

The *Culicoides* (Diptera: Ceratopogonidae) of Belize, Central America

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Abstract. The *Culicoides* fauna of Belize is poorly known, and until 1974 only 3 species were recorded. Nineteen species of *Culicoides* from Belize were identified from six collection sites: *C. barbosai* Wirth & Blanton, *C. crepuscularis* Malloch, *C. debilipalpis* Lutz, *C. diabolicus* Hoffman, *C. foxi* Ortiz, *C. furens* (Poey), *C. gabaldoni* Ortiz, *C. heliconiae* Fox & Hoffman, *C. hoffmani* Fox, *C. imitator* Ortiz, *C. insignis* Lutz, *C. jamaicensis* Edwards, *C. leopoldoi* Ortiz, *C. limai* Barretto, *C. paraensis* (Goeldi), *C. pifanoi* Ortiz, *C. pusilloides* Wirth & Blanton, *C. pusillus* Lutz, and a new species, *C. mckeeveri* Brickle & Hagan is described and illustrated.

KEY WORDS: Insecta, Belize, bluetongue, epizootic hemorrhagic disease, Central America, biting midges

Introduction

Although *Culicoides* are known to vector diseases such as bluetongue and epizootic hemorrhagic disease, few studies have been conducted in Central America to determine which species are present, and their abundance and geographic distribution. Murray and Dyce (1970) noted that taxonomic knowledge of insect vectors is essential for any epidemiological investigation.

No significant effort was made to collect *Culicoides* within Belize until the mid-1960's. Thus, the number of *Culicoides* species known from Belize are few. In 1974, Wirth and Blanton reported only three species (*C. foxi*, *C. furens*, and *C. jamaicensis*) from this country. The purpose of this study is to provide a checklist of the *Culicoides* species of Belize, give a key to the known species and to describe one new species.

Materials and Methods

Between 1965 and 1970, several collecting expeditions were made within Belize. The most noteworthy collections were made during an Earth Watch expedition, conducted by Donald H. Messersmith (U. of Maryland, College Park) during the summer of 1969. W.L. Hasse also made numerous collections between 1968 and 1970. Most collection were made in June or July, using either New Jersey or black

light traps. The specimens were mounted on slides and deposited in the U.S. National Museum, Washington, DC. Figure 1 indicates location of the six collecting sites.

Slide mounted specimens were examined, and the following characters measured or calculated: wing length, costal ratio, antennal ratio, palpal ratio, and antennal sensory pattern, including number and location of sensilla coeloconica. Measurements were the mean of six individuals. Values were compared with those in Wirth & Blanton (1959) and Blanton & Wirth (1979). Wing pigmentation patterns, spermathecae shape and size, as well as number and length of tibial spines, were also used in the identifications.

Results and Discussion

Nineteen species of *Culicoides* were identified as listed in Table 1, which also provides numerical character data for these species.

Four species comprised over 94% of the collections: *C. furens*, *C. diabolicus*, *C. insignis* and *C. jamaicensis*. Table 2 gives number of specimens from each collection locality within Belize. Table 3 gives larval habitat and adult feeding habits of Belize *Culicoides* (from Wirth & Blanton 1959).

Culicoides (Diphaomyia) mckeeveri Brickle and Hagan, New Species

Head: eyes nearly contiguous. Antenna with flagellomere lengths in proportions of 27-19-19-20-

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20-20-18-19-31-34-34-36-56; AR 1.17; sensory pattern 3, 7-10, occasionally on segment 5. Third palpal segment greatly swollen (Fig. 2), PR 2.0; sensory pit deep with large opening. Proboscis moderately short, P/H Ratio 0.71; mandible with 11 teeth.

Thorax: dark spots surrounding femoro-tibial joint, with distinct pale bands on either side of joint; hind tibia without pale bands; 4 tibial spines, one nearest spur longest.

