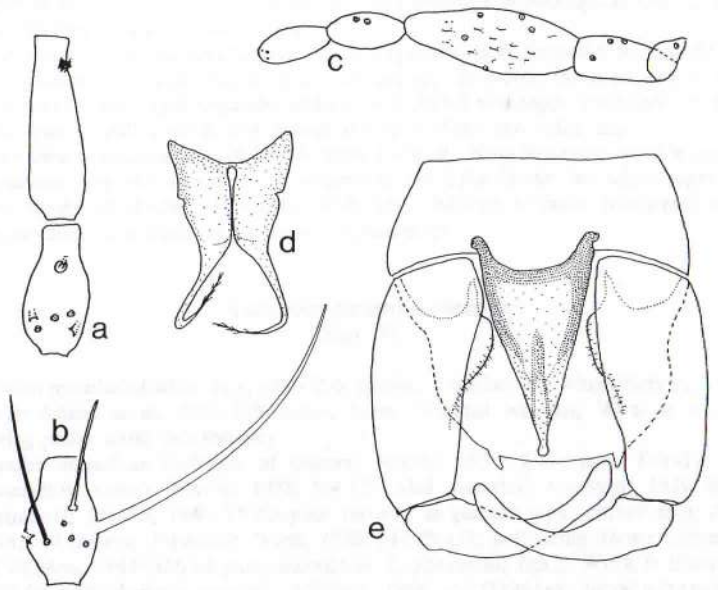


Fig. 28. *Culicoides paramaruim*; a-c, female; d-e, male: a, antennal segments 10 and 11; b, antennal segment 6; c, palpus; d, parameres; e, genitalia, parameres omitted.

Culicoides plaumanni Spinelli, new species
(Figs. 29 (a-e), 58)

Female. Wing length 1.18 (1.05-1.27, n = 7) mm; breadth 0.55 (0.49-0.61, n = 7) mm.

Head: Dark brown. Eyes bare, contiguous for a distance equal to diameter of 1.5-2.5 ommatidial facets. Antenna (Fig. 29c,d) brown, bases of flagellar segments 3-10 pale; lengths of flagellar segments in proportion of 20-16-16-16-16-26-26-18-26-28-28-32-45; antennal ratio 1.14 (1.09-1.20, n = 6); sensillar pattern 3,11-15; ATR ratio 2.60 (2.40-2.80, n = 7). Palpus (Fig. 29b) dark brown, lengths of segments in proportion of 11-25-30-15-15; 3rd segment with irregular sensory pit; palpal ratio 3.25 (3.00-3.35, n = 7). Mandible with 13-15 teeth; P/H ratio 0.86 (0.83-0.93, n = 7).

Thorax: Dark brown; Mesonotum without definite pattern. Wing (Fig. 58) with contrasting pattern; r-m crossvein dark on anterior 1/2; vein R4+5 pale, slightly infuscated on lower margin; one distal, somewhat crescent-shaped pale spot in cell R5 narrowly

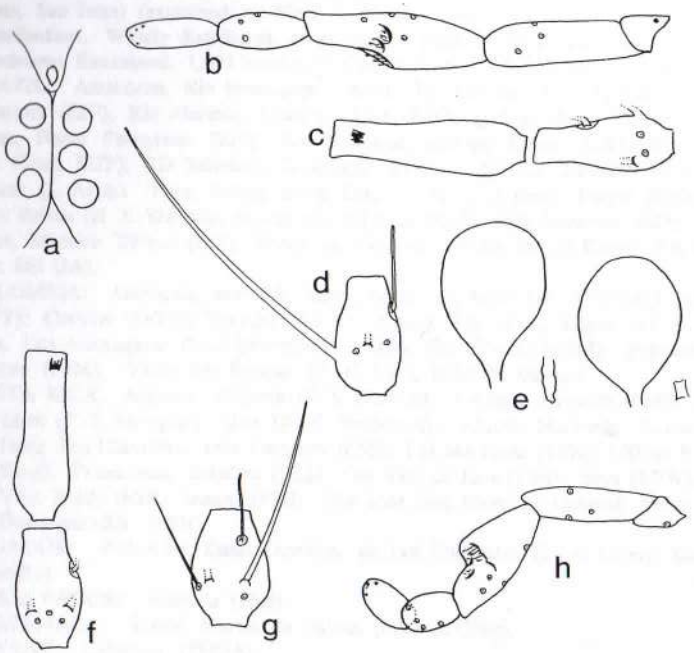


Fig. 29. *Culicoides plaumanni* (a-e) and *C. ruizi* (f-g), females: a, eye separation; b, h, palpus; c, f, antennal segments 10 and 11; d, g, antennal segment 6; e, spermathecae.

meeting wing margin (sometimes separate); 2 distal pale spots in cell M1; distal pale spot in cell M2 large, rounded; pale spot in cell M4 not connected with pale line bordering lower margin of vein M3+4 anal cell with 2 large distal pale spots; apices of veins M1, M2 and M3+4 pale, apex of vein Cu1 dark; macrotrichia present on distal 1/3 of wing; costal ratio 0.66 (0.65-0.68, n = 9). Halter dark brown. Legs dark brown; apices of mid tibia and hind femur yellowish, all tibiae with subbasal yellowish rings; hind tibial comb with 5 bristles.

Abdomen. Dark brown. Spermathecae pyriform, unequal (Fig. 29e), measuring 0.069 x 0.046 mm, and 0.061 x 0.046 mm.

Male. Unknown.

Distribution. Argentina, Bolivia, Brazil.

Types. Holotype female, Argentina, Chaco, Parque Nac. "El Chaco," 11-13.x.1982,G. R. Spinelli, light trap (in Mus. La Plata). Paratypes, 6 females, as follows:

ARGENTINA: Same data as type, 2 females.

BOLIVIA: Santa Cruz, Saavedra Agr. Exp. Sta., i.1960, R. E. Cummings, black light, 1 female. Yapacani, 28.viii.1983, H. Bermudez, 2 females.

BRAZIL: Amazonas, Rio Solimoes near S. Antonio do Ica, 28.viii.1961, E. J. Fittkau, at light, 1 female.

Wing Photo (Fig. 58). Paratype, Argentina, Chaco, Parque Nac. "El Chaco" (Spinelli).

Discussion. This species is named for Fritz Plaumann of Nova Teutonia, Brazil, in recognition of his important contribution to our knowledge of Neotropical Ceratopogonidae by his activities as a professional collector.

