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THE SABETHINES OF NORTHERN ANDEAN COFFEE-GROWING REGIONS OF COLOMBIA

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ABSTRACT. Sampling for sabethine mosquitoes occurred intermittently from September 2007 to April 2013 in 17 municipalities, located in 5 departments (divisions) in the northern Andean coffee-growing regions of Colombia. Of the 9 genera within the Sabethini tribe known to occur in the Neotropical region, 6 were encountered including 15 species: *Jonhbelkinia ulopus, Limatus durhamii, Sabethes ignotus, Sa. luxodens, Sa. undosus, Shannoniana fluviatilis, Trichoprosopon compressum, Tr. digitatum, Tr. evansae, Tr. pallidiventer* s.l., *Tr. pallidiventer s.s., Wyeomyia arthrostigma, Wy. oblita, Wy. ulocoma,* and *Wy. undulata*. The species *Sa. luxodens* and *Wy. undulata* constitute new records for Colombia. These records broaden the knowledge of this important group that includes some important species related to the arbovirus transmission. Records are from the northern Colombian Andes, a region noted for coffee cultivation and ecotourism.

KEY WORDS Sabethini, arbovirus, phytotelmata, Andean region

INTRODUCTION

A high level of diversity occurs among the mosquito species included in the tribe Sabethini Blanchard, not only considering morphological characters but also their biology (Judd 1996). However, within a given genus, females often tend to be quite similar and difficult to identify on the basis of morphological characters (Harbach 2007). Based on a mosquito taxonomic inventory (Harbach 2014), there are currently 429 recognized species, classified into 14 genera of which 9 occur in the Neotropical region: *Isostomyia* (4 species), *Johnbelkinia* (3), *Limatus* (8), *Onirion* (7), *Runchomyia* (7), *Sabethes* (39), *Shannoniana* (68), *Trichoprosopon* (13), and *Wyeomyia* (140). With regard to Colombia, 54 species have been identified: *Johnbelkinia* (2), *Limatus* (2), *Onirion* (1), *Runchomyia* (1), *Sabethes* (11), *Shannoniana* (1), *Trichoprosopon* (7), and *Wyeomyia* (29) (WRBU 2014). However, these genera have not been well studied, and many additional species occur in the country. For those known to occur in Colombia, the geographic distribution of most of them is not well known.

Some sabethine species are vectors of arboviruses, especially certain species of *Sabethes* (Rodaniche and Galindo 1957, Downs et al. 1963, Groot 1964, Pinheiro et al. 1981, Hervé et al. 1986, Yuill 1986, Vasconcelos et al. 2001, Forattini 2002, Barrett and Higgs 2007, Auguste et al. 2010). However, arbovirus infections also have been found in *Johnbelkinia* (Zavortink 1979a, Consoli and Lourenço-de-Oliveira 1994), *Limatus* (Kumm et al. 1940, Galindo and Trapido 1957, Downs et al. 1963, Pinheiro et al. 1981, Salas et al. 2001), *Trichoprosopon* (Galindo et al. 1951, Rodaniche and Galindo 1956, Shope et al. 1964, Galindo et al. 1966, Yuill 1986, Hastrister et al. 1998, Auguste et al. 2010), and *Wyeomyia* (Hervé et al. 1986, Yuill 1986, Turell et al. 2005).

The northern Andes in Colombia, where this study was performed, is the most important Colombian coffee-growing region. Despite its small size (0.015% of the total country size), at least 7% of the known fauna and flora for the country are reported there, being very important in terms of agriculture, ecotourism, and conservation activities (Rodríguez et al. 2009). In addition, approximately 29% of the population of the country live in this area (Valencia et al. 2013). This offers several microhabitats that favor the presence of insects acting as vector-borne diseases (Contreras-Gutiérrez et al. 2014).

As a foundation for present and future studies of the Colombian sabethine genera, the geographic distribution of species currently known to occur in the country is summarized from previous records in the literature along with recent observations from the northern Andean coffee-growing region.

MATERIALS AND METHODS

From September 2007 to April 2013 mosquito collections were made in 17 representative municipalities of the Colombian coffee-growing region, an area encompassing 5 departments (divisions; Fig. 1). The municipalities, all within the northern

