

[3.0029]

**A REVIEW OF THE *Culicoides Nigrigenus* GROUP,
WITH TWO NEW SPECIES (DIPTERA: CERATOPOGONIDAE)¹**

Willis W. Wirth² and Franklin S. Blanton³

The *Culicoides nigrigenus* group (Wirth and Blanton, 1959) includes five previously known species from Central America and the West Indies: *C. decor* (Williston) from St. Vincent, *C. nigrigenus* Wirth and Blanton from Panama, *C. lutealaris* Wirth and Blanton from Panama, *C. chrysonotus* Wirth and Blanton from Panama, and *C. hayesi* Matta from Honduras. We are taking this opportunity to add descriptions of two new species from the West Indies, to give a redescription of *C. decor*, to provide a key for the separation of the seven known species, and to present some new distribution records. The known distribution of the group is shown in fig. 1.

The following measurements and special terms are used in our descriptions of the female and in our summary of numerical characters in Table 1. Wing length is measured from the basal arculus to the wing tip; Costal Ratio (CR) is the length of the costa measured from the basal arculus to the tip of the second radial cell (2RC) divided by the wing length. Antennal Ratio (AR) is the combined length of the five elongated distal segments (in this paper the flagellomeres for convenience are called segments) divided by the combined length of the preceding eight. Sensory pattern is distribution of antennal segments bearing distal sensory tufts. Palpal Ratio (PR) is the length of the third palpal segment divided by its greatest breadth. Proboscis/Head Ratio (P/R Ratio) is the length of the proboscis measured from the distal end of the labrum-

¹This investigation was supported in part by the United States Army Medical Department Contract no. DA-49-193-MD-2177. Accepted for publication February 13, 1970.

²Systematic Entomology Laboratory, Agriculture Research Service, USDA; mail address: c/o United States National Museum, Washington, D. C. 20560.

³Department of Entomology, University of Florida, Gainesville, Florida 32601.

epipharynx to the anterior margin of the tormae divided by the distance measured from the latter point to the median hair socket between the eyes.

Material studied is in the collection of the U. S. National Museum in Washington, D. C.

We are greatly indebted to Miss Linda Heath for making the illustrations.

Table 1. Numerical characters of species of the *nigrigenus* group of *Culicoides*.

	Wing Length mm	Costal Ratio	Antennal Ratio	Antennal Sensoria	Palpal Ratio	Mandibular Teeth	P/H Ratio
<i>chrysonotus</i>	1.66	0.60	2.10	3,8-15	2.4	14	0.74
<i>decor</i>	1.20	0.60	1.25	3,8,10-15	3.2	15	0.85
<i>dominicanus</i>	1.22	0.62	1.85	3-15	2.3	15	0.75
<i>farri</i>	1.25	0.60	1.35	3,10-15	2.0	13	0.68
<i>hayesi</i>	1.36	0.58	1.48	3-15	2.5	15	0.91
<i>lutealaris</i>	1.56	0.58	1.30	3-15	2.0	14	0.70
<i>nigrigenus</i>	1.11	0.64	2.00	3-15	1.9	13	0.83

The species treated in this paper are members of the subgenus *Anilomyia* Vargas (type-species, *C. covagarciai* Ortiz), which is characterized as follows: Neotropical species of medium to large size with the 2RC ending in a pale spot, no pale area in the base of cell M_4 bordering veins M_{3+4} and Cu_1 ; sensory pattern 3, 11-15, and sometimes also on some or all of segments 4-10; two sclerotized spermathecae and a rudimentary third present, a sclerotized ring present or absent; scutum yellowish to brownish, without conspicuous pattern; leg markings various, characteristic for each species and species group; hind tibial comb with 4 to 6 spines; male genitalia with dorsal and ventral roots slender, subequal; apicolateral processes of ninth tergum usually well developed, the caudal margin between them usually transverse; parameres usually separate.

The subgenus *Anilomyia* comprises two species groups, the *covagarciai* group (Wirth and Blanton, 1959) containing the type-species and four other Neotropical species, and the *nigrigenus* group with seven species, all Neotropical and circum-Caribbean (fig. 1). The male genitalia of the species placed by Wirth and Blanton (1959) in the *covagarciai* group are rather diverse in structure and some species will have to be transferred elsewhere, but the species of the *nigrigenus* group are remarkably uniform in their genitalia, coming reasonably close to the type found in *C. covagarciai* Ortiz.