Culicoides plaumanni was recorded from Argentina as *C. fernandoi* by Spinelli & Wirth (1986), because of its close similarity to that species. However, the paratypes of *fernandoi* show a stouter 3rd palpal segment, and the vein R4+5 is strongly infuscated on the lower margin, with a small darkish spot behind the apex of the 2nd radial cell.

Two female specimens from Brazil, Santa Catarina, Nova Teutonia, viii.1961 and i.1971, F. Plaumann, are very similar to *C. plaumanni,* but differ in the 3rd palpal segment more slender, longer proboscis, and smaller ATR ratio. Because of these differences we do not designate these specimens as paratypes of *plaumanni.*

Culicoides pseudodiabolicus Fox
(Figs. 30, 59)

Culicoides pseudodiabolicus Fox, 1946: 256 (female; Trinidad; fig. wing);Barbosa, 1947: 8 (in key); Aitken et al, 1975: 137 (status; notes; Trinidad records); Wirth el al., 1988: 18 (wing photo atlas; distribution).

Culicoides diabolicus Hoffman of authors; Macfie, 1937: 7 (in part, Trinidad records; descriptive notes); Macfie, 1938: 164 (Trinidad records); Adamson, 1939: 8l (habits; Trinidad); Macfie, 1940: 25 (Guyana records, as *guttatus* (syn.: *diabolicus*)); Adamson, 1941: 74 (habits; Trinidad); Wirth, 1956: 249 (Brazil; pollinating *Hevea* rubber); Wirth & Blanton, 1956: 316 (in part; description & discussion; figs.); Wirth & Blanton, 1959: 280 (in part; Panama records); Williams, 1964: 463 (Trinidad; larval habitats); Aitken et al., 1968: 265 (Trinidad, habits); Wirth et al., 1968: 32 (Panama; reared ex palm); Greiner et al., 1989: 103 (Trinidad records).

Culicoides trinidadensis Hoffman; Myers, 1935: 71 (in part, Trinidad; inland biting records).

Culicoides guttatus (Coquillett) of authors, misident.; Macfie, 1938: 169 (in part, Trinidad records).

Diagnosis. A medium-sized brown species. Eyes contiguous by a distance equal to diameter of 2-3 ommatidial facets. Antenna (Fig. 30a,b) brown, bases of segments 3-10 pale; sensillar pattern 3,(7),(9),11-15. Palpus (Fig. 30c) brown; 3rd segment stout, with irregular sensory pit. Mandible with 14-16 teeth. Mesonotum dull grayish pruinose, a pair of prominent sublateral, dark brown vittae, and dark brown on lateral margins also; a pair of large prominent dark spots in prescutellar depression. Wing (Fig. 59) with contrasting wing pattern; r-m crossvein dark on anterior 1/2; vein R4+5 pale (infuscated for a short distance in some specimens); one large transverse distal pale spot in cell R5 broadly meeting wing margin; cell M1 with 2 distal pale spots; apices of veins M1, M2 and M3+4 pale, apex of vein Cu1 dark; scattered macrotrichia present at apices of cells R5, M1 and M2. Halter pale (knob very slightly infuscated in some specimens). Legs brown; apex of mid femur, bases of tibiae, and apex of hind tibia yellowish. Spermathecae ovoid, distinctly unequal. Male 9th tergum (Fig. 30e) with short caudal cleft, apicolateral processes widely separated; apex of aedeagus blunt, without terminal papilla; parameres (Fig. 30d) fused at base by a short distance, each with main body elongated, apex without fringing hairs.

Variation (N = 10): WL 1.00 (0.92-1.07); CR 0.66 (0.64-0.68); AR 1.12 (1.06-1.10); ATR 2.35 (2.10-2.60); PR 2.80 (2.50-3.30); P/HR 0.89 (0.85-0.95).

Types. Holotype female (on slide) and 1 pinned female paratype, Cumuto Village, Trinidad, 7,9.viii.1941,resting on walls of a stable (in Univ. Puerto Rico School of Tropical Medicine, San Juan) (examined by Wirth & Blanton, 1956).

Distribution. Widely distributed, from Mexico south to Peru and Brazil.

Specimens Examined. 1,991 females, 269 males from the following localities (collector):

BRAZIL: Amazonas, Rio Branquinho, mouth Rio Cueiras (E. J. Fittkau); Rio Negro, Ilha Marana (EJF); Rio Marauia, Chamata Dist. (EJF); Igarape Barro Blanco (EJF); Rio Solimoes, Ponte Periquitos (EJF); Rio Solimoes, Igarape Catua (EJF); Rio Solimoes, Igarape Catua (EJF); Rio Solimoes, S. Antonio do Ica (EJF); Rio Tocantins (EJF); 50 km N Manaus (J. Arias). Para, Belem, many dates (T. H. G. Aitken); Belem Harbor (H. A. Wright); Belem (H. E. Warmke, on stigmas of *Hevea brasiliensis*); Santarem (EJF); Rio Paru de Oeste, Mission Tiriyos (EJF). Rondonia, Guajara Mirim, km 26 Ramal Est. (JA); BR 319 Km 861 (JA).

COLOMBIA: Antioquia, near Rio Anori, tropic rain forest (D. G. Young). Choco, Rt. 25 (DGY); Curiche (DGY); Teresita (DGY). Cauca, Rio Micay, Lopez (M. A. Tidwell). Caqueta, Los Alicangaras (C. J. Marinkelle). Meta, Pto. Boyaca (CJM). Putumauyo, Pto. Leguizamo (CJM). Valle, Rio Raposo (V. H. Lee); *idem* (P. Barreto).

COSTA RICA: Alajuela, Alajuela (F. S. Blanton). Cartago, Navarro (FSB); Turrialba (FSB); *idem* (P. J. Spangler); *idem* (R. E. Woodruff). Limon, Hacienda Theobroma (L. G.Saunders); Los Diamantes near Guapiles (FSB); Las Mercedes (FSB); 120 km N Quesada (R. M. King). Puntarenas, Sabalito (FSB); San Vito de Java (FSB); *idem* (REW); Golfito (FSB); Villa Neilly (FSB); Irazun (FSB). San Jose, San Isidro de General, Perez Zeledon (FSB); Desamparados (FSB).

ECUADOR: Pichincha, Santo Domingo de Los Colorados (L. A. Leon); Manabi (R. Levi-Castillo).

EL SALVADOR: Acajutla (FSB).

GUATEMALA: Izabal, Martin de Galvez (Flint & Ortiz).