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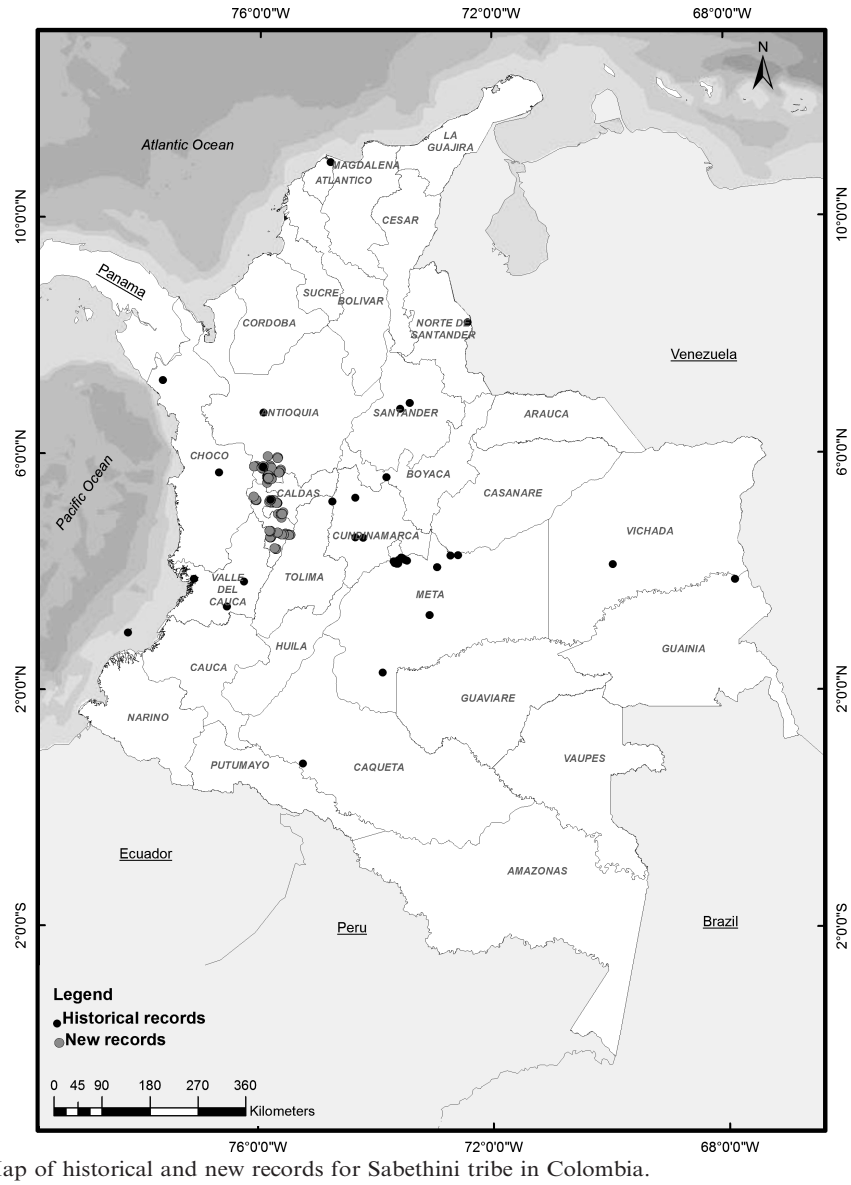

Fig. 1. Map of historical and new records for Sabethini tribe in Colombia.

Andes, were Alcalá, Anserma, Chinchiná, Ciudad Bolívar, Córdoba, Filandia, Fredonia, Hispania, Jardín, Jericó, Manizales, Pueblo Rico, Quimbaya, Salento, Támesis, Valparaíso, and Venecia. The primary vegetation environments sampled with this region were coffee plantations, bamboo thickets/stands, forests, pastures, and country gardens. Elevation of the sampling sites ranged from 800 to 2,500 m above sea level.

Sampling of mosquitoes was based on the methodology proposed in Belkin et al. (1965). Sabethine larvae and pupae were found in several distinct microhabitats, especially various types of phytotelmata as well as artificial breeding sites including bamboo ovitraps. Adults were captured using Shannon traps, oral aspirators, entomologic nets, and Centers for Disease Control and Prevention light traps. All of the field collections were transported to the laboratories of Programa de Estudio y Control de Enfermedades (PECET) at the Universidad de Antioquia and of Grupo de Investigación en Sistemática Molecular (GSMUN) at the Universidad Nacional de Colombia sede Medellín. The protocol of Pecor and Gaffigan (1997) was followed for rearing under laboratory conditions field-collected mosquito larvae and pupae to the adult stage. All collection sites in the field were described and geo-referenced.

Identification of specimens to species was based primarily on male genitalia, which had been

stained, dissected, and mounted in Euparal on microscope slides. Also, fourth-instar larvae as well as larval and pupal exuviae were mounted in Euparal on microscope slides. Identified specimens were deposited in the Entomological Museum Francisco Luis Gallego at the Universidad Nacional de Colombia, Medellín, campus. The following references were used to identify sabethine mosquitoes: Lane and Cerqueira (1942), Lane (1945, 1953), Forattini (1965), Zavortink (1979a, 1979b, 1981), Clark-Gil and Darsie (1983), Harbach (1994), Judd (1996), Harbach and Kitching (1998), Motta and Lourenço-de-Oliveira (2000), Forattini (2002), Harbach (2007), Motta et al. (2007), and Navarro and Liria (2007).