The species of the *nigrigenus* group have in common the following characters: Eyes contiguous to narrowly separated, bare. Antenna with distal five segments elongated, antennal ratio 1.25-2.10; sensory pattern 3-15; 8-15; or 3, 8, 10-15. Palpus with third segment bearing a distinct sensory pit which is usually deep and opens in a round pore, sometimes smaller in diameter than the pit. Pale wing markings usually extensive, frequently interconnected; wing usually with abundant macrotrichia. Hind tibial comb with four spines; legs always with all the knees bearing a conspicuous black spot, the legs usually extensively yellowish. Spermathecae without a sclerotized ring on the membranous duct. Male genitalia with parameres always separate, a strong basal knob present, distal portion slender, abruptly bent laterad and ventrad with sharp simple tip; aedeagus without transverse sclerotized bar across the base of the arch or a papilli-form tip; apicolateral processes always well developed, usually long and slender, diverging dististyles slender with bent, pointed tip.



Figure 1. Distribution of the *Culicoides nigrigenus* group in the Caribbean.

Biology.— The biting habits of the females are unknown. The immature stages so far as known are found in bromeliads. Dr. R. W. Williams reared *C. nigrigenus* from a bromeliad of the genus *Guzmania* in Trinidad, and H. A. Trevino reared *C. hayesi* from a bromeliad in Tamaulipas, Mexico.

Key to the Species of the *nigrigenus* Group (females)

- 1. Hind femur pale, a conspicuous dark band only on midportion 2
- Hind femur dark, with only a subapical pale band 3
- 2(1). Spermathecae small and subequal, each measuring 0.057 by 0.044 mm; distal antennal segments very elongate, 11 1.5 as long as 9-10 combined; AR 2.00; sensory pattern 3-15 *nigrigenus* Wirth and Blanton
- Spermathecae large and unequal, measuring 0.130 by 0.090 mm and 0.102 by 0.068 mm; distal antennal segments moderately elongate, 11 0.9 as long as 9-10 combined; AR 1.25; sensory pattern 3, 8, 10-15 *decor* (Williston)
- 3(1). Antenna with sensory pattern 3, 8-15 or 3, 8, 10-15 4
- Antenna with sensory pattern 3-15 5
- 4(3). Antenna with segment 11 1.5 as long as 9-10 combined; AR 2.10; large species, wing 1.66 mm long; wing pattern dark, pale spot straddling middle of vein M₂ isolated. *chrysonotus* Wirth and Blanton
- Antenna with segment 11 not as long as 9-10 combined; AR 1.35; small species, wing pale, pale spot straddling middle of vein M₂ not isolated. *farri* n. sp.
- 5(3). Wing paler, pale spot straddling middle of vein M₂ not isolated; smaller species, wing 1.22 mm long *dominicanus* n. sp.
- Wing darker, pale spot straddling middle of vein M₂ isolated from adjacent pale spots; larger species, wing 1.36-1.56 mm long 6
- 6(5). Proboscis long, P/H Ratio 0.91; third palpal segment longer and not as stout, PR 2.5; wing 1.36 mm long *hayesi* Matta
- Proboscis short, P/H Ratio 0.70; third palpal segment stouter, PR 2.0; wing 1.56 mm long *lutealaris* Wirth and Blanton