GUYANE: Cabassou (THGA).

HONDURAS: Atlantida, Lancetilla (FSB); *idem* (P. Galindo).

MEXICO: Puente Nacional (FSB).

PANAMA: Bocas del Toro, Almirante (FSB). Cocle, El Valle (FSB). Colon, Pina (FSB). Canal Zone, Balboa (P. A. Woke); Gamboa, Rio Agua Salud (W. W. Wirth); Mandinga (FSB); Madden Dam (FSB); Barro Colorado I. (WWW); *idem* (S. & W. Duckworth); Ft. Sherman, Mojinga Swamp (FSB); Mindi Dairy (FSB). Chiriqui, Fortuna, north Hill (THGA); Rovira, Elvira Farm (FSB); *idem* on Rio Chiriqui (FSB); El Volcan (A. Broce); Potrerillos (AB); Moras Farm (AB); El Pueblo Stream (AB). Panama, Cerro Campana (FSB). Los Santos, Pan de Azucar (FSB). Pedregal (FSB). Taboga (. (FSB). El Maria (FSB). Pacora (FSB). Rio Hato (FSB).

PERU: Lov. Pucallpa (P. & P. Spangler).

TRINIDAD: Arena Forest (THGA). Aripo Valley (P. Bacon). Ravine Stable Trace, Vega de Oropouche (THGA). Rio Grande Forest, Sangre Grande (THGA). Simla (W. Duckworth). St. Pats, tree station (THGA); Arima (W. G. Downes). Toto Rd., Gloriana, Balambre (F. D. Bennett). Tucker Valley (THGA). Turure (J. B. Davies).

VENEZUELA: Anacoco, Rio Cuyuni (? collector). TFA Base Camp, 140 m, Cerro de la Neblina (Flint & Louton).

Wing Photo. (Fig. 59). Trinidad, St. Pats Estate (Aitken).

Discussion. Several species in the *guttatus* Group are very similar to *pseudodiabolicus*, especially in wing pattern, but *pseudodiabolicus* can easily be recognized by its stouter 3rd palpal segment with characteristic subdivided pit, pale halter, distictly unequal spermathecae, and male aedeagus without terminal papilla.

Habits. Aitken et al (1975: 138) gave the following discussion on habits in Trinidad: "*Culicoides pseudodiabolicus* is a common Trinidadian species frequently referred to as *diabolicus*. Our collections (more than 120) mainly cover the period 1954 to 1966. Adults were taken throughout the year but were most abundant during the wet season (July-December). Human bait yielded most specimens, some of which were taken as high as 95 ft in the forest canopy. Many were also caught in light traps. Studies by Tikasingh & Davies (1970) and Tikasingh (1972) in Trinidad showed that this species (reported as *diabolicus)*
readily feeds on man; further it was caught in forest canopy traps in much greater numbers than on the ground, suggesting that arboreal animals might provide many blood meals. Tikasingh (1972) reported that *pseudodiabolicus* appeared at Vega de Oropouche shortly after the onset of the rains and is most abuindant at the height of the rainy season with a peak attack rate of 122 bites per man hour in December."

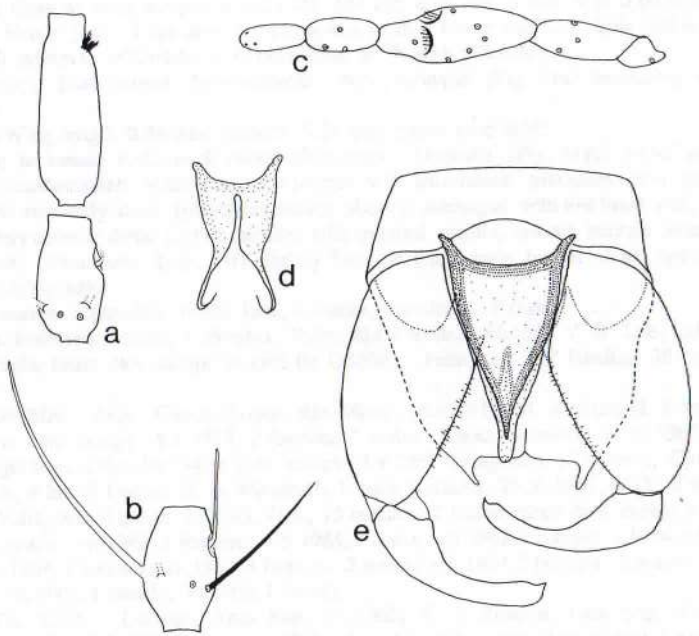


Fig. 30. *Culicoides pseudodiabolicus*; a-c, female; d-e, male: a, antennal segments 10 and 11; b, antennal segment 6; c, palpus; d, parameres; e, genitalia, parameres omitted.

Williams (1964) reared this species (as *diabolicus)* from (a) cocoa pods at Vega de Oropouche, (b) stump of "fig", *Musa* sp. (Musaceae) at Maracas, and (c) emergence trap from grassy edge of a fish (*Tilapia*) pond at Valsayn." Wirth et al. (1968) reared this species (reported as *diabolicus*) from rotting spadices of the Panama hat palm (*Carludovica palmata*) in Panama.

Culicoides ruizi Forattini
(Figs. 29f-h, 60)

Culicoides ruizi Forattini, 1954a: 189 (male, female; Brazil; figs.); Wirth & Blanton, 1956: 310 (redescribed from paratype; figs.); Spinelli & Wirth, 1986: 52 (in key; wing photo); Wirth et al., 1988: 18 (wing photo atlas).

Diagnosis. A large-sized dark brown species. Eyes contiguous for a distance equal to diameter of 2.5 ommatidial facets. Antenna (Fig. 29f,g) brown, bases of segments 3-10 pale; sensillar pattern 3,11-15. Palpus (Fig. 29h) short; 3rd segment stout, with irregular sensory pit. Mandible with 14-16 teeth. Mesonotum dark brown, densely whitish pruinose, with 2 small, faintly indicated, sublateral brown vittae. Wing (Fig. 60) with pale spots extensive; r-m crossvein pale; vein R4+5 pale; 2 distal pale spots in cell R5 (the usual one, transverse and meeting wing margin, and a small rounded 2nd near wing tip, but not reaching it); 2 distal pale spots in cell M1; apices of veins M1, M2 and M3+4 broadly pale, apex of vein Cu1 dark; membrane nearly bare, only a few macrotrichia near apex. Halter knob dark brown. Legs dark brown, fore and mid knees and base of hind tibia narrowly yellowish. Spermathecae pyriform, slightly unequal.