Records for previous published data of sabethine mosquitoes in Colombia were also studied (Fig. 1). Information was obtained from publications and records available through a search of websites (WRBU 2014, Harbach 2011, AFPMB 2014, BHL 2014), bibliographic databases such as Scopus, JSTOR, SciELO, ScienceDirect, and the SIB Colombia data portal (IAvH 2014).

RESULTS

A total of 1,589 sabethine species belonging to the Sabethini tribe, represented by 618 males and 971 females, were collected in the 17 municipalities of the Colombian Andean region as previously described. A list of collected sabethines and the new records of distribution was compiled (Table 1). The majority of these specimens were of the following 15 species: *Jonhbelkinia. Ulopus* Dyar and Knab, *Limatus durhamii* Theobald, *Sabethes* (*Peytonulus*) *ignotus* Harbach, *Sa.* (*Pey.*) *luxodens* Hall, Howard, Harbach, *Sa.* (*Pey.*) *undosus* Coquillet, *Shannoniana. Fluviatilis* (Theobald), *Trichoprosopon compressum* Lutz, *Tr. digitatum* (Rondani), *Tr. evansae* Antunes, *Tr. pallidiventer* (Lutz) s.l., *Tr. pallidiventer* s.s., *Wyeomyia* (*Wyeomyia*) *arthrostigma* (Lutz), *Wy.* (*Miamyia*) *oblita* (Lutz), *Wy.* (*Decamyia*) *ulocoma* (Theobald), and *Wy. undulata* del Ponte and Cerqueira. Four morphospecies also were recognized, but in the absence of males their identification is provisional: *Sa.* (*Sabethinus*) *intermedius* (Lutz), *Sa.* (*Sabethinus*) *xhyphydes* (Harbach), *Sa.* (*Sabethoides*) *chloropterus* (von Humboldt), and *Wy. phroso* Howard, Dyar, and Knab. In addition, 9 other species with males were encountered, which remain unidentified. Many of these species exhibited close affinity to described species but possessed morphological differences that require direct comparison with type material. They are tentatively identified as follows: *Sa.* (*Pey.*) *ignotus* affinis, *Trichoprosopon* sp. A, *Trichoprosopon* sp. B, *Wy.* (*Nunezia*) *trujilloi* affinis, *Wy.* (*Nuz.*) sp. A, *Wy.* (*Nuz.*) sp. B, *Wy.* (*Dec.*) *pseudopecten* affinis Dyar & Knab, *Wy.* (*Dec.*) sp. A., and *Wy.* (*Wyo.*) *scotinomus* affinis Dyar and Knab. The altitudinal profile for the sabethines located at northern Andean region varied between 817 and 2,515 m above sea level (Fig. 2).

After collected mosquitoes were identified and previously published data were studied, a list of all species currently known to occur in Colombia along with their known distribution in the country was compiled and is presented below.

Genus *Johnbelkinia*

Johnbelkinia longipes (Fabricius): Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]); Zavortink (1979a) (Meta [Villavicencio]); Barrera et al. (2002) (Santander [Cimitarra]); Ferro et al. (2008) (Santander [Barrancabermeja]); (IAvH 2014) (Meta [Restrepo], Meta [Villavicencio]).

Johnbelkinia ulopus: Zavortink (1979b) (Boyacá [Chiquinquirá], Boyacá [Pauna], Meta [Restrepo], Meta [Villavicencio], Nariño [Isla Gorgona], Norte de Santander [Villamizar], Valle del Cauca [Buenaventura], Valle del Cauca [Calima El Darién]); (IAvH 2014) (Meta [Villavicencio]); present study (Antioquia [Hispania, Jardín, Valparaiso], Caldas [Anserma, Chinchiná]).

Genus *Limatus*

Limatus asulleptus (Theobald): Stone et al. (1959) (Valle del Cauca [Buenaventura]); Heinemann and Belkin (1978) (Valle del Cauca [Buenaventura]); IAvH (2014) (Meta [Villavicencio]).

Limatus durhamii: Stone et al. (1959) (Meta [Puerto Rico]); (Heinemann and Belkin (1978) (Guainía [Inírida], Meta [Puerto López], Meta [Puerto Rico], Santander [San Vicente de Chucurí], Tolima [Honda]); Parra-Henao and Suárez (2012) (Antioquia [Turbo]); Barajas et al. (2013) (Caldas [Anserma]); present study (Antioquia [Hispania], Caldas [Anserma, Chinchiná]).

Genus *Onirion*

Onirion personatum (Lutz): Harbach and Peyton (2000) (Valle del Cauca [Buenaventura]).

Genus *Sabethes*

Sabethes (Sabethes) belisarioi Neiva: Stone et al. (1959) (Valle del Cauca [Buenaventura]); Vargas and Díaz Nájera (1959) (Valle del Cauca [Buenaventura]); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]).