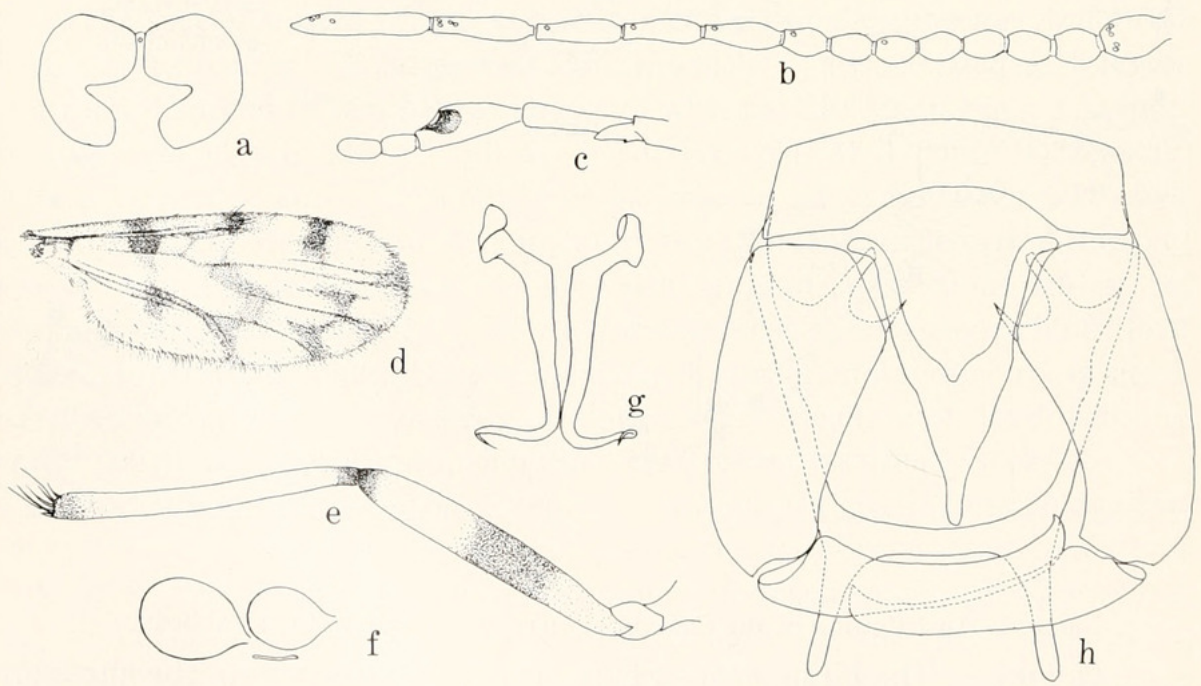


Figure 2. *Culicoides decor*. a, female eye separation; b, female antenna; c, female palpus; d, female wing; e, hind femur and tibia; f, spermathecae; g, male parameres; h, male genitalia, parameres removed.

Culicoides chrysonotus Wirth and Blanton

Culicoides chrysonotus Wirth and Blanton, 1956, Proc. Ent. Soc. Washington 58: 226 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia); Wirth and Blanton, 1959, Proc. United States Nat. Mus. 109: 312 (redescribed; fig. wing, scutum, palpus, tibial comb, spermathecae, male genitalia).

A large dark brown species, wing 1.66 mm long. Antenna with segment 11 1.5 as long as 9-10 combined; AR 2.10; sensory pattern 3, 8-15. Third palpal segment moderately long, PR 2.4; sensory pit relatively small and deep. Proboscis short, P/H Ratio 0.74. Legs brownish with markings as found in *C. decor*; pale wing markings more restricted than in *decor*, with an isolated pale spot straddling middle of vein M_2 . Spermathecae small and slightly unequal, with short, relatively stout necks. Male genitalia with ninth tergum bearing long, divergent apicolateral processes; aedeagus with short basal arch and stout basal arms, the distal process tapering to a blunt point; parameres with main portion relatively stout.

Distribution: Costa Rica, El Salvador, Panama.

New records: COSTA RICA: Cartago, Navarro, July, 1962, F. S. Blanton, light trap, 2 females. EL SALVADOR: Santa Ana, Ayutuxtepea, 3000 ft., 18 November 1961, J. Calvo, 1 female; Las Navanjos, 1000 m, 19 November 1961, J. Calvo, 2 females; Volcano, 14 November 1961, J. Calvo, 1 female. PANAMA: Chiriqui, El Volcan, 22 July 1966, A. Broce, light trap, 1 female.

Culicoides decor (Williston)

Ceratopogon decor Williston, 1896, Trans. Ent. Soc. London 1896: 281 (female; St. Vincent, W. I.; fig. wing).

Culicoides decor (Williston); Johannsen, 1943, Ann. Ent. Soc. America 36: 779 (combination); Wirth and Blanton, 1956, Proc. Ent. Soc. Washington 58: 227 (notes on type; comparison); Forattini, 1957, Arq. Fac. Hig. Saude Pub. Univ. Sao Paulo 11: 265 (notes, comparison; fig. wing).