Wing (Fig. 2): wing length 0.89 mm; CR 0.59; second radial cell ending in very dark spot; pale spot over crossvein r-m reaching costal margin; cell R_5 with transverse double pale spot in distal portion, reaching wing margin; pale spot straddling vein M_1 , beginning directly beneath second radial cell; veins M_1 , M_2 , M_{3+4} , Cu_1 pale at wing margin; pale spot in cell M_4 , normally touching vein M_{3+4} ; distal pale spot in cell M_1 lying far from wing margin; pale spot straddling middle of M_2 ; distal pale spot in cell M_2 small, not reaching wing margin; two pale spots in cell M_2 , one behind medial fork, another anterior of mediocubital fork; pale spot in distal area of anal cell. Macrotrichia sparse, mainly on distal third of wing; halter pale.

Abdomen: medium brown. Two spermathecae (Fig. 2), oval with long, slender, sclerotized necks; unequal measuring 0.055mm by 0.041mm and 0.052mm by 0.037mm; sclerotized ring, rudimentary third spermatheca present.

This species is closely related to *C. baueri* Hoffman, *C. iriartei* Fox and *C. evansi* Wirth & Blanton, all of which belong to the subgenus *Diphaomyia* (*iriartei* group). Females of this species may be distinguished from *C. baueri* by their smaller size, as well as the presence of a well defined pale spot in M_2 over the mediocubital fork. *Culicoides evansi* differs in having veins M_1 , M_2 , M_{3+4} and Cu_1 dark at the wing margin. *Culicoides iriartei* may be distinguished by the presence of a second pale spot lying adjacent to vein M_1 halfway between the crossvein and post-stigmatic pale spot. The hind tibia of *C. iriartei* also have pale bands which are lacking on those of *C. mckeeveri*, n. sp.

Specimens of *C. mckeeveri* were collected on the Central Farm, Cayo District of Belize, off the Western Highway, near Mile Post 66 in June 1969 by W. and D. Hasse using a NJ light trap.

The following characteristics place *C. mckeeveri* in the subgenus *Diphaomyia* (*iriartei* group): small to medium size; eyes narrowly separated; second radial cell dark to tip; pale spot straddling middle of vein M_2 ; female antenna with sensory tufts on segments 3, 7-10; four spines in tibial comb; two

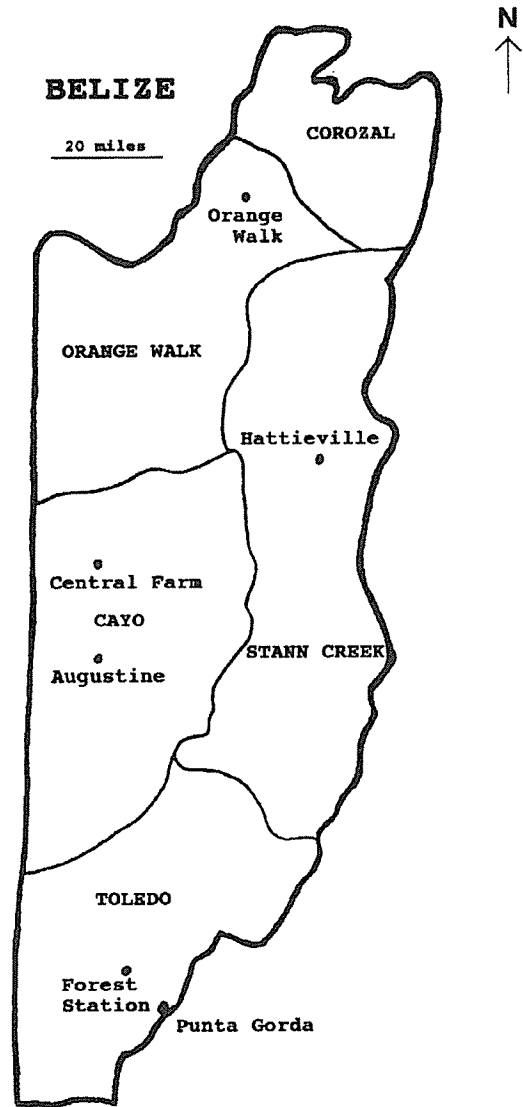


Figure 1. Belize map showing collection locations.

spermathecae plus a third rudimentary spermatheca, spermathecae ovoid with long slender sclerotized necks.

Specimens deposition: Holotype, 2 paratype females deposited in the U.S. National Museum, Washington, D.C. (USNM); 2 paratype females deposited in the Natural History Museum, London, UK (BMNH); 1 paratype female deposited in the Museo de La Plata, Argentina.