Sabethes (Sabethoides) chloropterus: Stone et al. (1959) (Meta [Villavicencio], Valle del Cauca [Buenaventura]); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]); IAvH (2014) (Meta [Villavicencio]).

Sabethes (Sab.) cyaneus (Fabricius): Stone et al. (1959) (Meta [Restrepo]); Barreto and Vernon

Table 1. Summary of collected species and geographic location for Sabethini mosquitoes in the north of the Colombian Andes.

Species	M	F	Coordinates	Altitude[1] (m above sea level)	Type of habitat[2] (breeding place/collecting method)
Johnbelkinia ulopus	3	15	5°10′34″N, 75°40′52″W[3]	848	Bamboo (BS/CT);
			5°36′04″N, 75°49′09″W[3]	1,751	forest (XA/IN)
Limatus durhamii	6	23	5°10′44″N, 75°40′39″W	817	Bamboo (BG, BS/AB);
			5°46′25″N, 75°56′19″W[3]	1,530	coffee (IN); forest (IN); urban (WS, HE)
Sabethes (Sabethinus) intermedius?	0	9	4°59′27″N, 75°35′58″W	1,315	Bamboo (IN); coffee
			5°13′35″N, 75°46′33″W	1,628	(AB); forest (IN, AB)
Sa. (Sbn.) xhyphydes?	0	1	5°10′34″N, 75°40′52″W	860	Bamboo (BI)
Sa. (Sabethoides) chloropterus?	0	1	5°46′23″N, 75°56′02″W	1,454	Forest (AB)
Sa. (Sbo.) sp.	0	4	5°35′03″N, 75°46′02″W	2,403	Forest (BR)
Sa. (Peytonulus) ignotus	1	0	4°59′28″N, 75°35′23″W[3]	1,485	Bamboo (BS)
Sa. (Pey.) ignotus aff.	2	0	5°10′41″N, 75°40′34″W	833	Bamboo (BG, BI)
Sa. (Pey.) luxodens	2	0	5°10′34″N, 75°40′52″W[3]	862	Bamboo (BI)
Sa. (Pey.) undosus	5	0	5°10′41″N, 75°40′34″W	833	Bamboo (BI, BG)
Shannoniana fluviatilis	0	1	5°36′49″N, 75°48′57″W[3]	2,253	Forest (IN)
Trichoprosopon compressum	3	4	5°10′13″N, 75°40′45″W[3]	833–980	Bamboo (BS)
Tr. digitatum	169	138	5°10′20″N, 75°40′39″W	833	Bamboo (BI, BS);
			5°13′43″N, 75°46′39″W	1,583	grassland (BG)
Tr. evansae	1	6	5°36′50″N, 75°48′58″W[3]	2,253–2,413	Forest (BR, XA/IN, SH)
Tr. pallidiventer s.s.	6	2	4°42′11″N, 75°48′01″W[3]	1,185–1,195	Bamboo (BS)
Tr. pallidiventer s.l.	346	416	5°10′50″N, 75°40′57″W*	798	Bamboo (BG, BI, BS);
			4°37′50″N, 75°28′08″W[3]	2,515	coffee (IN); forest (BR, XA); grassland (AB/BO, BI, BS)
Trichoprosopon sp. B	0	3	5°47′18″N, 75°47′26″W	2,002	Urban (XA)
Trichoprosopon sp. A	0	28	5°36′49″N, 75°48′57″W	2,253	Forest (AB, IN)
Wyeomyia (Dendromyia) sp.	0	2	4°42′10″N, 75°48′01″W	1,189	Bamboo (BS)
Wy. (Decamyia) ulocoma	22	12	4°59′28″N, 75°35′24″W[3]	1,079	Coffee (HE); forest
			4°35′01″N, 75°51′05″W	1,514	(BR. HE)
Wy. (Dec.) pseudopecten affinis	6	1	5°47′58″N, 75°54′25″W	976	Urban (HE)
Wy. (Dec.) sp.	1	9	4°59′29″N, 75°35′24″W	1,426	Coffee (BR); forest
			5°46′36″N, 75°56′22″W	1,528	(HE)
Wy. (Wyeomyia) sp.	5	105	5°10′13″N, 75°40′45″W	833	Bamboo (BS, BI);
			5°36′05″N, 75°49′12″W	1,751	coffee (IN, HE); forest (AB, BR, IN)
Wy. (Wyo.) arthrostigma	3	0	4°41′59″N, 75°47′33″W[3]	1,194	Grassland (BS)
Wy. (Wyo.) undulate	8	40	5°13′43″N, 75°46′39″W[3]	828–1,628	Bamboo (BI, BG, BS); forest (AB, IN)
Wy. (Wyo.) scotinomus aff.	10	15	4°59′27″N, 75°35′58″W	1,315	Coffee (HE); forest
			4°59′29″N, 75°35′18″W	1,514	(BR)
Wy. (Wyo.) phroso?	0	32	4°59′27″N, 75°35′58″W	1,313	Forest (AB, IN)
			5°36′49″N, 75°48′57″W	2,253	
Wy. (Myamyia) oblita	1	1	5°45′24″N, 75°55′09″W[3]	833	Bamboo (BI, BS)
			5°10′13″N, 75°40′45″W	1,050	
Wy. (Nunezia) sp. A	3	0	4°59′29″N, 75°35′18″W	1,514	Forest (BR)
			5°36′47″N, 75°49′01″W	2,245	
Wy. (Nuz.) sp. B	2	0	5°35′52″N, 75°47′39″W	2,316	Forest (BR)
Wy. (Nuz.) sp.	8	101	4°59′28″N, 75°35′24″W	1,313	Bamboo (IN); coffee
			5°36′49″N, 75°48′57″W	2,427	(IN); forest (AB, BR, IN); grassland (IN)
Wy. (Nuz.) trujilloi aff.	5	2	5°48′49″N, 75°48′16″W[3]	1,403	Urban (BR)
			5°46′18″N, 75°47′19″W	1,874	