Female.— Length of wing 1.20 mm.

Head: Eyes (Fig. 2a) narrowly separated. Antennae (Fig. 2b) with lengths of flagellar segments in proportion of 36-25-25-24-24-23-23-24-45-48-50-50-76, AR 1.25; sensory pattern 3, 8, 10-15. Palpal segments (Fig. 2c) with lengths in proportion of 20-40-70-20-27, PR 3.2; third segment long, slightly swollen distally, with a large, deep, round pit opening by a slightly smaller pore. Proboscis moderately long, P/H Ratio 0.85; mandible with 15 teeth.

Thorax: Yellowish brown; scutum with dense grayish pollen, scutal pits and anterior margin between them dark brown; scutum with numerous erect yellowish hairs; pleuron dark brown below. Legs (Fig. 1e) yellowish, knee spots blackish; proximal 0.6 of femora and distal 0.6 of tibiae on fore and mid legs brownish, hind femur with prominent dark brown band in midportion, and hind tibia with narrow apex brown; hind tibial comb with four spines, the one nearest the spur longest.

Wing (Fig. 2d): Pattern as figured; distal 0.6 of 2RC in a pale area; pale areas large, leaving the dark areas forming a narrow zig-zag pattern; CR 0.60; radial cells both elongate, with broad lumens; macrotrichia numerous, extending to base of wing in anal cell. Halter pale.

Abdomen: Yellowish, becoming brownish distally. Spermathecae (Fig. 2f) large and ovoid, with short, slender necks; unequal measuring 0.130 by 0.090 mm and 0.102 by 0.068 mm.

Male.— Similar to the female with the usual sexual differences; antenna with yellowish brown plume, last three segments with lengths in proportion of 70-56-75. Genitalia (Fig. 1h). Ninth sternum with shallow caudomedian excavation, the ventral membrane not spiculate; ninth tergum moderately long and tapering, with long, slender apicolateral processes. Aedeagus with basal arch extending to nearly half of total length, basal arms slender and curved; distal portion tapering to long, slender median point. Parameres (Fig. 2g) each with slender anterolateral process; main portion long and straight, tapering to slender simple tip abruptly bent laterad and ventrad.

Distribution.— Dominica, St. Lucia, St. Vincent.

Specimens examined: DOMINICA: Clarke Hall, January-March 1965, W. W. Wirth, light trap, 40 males, 50 females; April-June 1964, O. S. Flint, light trap, 8 males, 22 females; July-August 1964, T. J. Spilman, light trap, 18 males, 24 females; Layou River mouth, 20 January 1965, W. W. Wirth, light trap, 3 females; Macoucheri, 12 February 1965, W. W. Wirth, light trap, 3 females; South Chiltern Estate, 19 February 1965, W. W. Wirth, light trap, 2 females. ST. LUCIA: Castries, Fairview, 14 April 1959, R. Darsie, light trap, 1 male; Gros Islet, Yacht Club, 27 October 1967, J. B. Davies, at light, 1 female; St. Lucia Beach Hotel, 27 October 1967, J. B. Davies, at light, 1 female.

Culicoides dominicanus Wirth and Blanton, NEW SPECIES (Figure 3)

Female.— Length of wing 1.22 mm.

Head: Eyes (Fig. 3a) narrowly separated. Antenna (Fig. 3b) with lengths of flagellar segments in proportion of 32-20-20-20-20-20-20-50-56-60-60-92, AR 1.85; sensory pattern 3-15. Palpal segments (Fig. 3c) with lengths in proportion of 15-40-52-17-17, PR 2.3; third segment swollen distally, with a large, round, deep, sensory pit. Proboscis moderately short, P/H Ratio 0.75; mandible with 15 teeth.

Thorax: Yellowish brown, scutum yellowish pollinose, dark brown on anterior margin; pleuron dark brown below; scutum with abundant yellowish hairs. Legs (Fig. 3e) brownish, knee spots blackish; fore and mid femora with subapical, and fore and mid tibiae with basal, broad yellowish bands; hind femur dark brown with broad subapical yellowish

ring, hind tibia yellowish except at extreme tip; hind tibial comb with four spines, the second from the spur longest.