This species is named in honor of Dr. Sturgis McKeever (Professor Emeritus, Department of Biology, Georgia Southern University) in recognition of his life-long contributions to various fields of biology, including parasitology and entomology.

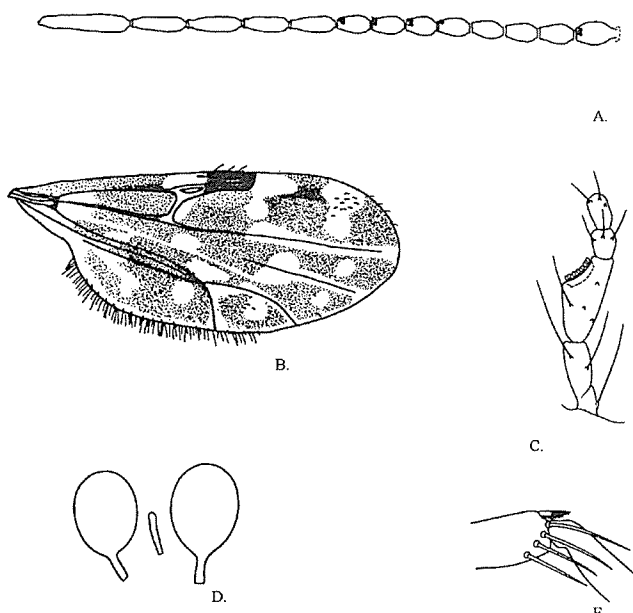


Figure 2. *Culicoides mckeeveri*, new species, female: A) antenna, B) wing, C) palpus, D) spermathecae, E) tibial comb.

Potential Disease Transmission in Belize

Of the species collected from Belize, five are thought to play a role in the transmission of bluetongue. The bluetongue virus has been isolated from *C. insignis*, the most common species of *Culicoides* in Central America, as well as the third most abundant species in our Belize collections. The virus has also been isolated from *C. debilipalpis*. While the virus has not been isolated from *C. diabolicus*, the second most abundant species in the Belize collections, correlations have been found between the presence of *C. diabolicus* and bluetongue infection levels (Monath 1988).

Seven viral serogroups within the genus *Orbivirus* may be transmitted by *Culicoides* spp. These serogroups include: African horse sickness, bluetongue, epizootic hemorrhagic disease (EHD), eastern encephalitis, palyam, wallal and warrego. Bluetongue and EHD, the most commonly vectored serogroups, are endemic throughout Central America. While most cattle and sheep in Belize seem to be infected with bluetongue virus, the disease itself rarely occurs, typically when an animal from a region with a low rate of infection enters a region with a higher rate of infection (Monath 1988).

In conclusion, this study will provide much needed baseline information of the *Culicoides* vec-

tors present in Belize for future studies by public health and agricultural specialists.

Taxonomic Key to Female Adult *Culicoides* of Belize, Central America*

1. Apex of second radial cell dark 2
 Apex of second radial cell pale 15
2. One spermathecae present 3
 Two spermathecae present 4
3. Macrotrichia long and dense; antennal sensory tufts on segments 3-15
 *crepuscularis* Malloch
 Macrotrichia scanty on distal third of wing; antennal sensory tufts on segments 7-10
 *leopoldoi* Ortiz
4. Pale spot straddling vein M_2 5
 No pale spot straddling vein M_2 8
5. Antennal sensory tufts on segments 3-15; spermathecae without sclerotized necks
 *jamaicensis* Edwards
 Antennal sensory tufts on segments 3,7-10; spermathecae with sclerotized necks 6
6. Vein M_2 dark entire length *limai* Barretto
 Vein M_2 pale entire length to wing margin 7
7. Anal cell with two pale spots; apices of vein Cu_1 dark at wing margin *pifanoi* Ortiz
 Anal cell with one pale spot; apices of vein Cu_1 pale at wing margin
 *mckeeveri* Brickle & Hagan, n. sp.
8. Wing without distinct pale spots ... *pusillus* Lutz
 Wing with distinct pale spots 9
9. Cell M_1 with two pale spots 10
 Cell M_1 with three pale spots 14
10. Third palpal segment with open sensory area
 *imitator* Ortiz
 Third palpal segment with sensory pit 11
11. Distal pale spot in cell R_5 , usually transverse, not filling breadth of cell; antennal segment 11 equal to or longer than segment 10 12
 Distal pale spot in cell R_5 , large and round nearly filling cell from wing margin to vein M_1 ; antennal segment 11 shorter than 10
 *gabaldoni* Ortiz
12. Antennal sensory tufts on segments 3, 8-10, condition in all r_5 13

Table 1. Systematic arrangement and numerical characters of Belize *Culicoides*.