[1] Minimum and maximum altitude are represented for 2 data.
[2] Breeding place/collecting method: aspirator (AB), bromeliad (BR), insect net (IN), bamboo internode (BI), bamboo stem in ground (BG), bamboo stump (BS), *Heliconia* spp. bracts (HE), water spring (WS), bamboo ovitrap (BO), CDC trap (CT), Shannon trap (SH), and *Xanthosoma* spp. leaf base (XA).
[3] New locality record.

Species	Municipality
Trichoprosopon digitatum	J, L, M
Tr. pallidiventer s.s	M
Tr. pallidiventer s.l.	A, B, C, D, E, F, I, J K, L, O, P, Q
Tr. compressum	J
Tr. evansae?	F
Trichoprosopon sp. A	F
Trichoprosopon sp. B	E
Johnbelkinia ulopus	D, F, H, L, M
Wyeomyia (*Dendromyia*) sp.	M
Wy. (*Wyeomyia*) *arthostigma*	M
Wy. (*Wyo.*) *undulata*	D, F, J, L
Wy. (*Wyo.*) *scotinomus* affinis	E, L
Wy. (*Wyo.*) *phroso*?	F, J, L
Wyeomyia (*Wyo.*) sp.	D, F, J, L
Wy. (*Miamyia*) *oblita*	F, J
Wy. (*Decamyia*) *ulocoma*	B, L, N
Wy. (*Dec.*) *pseudopecten* aff.	D
Wyeomyia (*Dec.*) sp.	D, L
Wy. (*Nunezia*) *trujilloi* aff.	E, L, G
Wyeomyia (*Nuz.*) sp. A	L, F
Wyeomyia (*Nuz.*) sp. B	F
Limatus durhamii	D, L, M
Sabethes (*Peytonulus*) *ignotus*	L
Sa. (*Pey.*) *ignotus* aff.	J
Sa. (*Pey.*) *luxodens*	J
Sa. (*Pey.*) *undosus*	J
Sa. (*Sabethinus*) *intermedius*?	D, J, L
Sa. (*Sbn.*) *xyphydes*?	J
Sa. (*Sabethoides*) *chloropterus*?	D
Sabethes (*Sbo.*) sp.	F
Shannoniana fluviatilis	F

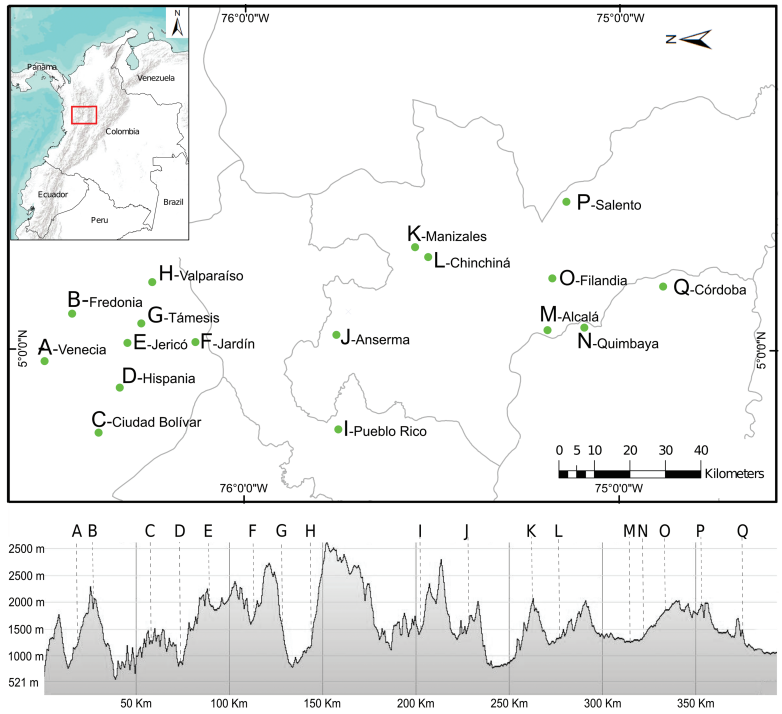

Fig. 2. Altitudinal profile of updated records for Sabethini tribe in the northern Andean region of Colombia.