According to Forattini (1954a, 1957) the aedeagus ends in a blunt tip without papilla, and the parameres are fused on the basal 1/4, apices without branches. The 9th tergum is damaged in the allotype.

Variation (N = 4): WL 1.18 (1.10-1.29); CR 0.67 (0.66-0.68); AR 1.06 (1.03-1.10); ATR 1.95 (1.85-2.20); PR 2.10 (2.00-2.30); P/HR 0.65 (0.59-0.72).

Types. Holotype female, allotype male, Aruana, Estado de Goiaz, Brazil, ix.1948, J. M. Ruiz, 16 female paratypes (in Fac. Hig. Saude Publica, Univ. Sao Paulo, Brazil). We have examined the holotype by courtesy of Dr. O. P. Forattini.

Distribution. Brazil, Colombia.

Specimens Examined.

BRAZIL: Amazonas, Rio Cururu, Mission Cururu, i-ii.1961, E. J.Fittkau, at light, 13 females. Goiaz, Aruana, ix.1948, J. M. Ruiz, 3 females (paratypes).

COLOMBIA: Intendencia de Arauca, 19.iii.1977, J. Jorgenson, 2 females.

Wing Photo (Fig. 60). Colombia, Arauca, Intendencia (Jorgenson).

Discussion. This species is very similar to *C. travassosi*, from which it can be distinguished by the stouter palpus, pale r-m crossvein, and vein R4+5 without a small blackish spot just beyond apex.

Culicoides tidwelli Spinelli, new species
(Figs. 31m, 61)

Culicoides diabolicus Hoffman; Wirth et al., 1988: 14 (misident.; wing photo in Atlas).

Female. Wing length 0.99 (0.92-1.13, n = 10) mm; breadth 0.48 (0.45-0.54, n = 10) mm.

Head: Dark brown. Eyes (Fig. 31a) bare, contiguous for a distance equal to diameter of 2 ommatidial facets. Antenna (Fig. 31c,d) brown, narrow bases of segments 3-10 slightly pale; lengths of flagellar segments in proportion of 17-12-12-13-13-13-14-13-22-23-25-28-41; antennal ratio 1.20 (1.10-1.32, n = 10); sensillar pattern 3,(5),(7),(9-10),11-15; ATR ratio 2.30 (2.15-2.40, n = 10). Palpus (Fig. 31b) brown, lengths of segments in proportion of 7-19-27-8-9; 3rd segment very stout, nearly without distal extension, pit irregular; palpal ratio 2.25 (2.00-2.45, n = 10). Mandible with 13-17 (n = 10) teeth; P/H ratio 0.75 (0.66-0.81, n = 10).

Thorax: Dark brown; mesonotum with 2 longitudinal yellowish patches anterior to prescutellar depression, and 2 conspicuous yellowish, lateral vittae. Wing (Fig. 61) with contrasting pattern; r-m crossvein pale; vein R4+5 pale; 2nd radial cell with broad lumen; one distal transverse pale spot in cell R5 reaching wing margin; 2 distal pale spots in cell M1, the 2nd one reaching wing margin, as well as the distal pale spot in cell M2; cell M4 with a rounded pale spot broadly meeting the pale line bordering lower margin of vein M3+4; anal cell with 2 distal pale spots; apices of veins M1 and M2 pale, apices of veins M3+4 and Cu1 dark; scattered macrotrichia present in narrow apices of cells R5 and M1, and a few close to wing margin in cells M2, M4 and anal cell; costal ratio 0.69 (0.67-0.73, n = 10). Halter pale. Legs dark brown; apices of mid femur and hind tibia yellowish, all tibiae with subbasal yellowish rings; hind tibial comb with 5 bristles.

Abdomen: Dark brown. Spermathecae ovoid, subequal (Fig. 31e), measuring 0.051 x 0.037 mm.

Male. Wing length 0.84 mm; breadth 0.34 mm; costal ratio 0.70.

Similar to female with usual sexual differences. Genitalia (Fig. 31g): Ninth sternum with deep caudomedian excavation; 9th tergum with apicolateral processes close together. Gonocoxite relatively stout; gonostylus curved distally. Aedeagus with low basal arch; lateral arms slightly convex; distal portion slender with terminal papilla; distinct internal sclerotized peg present. Parameres (Fig. 31f) slightly fused at base; main bodies short; apices with minute fringing hairs.

Distribution. Colombia, Costa Rica, Ecuador, Honduras, Panama.

Types. Holotype female, Colombia, Valle, Rio Raposo, viii.1965, V. H. Lee, light trap; allotype male, same data except iv.1963 (in USNM). Paratypes, 117 females, 38 males, as follows:

COLOMBIA: Dept. Cauca, Lopez, Rio Micay, 16.v.1977, M. A. Tidwell, 1 female, 1 male; same data except 18.v.1977, 2 females, 2 males. Choco, Curiche, 12.xi.1967, D. G. Young, light trap, 2 females; same data except 19.x.1967, biting man, 11 females; Oleoducto de Pacifico, 9 km N Daque, R. E. Woodruff, 1 male; Teresita, 25.vi.1967, DGY, 2 females, 1 male. Valle, Rio Raposo, iv.1963, VHL, 15 females, 3 males; same data except v.1963, 1 female, 2 males; vii.1963, 2 females; viii.1963, 2 males; xii.1963, 1 female; i.1964, 1 female, 1 male; ii.1964, 8 females; iii.1964, 4 females, 2 males; viii.1964, 2 females, 2 males; ii.1965, 1 female; iii.1965, 1 female; vi.1965, 1 female.

COSTA RICA: Cartago, Tres Rios, vii.1962, F. S. Blanton, light trap, 1 female; Navarro, vii-viii.1962, FSB, light trap, 39 females, 11 males; same data except 4.xii.1961, 3 females; 17.vii.1962, 2 females; 20.vii.1962, 2 females; 25.vii.1962, 2 females. San Jose, Desamparados, ix.1961, FSB, light trap, 1 male.

ECUADOR: Pichincha, 113 km via Puerto Quito, 30.viii.1976, J. Cohen, CDC light trap, 1 female.

HONDURAS: Lancetilla, ii.1954, P. Galindo, light trap, 2 males.

PANAMA: Chiriqui Prov., Fortuna, 1000 m, 11.ii.1976, T. H. G. Aitken, CDC light trap, 5 females, 5 males; same data except 14.ii.1976, 1 female, 1 male; 23.ii.1976, 1 female; 18.ii.1976, 1 female.