	Wing Length mm	Costal Ratio	Antennal Ratio	Antennal Sensory Pattern
Subgenus <i>Avaritia</i>				
<i>pusilloides</i>	0.69	0.57	1.12	3, 12-15
<i>pusillus</i>	0.64	0.53	1.18	3, 13-15
Subgenus <i>Beltranmyia</i>				
<i>crepuscularis</i>	1.30	0.56	1.40	3-15
Subgenus <i>Hoffmania</i>				
<i>Guttatus</i> group				
<i>diabolicus</i>	1.03	0.67	1.14	3, 11-15
<i>foxi</i>	1.21	0.68	1.10	3, 11-15
<i>insignis</i>	1.11	0.65	1.32	3, 5, 7, 9, 11-15
<i>Hylas</i> group				
<i>heliconiae</i>	1.46	0.68	1.06	3, 11-15
Subgenus <i>Oecacta</i>				
<i>Daedalus</i> group				
<i>jamaicensis</i>	0.97	0.57	1.21	3-15
<i>Debilipalpis</i> group				
<i>debilipalpis</i>	0.80	0.65	0.83	3, 8-10
<i>gabaldoni</i>	0.65	0.62	0.91	3, 8-10
<i>hoffmani</i>	0.76	0.59	0.79	3, 8-10
<i>imitator</i>	0.68	0.53	0.91	3, 8-10
<i>paraensis</i>	0.78	0.59	0.77	3, 8-10
<i>Fluvialis</i> group				
<i>leopoldoi</i>	0.85	0.61	1.21	3, 7-10
<i>Furens</i> group				
<i>barbosai</i>	0.88	0.58	0.93	3, 7-10
<i>furens</i>	0.91	0.58	1.28	3, 7-10
<i>Limai</i> group				
<i>limai</i>	0.80	0.63	1.13	3, 7-10
<i>Reticulatus</i> group				
<i>pifanoi</i>	0.78	0.60	0.91	3, 7-10
Subgenus <i>Diphaomyia</i>				
<i>mckeeveri</i>	0.90	0.58	1.13	3, 7-10

*Numeric data from Wirth & Blanton, 1959.

- Antennal sensory tufts on segments 3,7-10; two longitudinally elongated poststigmatic pale spots in cell r_3 *barbosai* Wirth & Blanton
13. Third palpal segment swollen with large deep sensory pit; cell R_5 with three spots *hoffmani* Fox
Third palpal segment with sensory pit small and deep, with pit deeper than diameter of pore opening, cell R_5 with two spots *debilipalpis* Lutz

Table 2. Number of slide-mounted *Culicoides* from each Belize collection site. Specific trap location is given, followed by the district and elevation of each site.

<i>Culicoides</i> Species	Augustine (Cayo) 200-600m	Central Farm (Cayo) 0-200m	Forest Station (Toledo) 0-200m	Hattieville (Stan.Cric) 0-200m	Orange Walk (Or. Wlk.) 0-200m	Punta Gorda (Toledo) 0-200m	Total no. of Specimens
<i>barbosai</i>	-	-	-	20	-	-	20
<i>crepuscularis</i>	-	1	-	-	-	-	1
<i>debilipalpis</i>	4	5	1	2	-	1	13
<i>diabolicus</i>	23	5	62	1	2	90	183
<i>foxi</i>	-	17	-	-	2	2	21
<i>furens</i>	-	1	-	304	1	2	308
<i>gabaldoni</i>	-	1	-	-	-	-	1
<i>heliconiae</i>	14	-	5	-	-	2	21
<i>hoffmani</i>	-	1	-	-	-	-	1
<i>imitator</i>	3	7	-	-	-	-	10
<i>insignis</i>	44	50	2	4	-	6	106
<i>jamaicensis</i>	1	34	2	-	-	-	37
<i>leopoldoi</i>	1	3	-	1	-	-	5
<i>limai</i>	17	-	-	-	-	-	17
<i>paraensis</i>	1	6	-	-	-	-	7
<i>pifanoi</i>	-	-	-	-	-	-	1
<i>pusilloides</i>	-	-	1	-	-	-	1
<i>pusillus</i>	-	15	1	-	-	-	16
<i>mckeeveri</i>	-	7	-	-	-	-	7