Wing (Fig. 3d): Pattern as figured, as in *C. decor*; CR 0.62; macrotrichia numerous, extending to base of wing in anal cell. Halter pale.

Abdomen: Yellowish, becoming brownish distally. Spermathecae (Fig. 3f) ovoid with short slender necks; moderately small, slightly unequal, measuring 0.080 by 0.058 mm and 0.072 by 0.055 mm.

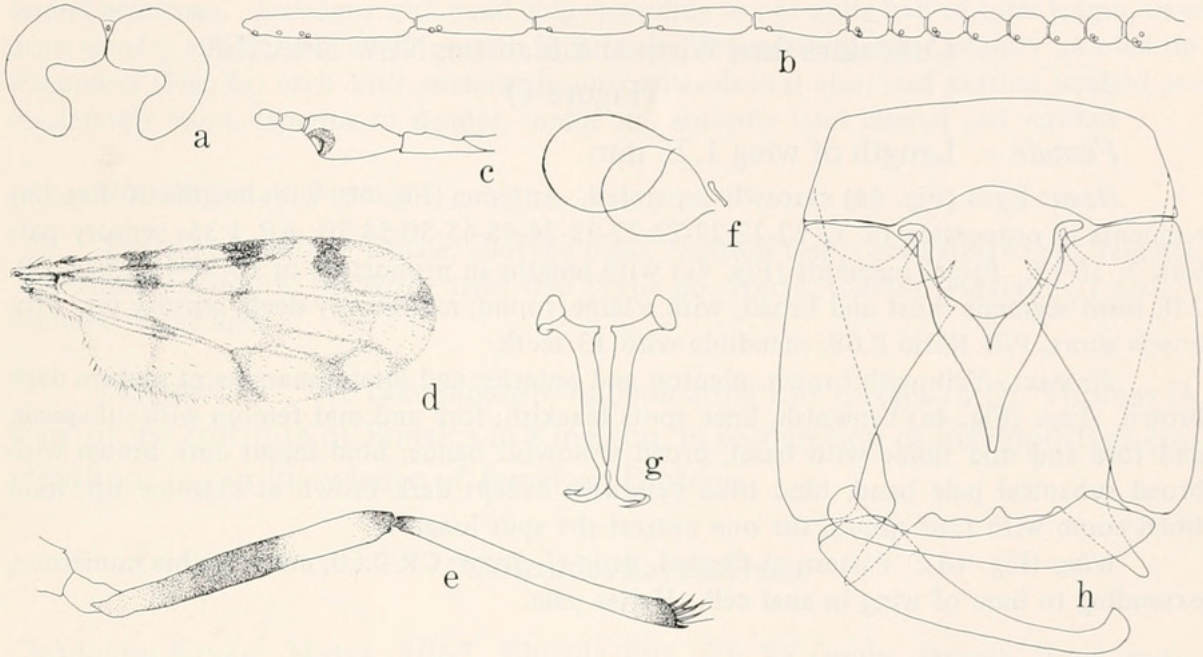


Figure 3. *Culicoides dominicanus*. a, female eye separation; b, female antenna; c, female pupa; d, female wing; e, hind femur and tibia; f, spermathecae; g, male parameres; h, male genitalia, parameres removed.

Male.— Similar to the female with the usual sexual differences; antenna with yellowish plume, last three segments with length in proportion of 82-65-93. Genitalia (Fig. 3h): Ninth sternum with shallow caudomedian excavation, the ventral membrane not spiculate; ninth tergum short and tapering, with moderately long, slender, diverging apicolateral processes. Aedeagus with basal arch extending to more than half of total length, rather angulate mesad, basal arms moderately stout and slightly bent; distal portion tapering to long slender median point. Parameres (Fig. 3g) each with short anterolateral arm; mid portion straight and moderately swollen at base, tapering distally to slender simple tip abruptly bent laterad and ventrad.

Distribution: Dominica.