Wing Photo (Fig. 61). Holotype: Colombia, Valle, Rio Raposo (Lee).

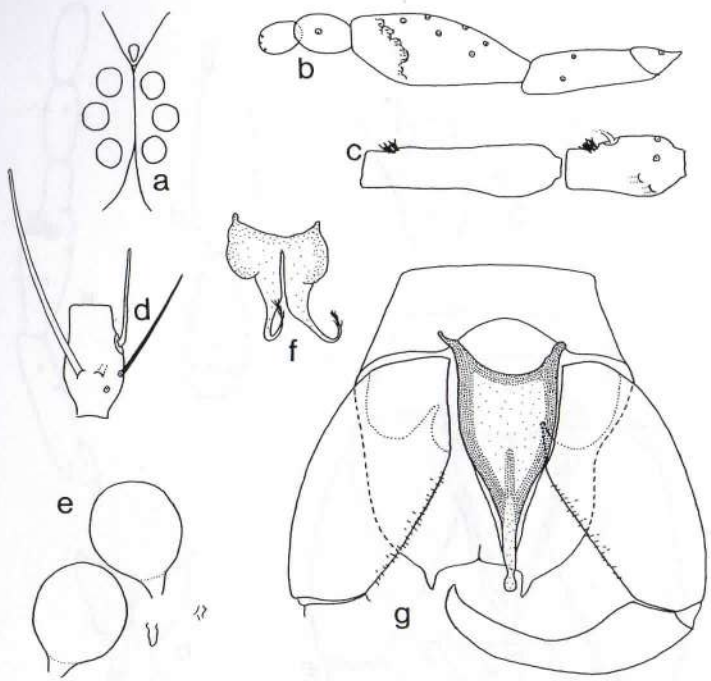


Fig. 31. *Culicoides tidwelli*; a-e, female; f-g, male: a, eye separation; b, palpus; c, antennal segments 10 and 11; d, antennal segment 6; e, spermathecae; f, parameres; g, genitalia, parameres and one gonostylus omitted.

Discussion. This species is dedicated to Mac A. Tidwell of the University of South Carolina, in recognition of his important contributions to our knowledge of the distribution of Colombian *Culicoides*.

Characters for separating *Culicoides tidwelli* from the closely related species *C. diabolicus* are found in the key and in the discussion under the latter species.

Culicoides travassosi Forattini
(Figs. 32, 62)

Culicoides travassosi Forattini, 1957: 198 (male, female; Brazil; figs.);Wirth & Blanton, 1973: 448 (Amazon records); Hudson, 1986: 293 (Surinam records); Wirth, Dyce & Spinelli, 1988:418 (wing photo atlas; distribution).

Diagnosis. A medium-sized dark brown species. Eyes contiguous by a distance equal to diameter of 2 ommatidial facets. Antenna (Fig. 32b,c) brown, bases of segments 3-10 pale; sensillar pattern 3,11-15. Palpus (Fig. 32a) brown; 3rd segment slightly broader beyond middle, pit subdivided. Mandible with 16-18 teeth. Mesonotum brown, dark brown anterolaterally, with 3 dark brown, mesal, short vittae. Wing (Fig. 62) with contrasting pattern; r-m crossvein dark; vein R4+5 pale, but with a small blackish spot behind apex; 2 distal pale spots in cell R5 (the usual one large, subdivided in some specimens, and a small 2nd near wing tip); 2 large distal pale spots in cell M1; apices of veins M1, M2 and M3+4 very narrowly pale, apex of vein Cu1 dark; scattered macrotrichia present on distal 1/4 of wing. Halter with dark brown knob, pedicel pale. Legs brown; fore and mid knees and base and apex of hind tibia yellowish. Spermathecae ovoid, slightly unequal. Male genitalia (Fig. 32e) characterized by the 9th tergum with short, widely separated apicolateral processes, aedeagus with terminal papilla, and parameres (Fig. 32d) joined at bases by a short loop, the tip bare.

Variation (N = 10): WL 1.06 (0.99-1.17); CR 0.68 (0.67-0.69); AR 1.21 (1.18-1.27); ATR 2.05 (1.90-2.10); PR 3.30 (3.00-3.50); P/HR 0.98 (0.89-1.05).

Types. Holotype, female, allotype, male, 15 paratypes, Serra do Cachimbo, E. Para, Brazil, i.1956, L. Travassos & S. Oliveira (in Fac. Hig. Saude Publ. Univ. Sao Paulo). We have examined the holotype, mounted on a slide under 3 cover slips, through the kindness of Dr. O. P. Forattini.

Distribution. Brazil, Surinam.

Specimens Examined.

BRAZIL: Amazonas, Rio Cururu, Mission Cururu, i.1961, E. J. Fittkau, 11 females, 3 males, at light. Para, Cachimbo, i.1956, L. Travassos & S. Oliveira, 1 male (paratype).

SURINAM, Para, Matta, 4.vi.1981, J. Hudson, 2 females, on man; *idem* except 15.viii.1979,1 female. Bigi Poika, ? collector, on man, 1 female.

Wing Photo (Fig. 62). Surinam, Para Dist., Matta (Hudson).

Discussion. Characters for separating *C. travassosi* from *C. ruizi* are given in the key and in the discussion under the latter species.

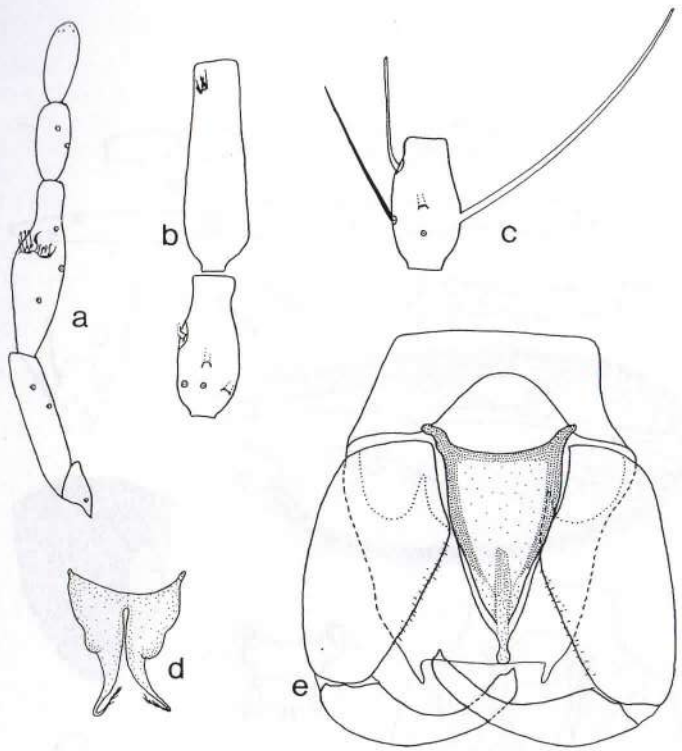


Fig. 32. *Culicoides travassosi*; a-c, female; d-e, male: a, palpus; b, antennal segments 10 and 11; c, antennal segment 6; d, parameres; e, genitalia, parameres omitted.