(1969) (Valle del Cauca [Buenaventura]); Heinemann and Belkin (1978) (Valle del Cauca [Buenaventura]); IAvH (2014) (Meta [Restrepo]).

Sabethes (Peytonulus) identicus Dyar and Knab: IAvH (2014) (Meta [Villavicencio]).

Sabethes (Pey.) ignotus: (Meta [Villavicencio]); Present study (Caldas [Chinchiná]).

Sabethes (Sabethinus) intermedius: Stone et al. (1959) (Valle del Cauca [Buenaventura]); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]); Harbach (1994) (Valle del Cauca [Buenaventura]).

Sabethes (Sab.) quasicyaneus Peryassú: Stone et al. (1959) (Santander [San Vicente de Chucurí]); Barreto-Reyes (1957) (Santander [San Vicente de Chucurí]).

Sabethes (Pey.) luxodens: Present study (Caldas [Anserma]).

Sabethes (Pey.) undosus Coquillet 1906: Heine Belkin (1978) (Meta [Puerto López]); Barajas et al. (2013) (Caldas [Anserma]); Present study (Caldas [Anserma]).

Sabethes (Pey.) xenismus Harbach: Harbach (1995) (Meta [Villavicencio]).

Genus *Shannoniana*

Shannoniana fluviatilis: Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]); present study (Antioquia [Jardín]).

Genus *Trichoprosopon*

Trichoprosopon andinum Levi-Castillo: Harbach and Peyton (2000) (Valle del Cauca [Cali]).

Trichoprosopon compressum: Lane and Cerqueira (1942) (Meta [Restrepo]); Parra-Henao and Suárez (2012) (Antioquia [Apartadó]); present study (Caldas [Anserma]).

Trichoprosopon digitatum: Vargas and Martínez (1953) (Norte de Santander [San Vicente de Chucurí]); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]); Heinemann and Belkin (1978) (Meta [Villavicencio], Norte de Santander [San Vicente de Chucurí]); Parra-Henao and Suárez (2012) (Antioquia [Apartadó]); Barajas et al. (2013) (Antioquia [Hispania], Caldas [Anserma]); IAvH (2014) (Cundinamarca [Soacha], Meta [Villavicencio], Norte de Santander [San Vicente de Chucurí]); present study (Antioquia [Hispania], Caldas [Anserma, Chinchiná], Valle del Cauca [Alcalá]).

Trichoprosopon evansae Antunes: Lane and Cerqueira (1942) (Meta [Villavicencio]); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]); Marchon-Silva et al. (1996) (Meta [Restrepo]).

Trichoprosopon lanei (Antunes): Stone et al. (1959) (Meta [Restrepo]); Marchon-Silva et al. (1996) (Meta [Restrepo]).

Trichoprosopon pallidiventer: Stone et al. (1959) (Valle del Cauca [Buenaventura]); Barreto and

Vernon (1969) (Valle del Cauca [Buenaventura]); Heinemann and Belkin (1978) (Cauca [Puerto Tejada], Valle del Cauca [Buenaventura]).

Trichoprosopon pallidiventer s.s.: Present study (Valle del Cauca [Alcalá]).

Trichoprosopon pallidiventer s.l.: Present study (Antioquia [Ciudad Bolivar, Fredonia, Hispania, Jardín, Jericó, Támesis, Venecia], Caldas [Anserma, Chinchiná, Manizales], Quindío [Córdoba, Filandia, Salento], Risaralda [Pueblo Rico]).

Genus *Wyeomyia*

Wyeomyia (Dodecamyia) aphobema Dyar: Stone et al. (1959) (Meta [Restrepo]); Heinemann and Belkin (1978) (Meta [Restrepo]); IAvH (2014) (Meta [Restrepo], Meta [Villavicencio]).

Wyeomyia (Triamyia) aporonoma Dyar and Knab: Stone et al. (1959) (Valle del Cauca [Buenaventura]); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]).

Wyeomyia (Wyeomyia) arthrostigma: Heinemann and Belkin (1978) (Cundinamarca [Soacha], Meta [Restrepo], Meta [Villavicencio], Valle del Cauca [Buenaventura], Valle del Cauca [Cali]); IAvH (2014) (Cundinamarca [Soacha], Meta [Restrepo], Meta [Villavicencio]); Present study (Valle del Cauca [Alcalá]).

Wyeomyia (Wyo.) celaenocephala Dyar and Knab: Stone et al. (1959) (Valle del Cauca [Buenaventura]); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]); Parra-Henao and Suárez (2012) (Antioquia [Apartadó]).