14. Cell R_5 with three small round poststigmatic pale spots in a triangle, the two next to second radial cell more or less fused *furens* (Poey)
Cell R_5 with four small round poststigmatic pale spots *paraensis* (Goeldi)
15. Cell M_1 with two pale spots 16
Cell M_1 with one pale spot *insignis* Lutz
16. Base of cell M_4 pale, bordering veins M_{3+4} and Cu pale; wing length, 1.03 mm or greater 17
Base of cell M_4 and adjacent veins in a dark area; wing length, 0.69 mm *pusilloides* Wirth & Blanton
17. Cell R_5 with a separate pale spot present anterior to the base of vein M_1 *heliconiae* Fox & Hoffman
Cell R_5 without a separate pale spot present anterior to base of vein M_1 ; pale spots continuous from r-m crossvein to borders of vein M_1 18
18. Small black spot present on vein R_{4+5} near end of second radial cell *foxi* Ortiz
No small black spot on vein R_{4+5} near end of second radial cell *diabolicus* Hoffman

* Modified after Wirth & Blanton, 1959

Table 3. Larval habitats and feeding habits of Belize *Culicoides*.

<i>Culicoides</i> sp.	Adult Host Preference	Larval Habitat*
<i>barbosai</i>	humans, horses	coastal mangrove, coral sands
<i>crepuscularis</i>	humans, birds	freshwater/ seawater mud, ditches margin, hoof prints
<i>debilipalpis</i>	humans, birds, horses	tree holes, rotting vegetation (cocoa and bamboo)
<i>diabolicus</i>	humans	unknown
<i>foxi</i>	humans, horses	ditch margins, horse/cow manure rotting cacao pods,
<i>furens</i>	humans, horses	coastal mangrove, water logged sand
<i>gabaldoni</i>	unknown	unknown
<i>heliconiae</i>	horses	<i>Heliconia</i> bracts, stumps, bamboo internodes, <i>Calathea</i> flowers
<i>hoffmani</i>	humans, birds	tree holes
<i>imitator</i>	unknown	unknown
<i>insignis</i>	cattle, humans	coastal mangrove, ditches margins, sugarcane fields
<i>jamaicensis</i>	unknown	cacti, rotting stems/fruit
<i>leopoldoi</i>	unknown	unknown
<i>limai</i>	unknown	unknown
<i>paraensis</i>	humans, birds, rabbits	tree holes, rotting fruit/cacao
<i>pifanoi</i>	unknown	flowers of <i>Heliconia mariae</i>
<i>pusilloides</i>	unknown	unknown
<i>pusillus</i>	humans	horse/cow manure, ditch margins, rotting fruit, bamboo, banana stalks
<i>mckeeveri</i>	unknown	unknown

*From Blanton & Wirth, 1979.

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References Cited

- Barretto, M. P. 1944. Sobre o genero "*Culicoides*" Latreille, 1809, com a descricao de tres novas especies (Diptera, Ceratopogonidae). Anais Fac. Med. Univ. Sao Paulo 20: 89-105.
- Blanton, F. S., and W. W. Wirth. 1979. Arthropods of Florida and Neighboring Land Areas: The Sand Flies (*Culicoides*) of Florida (Diptera: Ceratopogonidae). Bureau of Ent., Contribution No. 424, Vol. 10.
- Edwards, F. W. 1922. On some Malayan and other species of *Culicoides*, with a note on the genus *Lasiohelea*. Bull. Ent. Res. 13: 161-167.
- Fox, I. 1946. A review of the species of biting midges of *Culicoides* from the Caribbean Region (Diptera: Ceratopogonidae). Ann. Ent. Soc. Amer. 39: 248-258.
- Fox, I., and W. A. Hoffman. 1944. New neotropical biting sandflies of the genus *Culicoides* (Diptera, Ceratopogonidae). Puerto Rico Journ. Publ. Health Trop. Med. 20: 108-111.