Culicoides trinidadensis Hoffman
(Figs. 33, 63)

Culcoides trinidadensis Hoffman, 1925: 286 (female; Trinidad; fig. wing); Myers, 1935: 1-18 (Trinidad; notes; in part); Costa Lima, 1937: 415 (in key); Fox, 1946: 256 (Stubals Bay, Trinidad); Barbosa, 1947: 10 (in key);Fox, 1948: 23 (fig. female palpus); Ortiz, 1950a: 445 (notes); Wirth & Blanton, 1956: 324 (redescribed; figs.; synonyms: *oliveri* Fox & Hoffman, *wokei* Barbosa (in part, not Fox), *diminutus* Barbosa); Forattini, 1957: 231 (redescribed; figs.;distribution); Wirth & Blanton, 1959: 287 (redescribed; figs.;Panama records); Wirth & Blanton, 1974: 82 (redescribed; figs.;West Indies records); Aitken et al., 1975: 140 (Trinidad records; wing photo); Wirth et al., 1988: 18 (wing photo atlas; distribution).

Culicoides oliveri Fox & Hoffman, 1944: 108 (female; Haiti; figs.; male is *insignis*); Barbosa, 1947: 9 (in key); Fox, 1948: 23 (discussion); Ortiz, 1950a: 449 (notes).

Culicoides wokei Barbosa (in part, not Fox), 1947: 28 (male, female; Balboa, Panama; figs. male genitalia, female palpus).

Culicoides diminutus Barbosa, 1951: 163 (new name for *wokei* Barbosa not Fox); Woke, 1954: 68 (Panama & Nicaragua records).

Diagnosis. A medium-sized dark brown species. Eyes contiguous by a distance equal to diameter of 1 ommatidial facet. Antenna (Fig. 33a,b,f) entirely dark brown; sensillar pattern 3,5,7,9,11-15. Palpus (Fig. 33c) brown; 3rd segment elongated, without pit, sensilla scattered on surface. Mandible with 15-17 teeth. Mesonotum (Fig. 33d) uniformly dull dark brown. Wing (Figs. 33e, 63) grayish brown, with inconspicuous pattern of diffuse pale spots; r-m crossvein darkened, the pale area where it is included small, rounded, not produced beyond radius; vein R4+5 infuscated; one crescent-shaped distal pale spot in cell R5, not reaching wing margin; only one distal pale spot in cell M1; apices of veins M1, M2, M3+4 and Cu1 dark; macrotrichia sparse on distal 1/3 of wing, but present in all marginal cells. Halter dark brown. Spermathecae (Fig. 33g) pyriform, subequal. Male 9th tergum (Fig. 33i) with mesal cleft, apicolateral processes very small and close together; aedeagus stout, with blunt apex and a pair of peculiar subapical projections extending ventrolaterad; parameres (Fig. 33h) with main bodies fused on basal 1/2, apices filiform and bare.

Variation (N = 10): WL 1.22 (1.09-1.39); CR 0.64 (0.62-0.66); AR 1.27 (1.19-1.38); ATR 1.75 (1.55-1.90); PR 3.40 (3.00-3.55); P/HR 1.02 (0.98-1.08).

Types. Holotype female of *trinidadensis*: Caronia River, Port of Sapin, Trinidad, 14.vi.1906, F. W. Urich (in USNM).

Holotype female of *oliveri* Fox & Hoffman (1944), Mariani, Haiti, 7.xii.1925, "biting viciously in sun." (in Univ. Puerto Rico School Trop. Med. San Juan)(examined by Wirth & Blanton, 1956).

Types of *diminutus:* Barbosa (1947) listed the following as syntypes of *wokei* Barbosa: 3 females, 3 males from Balboa, Panama, P. A. Woke, 1942; 1 female from Tepico, Mexico, A. Duges; 1 female from Finca Basilio, Solola, Guatemala, Moralles coll.; 3 females, Cacao, Tres Aguas, Guatemala, Barber & Schwarz, coll.; several females and males from Corinto, Nicaragua, P. A. Woke, coll. Barbosa (1951) selected the male from Balboa, Panama, labelled in plate 7, fig. 1, in Barbosa (1947), as lectotype of *diminutus* Barbosa n. name for *wokei* Barbosa, not Fox (deposited in USNM).

Distribution. Coastal; Central America and West Indies; South America to Venezuela, Colombia, Ecuador and Surinam.

Specimens Examined. 80 females, 18 males, from the following localities (collectors):

BAHAMAS: Abaco (G. M. Stokes); Andros Island, Driggs Hill near South Bight (Hayden & Giovannoli). Great Harbour Cay (GMS).

CAYMAN ISLANDS: Grand Cayman (GMS).

COLOMBIA: Antioquia, Currulao (E. Cura). Bahia Buenaventura, Bella Vista (V. H. Lee). Choco, Curiche (D. G. Young). Valle, Rio Raposo (VHL).

COSTA RICA: Puntarenas (F. S. Blanton).

CUBA: Guantanamo (J. E. Tisdale); *idem* (E. R. Turner).

ECUADOR: El Oro, El Guabo (R. Levi-Castillo); Machala (RLC).

EL SALVADOR: Sonsonate, Metalio (S. G. Breeland).

HAITI: Bayeux (R. C. Lowrie).

HONDURAS: Isla Barbareta (G. Magnon).

NICARAGUA: Corinto (P. A. Woke).