Types.— Holotype, female, allotype, male, Dominica, 0.3 mi e Point Casse, 6 May 1964, O. S. Flint, at light (Type no. 70653, USNM). Paratypes, 53 males, 37 females, as follows:

DOMINICA: Castle Bruce Junction, 21 March 1965, J. F. G. Clarke, 4 males; Dleau Gommier, 17 March 1956, J. F. G. Clarke, at light, 5 males, 2 females; Point Lolo, 25 Jan-

uary 1965, W. W. Wirth, at light, 3 females; Point Casse, June 1964, O. S. Flint, at light, 41 males, 15 females, 12 March 1965, W. W. Wirth, light trap, 9 males, 8 females; South Chiltern Estate, 19 February 1965, W. W. Wirth, light trap, 4 males, 9 females.

Discussion.— In Dominica, where both *C. decor* and *dominicanus* have been taken, the endemic species is found only at the higher elevations, while the more widespread *C. decor* is restricted to lowland habitats.

Culicoides farri Wirth and Blanton, NEW SPECIES
(Figure 4)

Female.— Length of wing 1.25 mm.

Head: Eyes (Fig. 4a) narrowly separated. Antenna (Fig. 4b) with lengths of flagellar segments in proportion of 32-22-22-22-22-22-23-24-45-45-50-54-70, AR 1.35; sensory pattern 3, 10-15. Palpal segments (Fig. 4c) with lengths in proportion of 15-30-46-15-18, PR 2.0; third segment short and broad, with a large, round, moderately deep, sensory pit. Proboscis short, P/H Ratio 0.68; mandible with 13 teeth.

Thorax: Yellowish brown, pleuron and anterior and lateral margins of scutum dark brown. Legs (Fig. 4e) brownish, knee spots blackish; fore and mid femora with subapical, and fore and mid tibiae with basal, broad yellowish bands; hind femur dark brown with broad subapical pale band, hind tibia yellowish except dark brown at extreme tip; hind tibial comb with four spines, the one nearest the spur longest.

Wing (Fig. 4d): Pattern as figured, as in *C. decor*; CR 0.60; macrotrichia numerous, extending to base of wing in anal cell. Halter pale.