Wyeomyia (Hystatomyia) chocoensis Porter and Wolff: Porter and Wolff (2004) (Chocó [Quibdó]).

Wyeomyia (Hys.) intonca Dyar and Knab: Porter and Wolff (2004) (Chocó [Quibdó]).

Wyeomyia (Miamyia) codiocampa Dyar and Knab: IAvH (2014) (Meta [Puerto López], Meta [Villavicencio]).

Wyeomyia (Antunesmyia) colombiana Lane: Stone et al. (1959) (Meta [Restrepo], IAvH (2014).

Wyeomyia (Dendromyia) complosa (Dyar): Stone et al. (1959) (Valle del Cauca [Buenaventura]); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]).

Wyeomyia (Ant.) flavifacies Edwards: Stone et al. (1959) (Antioquia [Turbo]); Parra-Henao and Suárez (2012) (Antioquia [Turbo]).

Wyeomyia (Mia.) hosautos Dyar and Knab: Stone et al. (1959) (Valle del Cauca [Buenaventura]); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]).

Wyeomyia (Den.) jocosa Dyar and Knab: Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]).

Wyeomyia (Cruzmyia) kummi Lane and Cerqueira: Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]).

Wyeomyia (Cru.) mattinglyi Lane: Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]).

Wyeomyia melanocephala Dyar and Knab: Stone et al. (1959) (Valle del Cauca [Buenaventura]); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]).

Wyeomyia (Wyo.) melanopus Dyar: Heinemann and Belkin (1978) (Valle del Cauca [Buenaventura]); Parra-Henao and Suárez (2012) (Antioquia [Apartadó], Antioquia [Turbo]).

Wyeomyia moerbista: Parra-Henao and Suárez (2012) (Antioquia [Apartadó]).

Wyeomyia (Miamyia) oblita: Barajas et al. (2013) (Antioquia [Anserma], Antioquia [Hispania]); Present study (Antioquia [Anserma], Antioquia [Hispania].

Wyeomyia (Wyo.) pertinans (Williston): Heinemann and Belkin (1978) (Meta [Restrepo], Meta [Villavicencio], Valle del Cauca [Buenaventura]).

Wyeomyia (Dec.) pseudopecten: Heinemann and Belkin (1978) (Valle del Cauca [Buenaventura]).

Wyeomyia (Wyo.) scotinomus: Stone et al. (1959) (Atlántico [Barranquilla]); Kano (1991) (Chocó); Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]).

Wyeomyia (Wyo.) simmsi Dyar and Knab: (Valle del Cauca [Buenaventura]); Kano (1991 (Chocó [Nuquí]); Zuluaga, Jaroslav, Rojas, and Orduz (1993) (Chocó [Nuquí]).

Wyeomyia (Exallomyia) tarsata Lane and Cerqueira: Barreto and Vernon (1969) (Valle del Cauca [Buenaventura]).

Wyeomyia (Dec.) ulocoma: Heinemann and Belkin 1978 (Valle del Cauca [Buenaventura]); Present study (Antioquia [Fredonia], Caldas [Chinchiná], Quindio [Quimbaya]).

Wyeomyia undulata: Present study (Antioquia [Hispania], Caldas [Anserma, Chinchiná].

DISCUSSION

The most comprehensive compilation of sabethine species in Colombia with associated geographic data and larval microhabitats is that by Heinemann and Belkin (1978). Other publications have focused on the fauna of a specific locality, thus Barreto-Reyes (1957) on San Vicente de Chucurí, Santander; Barreto and Vernon (1969) and Aguilera and Isaza (2011) on Buenaventura, Valle del Cauca; Barrera et al. (2002) on Cimitarra, Santander; and Ferro et al. (2008) on Barrancabermeja, Santander. Other relevant publications with a somewhat broader focus include those of Zavortink (1979a), Harbach (1995), and Marchon-Silva et al. (1996) on the eastern tropical savanna of Colombia (Llanos Orientales); Porter and Wolff (2004) on the lowlands of the northern Pacific Coast; Parra-Henao and Suárez (2012) on the Urabá region of the north-

occidental side of Colombia; and Barajas et al. (2013) with 3 municipalities in the Eje Cafetero.

The presence of some species is noted for the first time in 1 or more of the departments where sampling occurred. All 17 of the municipalities included in the study had at least 1 new record of a species presence. Two species, *Sa. luxodens* and *Wy. undulata*, represent new additions to the Colombian mosquito fauna. Both species were collected in the Department of Caldas, and *Wy. undulata* also was found in the Department of Antioquia. A new morphotype related to *Tr. pallidiventer* and designated as *Tr. pallidiventer* s.l. was found at several of the municipalities sampled. Morphological differences between these 2 species are primarily associated with the male genitalia, and a description with comparisons is being prepared.