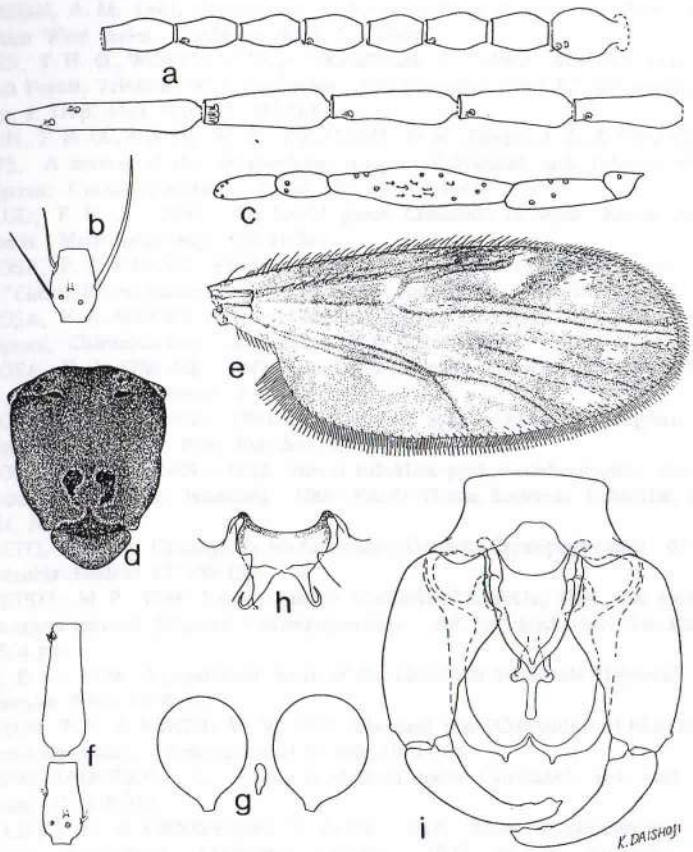


Fig. 33. *Culicoides trinidadensis*; a-g, female; h-i, male: a, antenna; b, antennal segment 6; c, palpus; d, dorsal thoracic pattern; e, wing; f, antennal segments 10 and 11; g, spermathecae; h, parameres; i, genitalia, parameres omitted.

PANAMA: Bocas Del Toro, Almirante (FSB). Canal Zone, Balboa (PAW); Fort Kobbe (FSB); Forte Sherman, Mojinga Swamp (FSB). Chiriqui, Rio Tabasara (FSB). Cocle, Puerto Farallon (FSB); Rio Hato (FSB). Darien, Santa Fe (A. Broce); Jaque (FSB); Patino Point (FSB); Garachine (FSB). Herrera, Pto. Chitre (FSB). Los Santos, Bayano (FSB). Panama, Arraijan (FSB); Camaron (FSB); Las Tablas (FSB); Pedregal (FSB); Rey Island (FSB); Rio Lajas, Coronado Beach (FSB); Vique Cove (FSB).

TRINIDAD: Chaguaramas (T. H. G. Aitken). Port of Spain (W. A. Hoffman). Stubals Bay (no collector stated).

Wing Photo (Fig. 63). Colombia, Bahia Buenaventura, Bella Vista (Lee).

Discussion. This species can readily be distinguished from its related congener *C.maruim* by the antennal sensillar pattern, by the small pale spot on the r-m crossvein, not produced beyond the radius, by the apicolateral processes of the male 9th tergum very small and close together (widely spearated in *maruim*), by the aedeagaus with blunt apex and subapical projections extending ventrolaterad, and by the main bodies of the parameres fused on basal 1/2.

The species redescribed by Forattini (1953) under the name *trinidadensis* is *ignacioi* Forattini (1957).