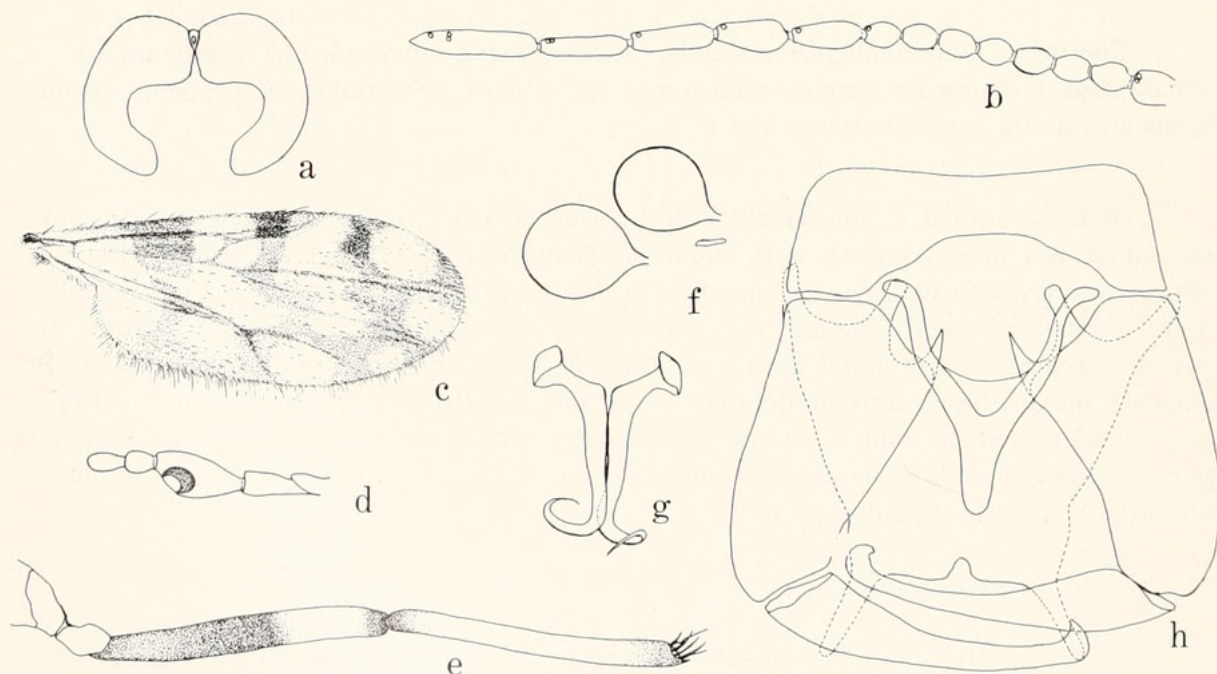


Figure 4. *Culicoides farri*. a, female eye separation; b, female antenna; c, female wing; d, female palpus; e, hind femur and tibia; f, spermathecae; g, male parameres; h, male genitalia, parameres removed.

Abdomen: Yellowish, becoming brownish distally. Spermathecae (Fig. 4f) ovoid with long slender necks, small and slightly unequal, measuring 0.064 by 0.046 mm and 0.058 by 0.042 mm.

Male.— Similar to the female with the usual sexual differences; antenna with yellowish brown plume, last three segments with lengths in proportion of 87-70-75. Genitalia (Fig. 4h): Ninth sternum with shallow caudomedian excavation, the ventral membrane not spiculate; ninth tergum short and tapering, with very long and slender, divergent, apicolateral processes. Aedeagus with basal arch extending to not quite half of total length, basal arms slender and curved; distal portion tapering to moderately slender, bluntly pointed tip. Parameres (Fig. 4g) each with moderately long anterolateral arm; mid portion straight and moderately stout, tapering to slender, simple tip, abruptly bent laterad and ventrad.

Distribution.— Jamaica.

Types.— Holotype female, allotype male, Hardwar Gap, Green Hills Cabin, Jamaica, 20 February 1969, W. W. Wirth, light trap (Type no. 70654, USNM). Paratypes, 1 male, 2 females. Same data.

Discussion.— We take pleasure in dedicating this species to Dr. Thomas H. Farr of the Institute of Jamaica in Kingston, in recognition of his important contributions to our knowledge of Jamaican Diptera.

Culicoides hayesi Matta

Culicoides hayesi Matta, 1967, Florida Ent. 50: 75 (male, female, larva, pupa; Honduras; fig. wing, antenna, palpus, tibial comb, eye separation, spermathecae, male genitalia, larval pharyngeal comb, pupal respiratory horn).

A moderately large, bright yellow and brown species; wing 1.36 mm long. Leg markings as in *C. dominicanus*; wing markings as in *decor* with the brown zig-zag bands somewhat broader than in *decor*, with an isolated pale spot straddling the middle of vein M_2 . Antenna with segment 11 as long as 9-10 combined, AR 1.48; sensory pattern 3-15. Third palpal segment moderately swollen distally, PR 2.5; with a large, round, moderately deep sensory pit. Proboscis long, P/H Ratio 0.91. Spermathecae subequal, relatively small, ovoid, with short slender necks. Male genitalia with apicolateral processes of ninth tergum long and slender; aedeagus with basal arch extending to slightly more than half of total length, the distal process slender; parameres with main portions quite slender.

Distribution.— Honduras, Mexico.

Specimens examined.— HONDURAS: La Tigra, Dist. Central, 6000 ft., 10 June 1966, J. F. Matta, light trap, 2 males, 4 females (holotype, allotype). MEXICO:

Tamaulipas, Ciudad Victoria, Rancho del cielo, 4 April 1963, H. A. Trevino, reared from bromeliad, 3 males, 3 females, 2 larvae, 2 pupae (paratypes).

***Culicoides lutealaris* Wirth and Blanton**

Culicoides lutealaris Wirth and Blanton, 1956, Proc. Ent. Soc. Washington 58: 225 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia); Wirth and Blanton, 1959, Proc. United States Nat. Mus. 109: 310 (redescribed; fig. wing, scutum, palpus, tibial comb, spermathecae, male genitalia).

A moderately large, yellowish brown species; wing 1.56 mm long. Leg markings as in *C. dominicanus*; wing pattern with an isolated pale spot straddling middle of vein M_2 . Antenna with segment 11 1.1 as long as 9-10 combined; AR 1.30; sensory pattern 3-15. Third palpal segment short and swollen, PR 1.9; with a large, round, deep sensory pit. Spermathecae small, subequal in size, with short, stout necks. Male genitalia with apicolateral processes of ninth tergum long and slender, divergent; aedeagus with basal arch extending to half of total length, the distal process very slender; parameres with main portion relatively slender.