- Hoffman, W. A.** 1925. A review of the species of *Culicoides* of North and Central America and the West Indies. *American J. Hyg.* 5: 274-301.
- Lutz, A.** 1913. Contribuicao para o estudo das Ceratopogoninas hematofagas do Brasil. *Mem. Inst. Oswaldo Cruz* 5: 45-73.
- Malloch, J. R.** 1915. The Chironomidae, or midges, of Illinois, with particular reference to the species occurring in the Illinois River. *Illinois St. Lab. Nat. Hist. Bull.* 10:275-543.
- Monath, T. P.** 1988. *The Arboviruses: Epidemiology and Ecology*. CRC Press, Inc. Boca Raton, FL. 2: 40-55.
- Murray, M. D., and A. L. Dyce** 1970. Native insects of Australia as disease vectors - A review of some current studies. *Austral. Vet. J.* 46: 138-140.
- Ortiz, I.** 1951a. Estudios sobre *Culicoides* (Diptera, Ceratopogonidae). VII. *Culicoides dominicii* n. sp. y clave para el reconocimiento de las especies venezolanas. *Nov. Cient. Contr. Ocas. Mus. Hist. Nat. La Salle, zool. ser., no. 5.*
- Ortiz, I.** 1951b. Estudios en *Culicoides* (Diptera, Ceratopogonidae). IX. Sobre los caracteres diferenciales entre *Culicoides paraensis* (Goeldi, 1905), *C. stellifer* (Coquillett, 1901) y *C. lanei* (Ortiz, 1950). Descripcion de cuatro nuevas especies con la redescription de algunas otras poco conocidas. *Rev. Sanid. Asist. Soc.* 16: 573-591.
- Ortiz, I.** 1952. Nota sobre la presencia de "*Culicoides eublepharus*" Macfie, 1948 (Diptera, Ceratopogonidae) en Venezuela - descripcion la armadura genital del macho. *Acta Cient. Venezolana* 3: 129.
- Ortiz, I.** 1953. Sobre una nueva especie del genero *Culicoides* (Diptera, Ceratopogonidae) proxima de *C. horticola* Lutz 1913. *Rev. Sanid. Asist. Soc.,* 18: 807-812.
- Poey, F.** 1851. El jejen, *Oecacta furens* Poey. *Mem. Hist. Nat. Isla Cuba* 1: 236-243.
- Spinelli, G. R., and M. M. Ronderos.** 1997. Description of the male of *Culicoides lahillei* and revalidation of *Culicoides debilipalpis* (Diptera: Ceratopogonidae). *Trans. Amer. Entomol. Soc.* 123 (4): 303-309.
- Wirth, W. W.** 1974. Family Ceratopogonidae. A Catalogue of the Diptera of the Americas south of the United States. *Museu de Zoologia, Universidade de São Paulo, Brazil.* 14: 1-89.
- Wirth, W. W., and F. S. Blanton.** 1955. Studies in Panama *Culicoides* (Diptera, Heleidae) IV. Description of three new species. *Bull. Brooklyn Entomol. Soc.* 50: 100-106.
- Wirth, W. W., and F. S. Blanton.** 1956. A new species of salt marsh sandfly from Florida, the Bahamas, Panama and Ecuador, its distribution and taxonomic differentiation from *Culicoides furens* (Poey) (Diptera, Heleidae). *Florida Entomol.* 39: 157-162.
- Wirth, W. W., and F. S. Blanton.** 1959. Biting midges of the genus *Culicoides* from Panama (Diptera, Heleidae). *Proc. U.S. Nat. Mus., no. 3415,* 109:237-482.
- Wirth, W. W., and F. S. Blanton.** 1974. The West Indian sandflies of the genus *Culicoides* (Diptera: Ceratopogonidae). *U.S. Dept. of Agr. Technical Bulletin No.* 1474.