The only specimen of *Shannoniana* genus was represented by a female adult identified as *Sh. fluviatilis*. The specimen was collected inside a premontane forest located at the Jardín municipality in Antioquia. The identification at species level was based on a taxonomic key for adult females of genus belonging to Sabethini tribe (Lane 1953). This species was reported before in Buenaventura, Colombia (Barreto and Vernon 1969). The finding of male adults from the Andean mountains of southwest of Antioquia is necessary to verify the species identification of *Sh. fluviatilis* using morphological structures of genitalia.

The species identified as *Wy. trujilloi* aff. showed some morphological differences when compared to *Wy. bicornis*. Recently, *Wy. trujilloi* was proposed as synonym of *Wy. bicornis* by Navarro and Liria (2007). Differences between specimens identified as *Wy. trujilloi* aff. and *Wy. bicornis* were based on variations of the male genitalia. Most notorious morphological variations are the form of apical region of gonostyle and the setae distribution.

The breeding places of immature stages were found in the following microhabitats, which were primarily phytotelmata: bromeliads (*Wyeomyia*), *Guadua angustifolia* Kunth stumps (*Limatus, Sabethes* [*Peytonulus*], *Trichoprosopon, Wyeomyia*), *G. angustifolia* internodes (*Sabethes* [*Peytonulus*], *Trichoprosopon, Wyeomyia*), *G. angustifolia* stems on the ground (*Limatus, Sabethes* [*Peytonulus*], *Trichoprosopon*), *Heliconia* spp. bracts (*Wyeomyia* [*Wyeomyia*]), *Xanthosoma* spp. leaf axils (*Johnbelkinia, Trichoprosopon*), and artificial containers (*Limatus*). Immature forms of sabethinae species are usually associated with specific phytotelmata (Lane and Cerqueira 1942). One example is that of species which undergo larval development in the internodes of bamboo. Ovipositing females of these mosquitoes enter the internodes through small perforations or holes made by animals, especially other insects. Thus, most species of the subgenus *Peytonulus* use this microhabitat as well as certain species of *Wyeomyia* such as *Wy. undulata* and *Wy. oblita* as seen here, specifically in bamboo areas located near coffee plantations. Another example is stumps remaining from cut *G. angustifolia* stems. These stumps are used by a distinct group of mosquitoes, which include species from several sabethine genera. Within the northern Andes region, frequent species collected are *Wy. arthrostigma, Tr. Digitatum,* and *Trichoprosopon pallidiventer* s.l. In the Colombian Andean region the most abundant species was *Tr. pallidiventer* s.l., found in stumps of *G. angustifolia* during the entomological collecting. Tank bromeliads are another common larval development site for mosquitoes, but again with a specific fauna. Thus, in the region encompassed by this study, the mosquitoes associated with bromeliads were several species of the *Wyeomyia* subgenus *Nunezia* as well as species of the subgenus *Wyeomyia* such as *Wy. scotinomus*. Mosquitoes belonging to *Nunezia* subgenus were found all in different kinds of vegetation such as grassland, coffee plantation, forest, and bamboo.

The *Wyeomyia* subgenus *Decamyia* is associated predominately with leaf bases of *Calathea* and flower bracts of *Heliconia* and *Wy. ulocoma* was found to be abundant in *Heliconia* spp. Leaf axils of the aroid *Xanthosoma* provide another species specific larval development site, which in the region sampled was inhabited by *Johnbelkinia ulopus* and *Trichoprosopon* sp. B.

Species richness in the northern Andean coffee-growing region of Colombia is likely related to its diverse topography and climatic variations, which influence local floristic assemblages and consequently the phytotelmata available to sabethine mosquitoes. However, within these environments human activity also influences the abundance and composition of the phytotelmata available to mosquitoes. For example, while thickets of *Guadua* spp. are common in the region, *G. angustifolia* also is cultivated on coffee farms for its versatile use in construction. As already described, when stems are harvested, the remaining trunks, once filled with rain water, are ideal sites for development of mosquito immature forms. Another cultural practice that may affect mosquito presence and abundance relates to cultivation of coffee under shade. Under these conditions the trees providing shade may support tank bromeliads. This phytotelmata microhabitat not only provides an excellent larval development site for certain sabethine mosquitoes but also for other species. An additional example of how human activity may affect the abundance of a sabethine mosquito is the cultivation of certain ornamental plants, as bromeliads, *Heliconia* spp., and *Calathea* spp. Not only do many farms in the region cultivate bromeliads, they also plant some *Heliconia* species, occasionally grown in larger

quantities to sell as cut flowers. *Heliconia* bracts also hold water, and larvae of species in the *Wyeomyia* subgenus (*Decamyia*) are closely associated with the bracts of these plants as well as those of *Calathea.* To varying degrees many of these species (not only sabethines) are anthropophilic and consequently represent a potential risk for infectious disease transmission. The information provided here is a baseline for future studies considering arbovirus potential transmission in coffee-growing areas that are also tourist attractions.

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