Distribution.— Panama, Costa Rica.

New records.— COSTA RICA: Cartago, Navarro, July 1962, F. S. Blanton, light trap, 2 females; Sabalito, August 1953, F. S. Blanton, light trap, 1 female. PANAMA: Chiriqui, El Volcan, July 1964, A. Broce, light trap, 1 female.

***Culicoides nigrigenus* Wirth and Blanton**

Culicoides nigrigenus Wirth and Blanton, 1956, Proc. Ent. Soc. Washington 58: 222 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia); Wirth and Blanton, 1959, Proc. United States Nat. Mus. 109: 308 (redescribed; fig. wing, scutum, palpus, tibial comb, spermathecae, male genitalia).

A moderately small, pale grayish yellow species; wing 1.11 mm long. Wing markings as in *C. decor*, the dark zig-zag bands becoming more or less interrupted by the more extensive pale markings; leg markings as in *C. decor*, the base of the hind femur broadly pale. Antenna with segment 11 1.3 as long as 9-10 combined, AR 2.00; sensory pattern 3-15. Third palpal segment short and swollen, PR 1.9; with a large, round, deep sensory pit. Spermathecae small, subequal,

with short, stout necks. Male genitalia with apicolateral processes of ninth tergum long and slender, divergent; aedeagus with basal arch extending to half of total length, distal process with relatively stout tip; parameres with main portion moderately stout.

Distribution.— Colombia, Mexico, Panama, Trinidad.

New records.— COLOMBIA: Rio Raposo, Valle Prov., July 1963, V. H. Lee, 1 female. MEXICO: Fortin de las Flores, Vera Cruz, June 1964, F. S. Blanton, light trap, 12 females. PANAMA: Los Santos, Los Santos Prov., 24 October 1952, F. S. Blanton, light trap, 1 female. TRINIDAD: Locality unknown, 29 August 1963, R. W. Williams, reared from *Guzmania*, 1 female; Macqueripe, 11 January 1956, T. Aitken, light trap, 1 male, 1 female; Tembladora, May 1958, T. Aitken, light trap, 2 females; United States Naval Station, January, November 1958, T. Aitken, light trap, 4 females.

Discussion.— Like *C. decor*, which it closely resembles in leg markings, *C. nigrigenus* is a lowland species.

Literature Cited

Wirth, W. W. and F. S. Blanton. 1959. Biting midges of the genus *Culicoides* from Panama (Diptera: Heleidae). Proc. United States Nat. Mus. 109: 237-482.

2.0029 A review of the *Culicoides Nigrigenus* Group, with two new species (Diptera: Ceratopogonidae).

Abstract.— The *Culicoides* subgenus *Anilomyia* and within it, the *C. nigrigenus* group are characterized, and a key is presented to the seven known species, including the following which are described as new: *C. dominicanus* from Dominica and *C. farri* from Jamaica. Brief diagnoses and new distribution records are given for the five other species. The distribution of the group is circum-Caribbean; female biting habits are unknown; the immature stages are found in bromeliads.— W. W. Wirth, *Systematic Entomology Laboratory, Agriculture Research Service, USDA*, and Franklin S. Blanton, *Department of Entomology, University of Florida, Gainesville, Florida 32601*.

Descriptors: Diptera; Ceratopogonidae; *Culicoides*; *Culicoides nigrigenus* group; Mexico; Central America; West Indies; n. South America.



Wirth, Willis Wagner. 1970. "A review of the *Culicoides Nigrigenus* group, with two new species (Diptera: Ceratopogonidae)." *Entomological news* 81, 141–151.

View This Item Online: <https://www.biodiversitylibrary.org/item/20722>

Permalink: <https://www.biodiversitylibrary.org/partpdf/1328>

Holding Institution

Smithsonian Libraries and Archives

Sponsored by

Smithsonian

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

Rights Holder: American Entomological Society

License: <http://creativecommons.org/licenses/by-nc-sa/3.0/>

Rights: <https://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.