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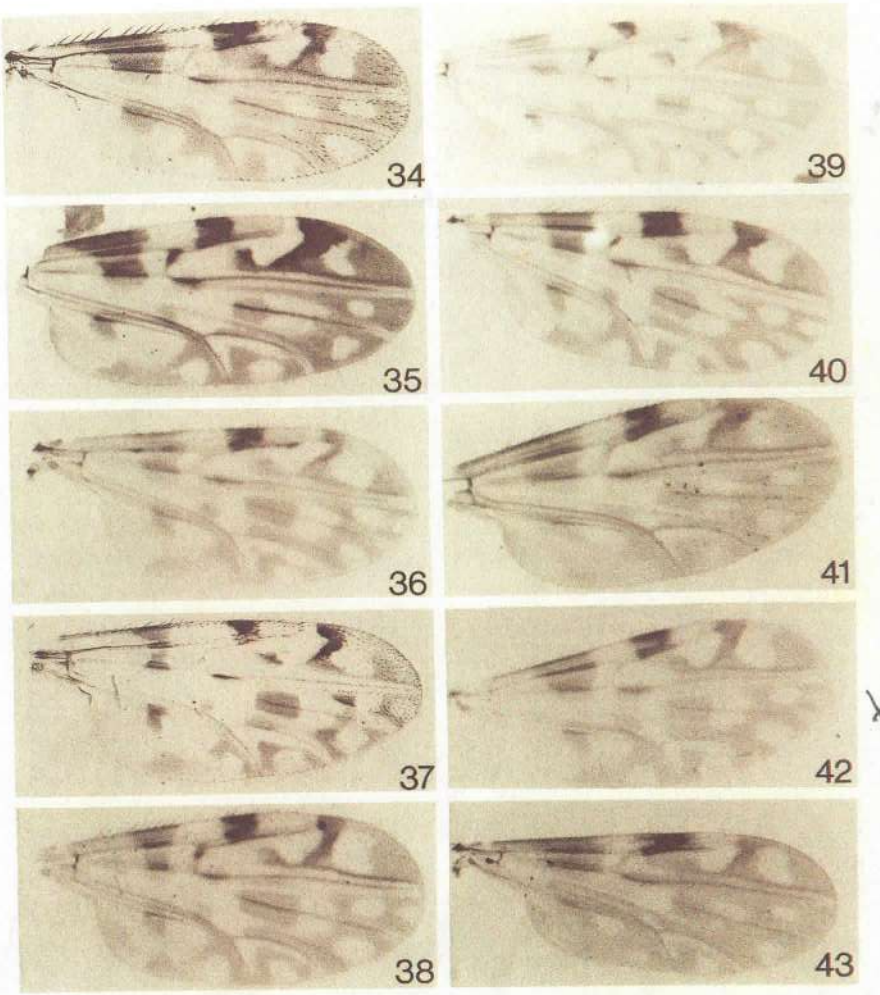
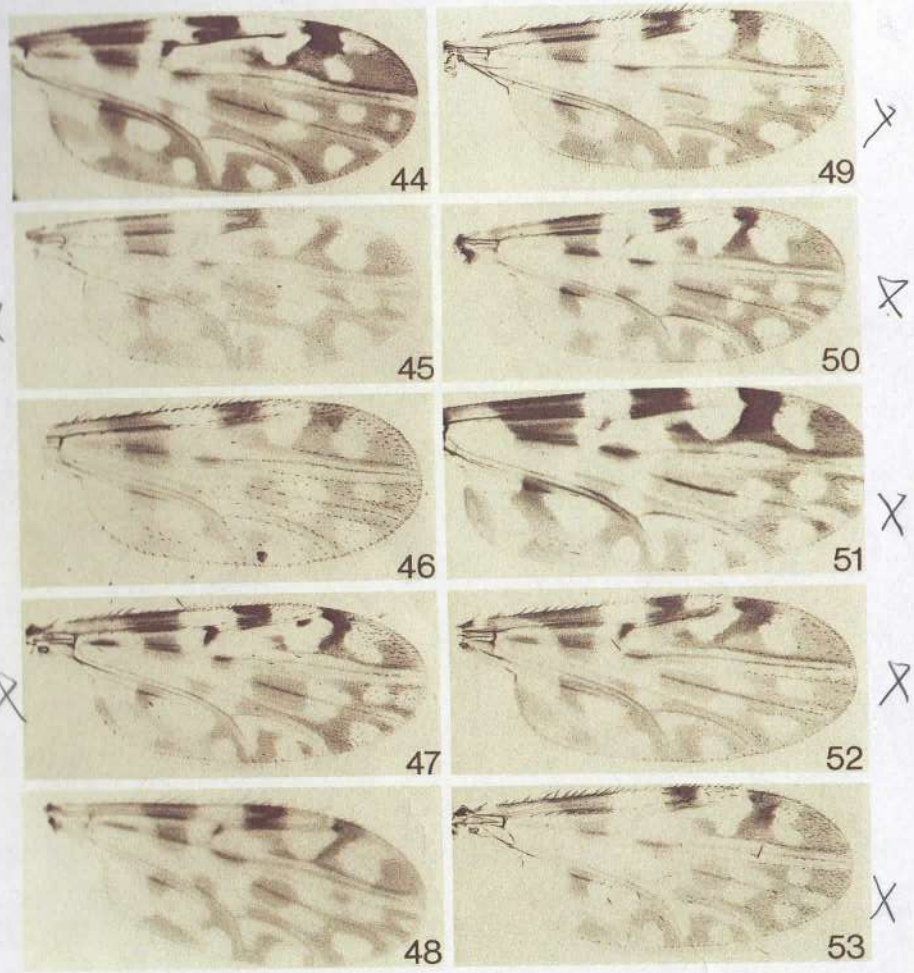
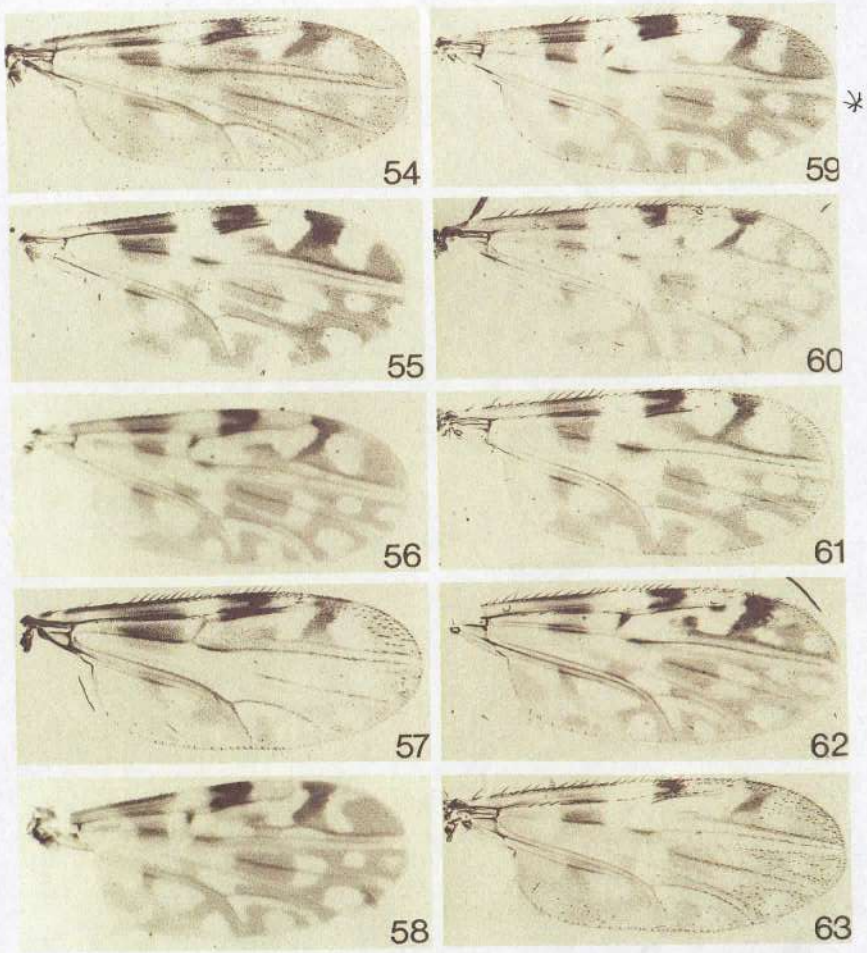


Figs. 34-43. Wings of female *Culicoides*: 34. *C. batesi;* 35. *C. biestroi;* 36. *C. bimaculatus;* 37. *C. brasilianum;* 38. *C. brownei;* 39. *C. charrua;* 40. *C. coutinhoi;* 41. *C. davidi;* 42. *C. diabolicus;* 43. *C. diffusus.*



Figs. 44-53. Wings of female *Culicoides:* 44. *C. fernandoi;* 45. *C. filarifer;* 46. *C. flavivenula;* 47. *C. foxi;* 48. *C. franklini;* 49. *C. fusipalpis;* 50. *C. guttatus;* 51. *C. ignacioi;* 52. *C. insignis;* 53. *C. lutzi.*

X = Amazonas.



Figs. 54-63. Wings of female *Culicoides:* 54. *C. maruim;* 55. *C. ocumarensis;* 56. *C. paraignacioi;* 57. *C. paramaruim;* 58. *C. plaumanni;* 59. *C. pseudodiabolicus* 60. *C. ruizi;* 61. *C. tidwelli;* 62. *C. travassosi;* 63. *C. trinidadensis.*