Ectoparasites (Diptera: Streblidae and Nycteribiidae) of bats from some localities of the Coast of Ecuador

Ectoparásitos (Diptera: Streblidae y Nycteribiidae) de murciélagos en algunas localidades de la Costa del Ecuador

ABSTRACT

In Ecuador, studies of parasitic bat flies are scarce and biased towards the family Streblidae: reports indicate the existence of 50 species, five of them on the western lowlands. Because of this situation, the present research focus on identifying the diversity of ectoparasites of the families Streblidae and Nycteribiidae that are associated with bats in several localities of the western lowlands of the country. Samples from the associated collection of parasites of the Mammalogy Section of the Zoology Museum at Pontificia Universidad Católica del Ecuador (QCAZ-M) were used, as well as the database of the collection that allowed obtaining information on the host taxa. Thus, 145 individuals of bats of 22 species of the families Phyllostomidae and Vespertilionidae and 27 species of 424 individuals of parasitic flies are reported. Of these, five records are new in Ecuador, 19 are confirmed records in the west and the geographic distribution was extended for species previously reported in this region. *Trichobius joblingi* was the most abundant parasitic fly species and together with *Speiseria ambigua*, were associated with the greatest number of bat species. Species of the genus *Carollia* were the most abundant and harbored the greatest diversity of flies. The study constitutes the first extensive review of Diptera (Streblidae and Nycteribiidae) in the area and, therefore, contributes to expanding the knowledge of the diversity of ectoparasites of bats in Ecuador.

Keywords: bats, ectoparasites, host, parasitic flies, Ecuadorian coast.

RESUMEN

En Ecuador, los estudios de moscas parásitas de murciélagos son escasos y sesgados hacia la familia Streblidae: los reportes indican la existencia de 50 especies, cinco de ellas en las tierras bajas del occidente. La presente investigación se enfocó en identificar la diversidad de ectoparásitos de las familias Streblidae y Nycteribiidae que se asocian a murciélagos de varias localidades del occidente. Se utilizaron muestras de la colección asociada de parásitos de la Sección de Mamíferos del Museo de Zoología de la Pontificia Universidad Católica del Ecuador (QCAZ-M), así como la base de datos de la colección que permitió obtener información de los taxones hospederos. Se reportan 145 individuos de murciélagos de 22 especies de las familias Phyllostomidae y Vespertilionidae y 27 especies de 424 individuos de las moscas parásitas. De ellas, cinco registros son nuevos en Ecuador, 19 son registros confirmados en el litoral y se amplió la distribución geográfica para especies previamente reportadas en esta región. *Trichobius joblingi* fue la especie de mosca parásita más abundante y en conjunto con *Speiseria ambigua*, se asociaron con el mayor número de especies de murciélagos. Las especies del género *Carollia* fueron las más abundantes y albergaron la mayor diversidad de moscas. El estudio constituye la primera revisión extensa de dípteros (Streblidae y Nycteribiidae) de la zona y, por consiguiente, contribuye a ampliar el conocimiento de la diversidad de ectoparásitos de murciélagos en Ecuador.

Palabras claves: ectoparásitos, hospedero, murciélagos, moscas parásitas, Costa ecuatoriana.

INTRODUCTION

Ectoparasites are organisms that can adhere and introduce themselves to the skin or its excretions for variable periods (Hopla et al., 1994). They are mainly part of the Phylum Arthropoda and are made up of different taxonomic groups such as fleas (Siphonaptera), lice (Phthiraptera), flies (Diptera), bedbugs (Hemiptera), ticks (Ixodida), and mites (Mesostigmata) (Sánchez et al., 2020).

A characteristic of ectoparasites is the ability to establish associations in the host to protect themselves from the external environment and changes in temperature and humidity, factors that determine their life cycle (Amat-Valero et al., 2013). They use the host as a means of transport to new and suitable habitats, increasing their dispersal capacity (Baumann, 2018). Around 6000 species of insects have been reported worldwide as external parasites of warm-blooded vertebrates; of these, 742 parasitize bats (Haelewaters et al., 2018; Marshall, 1982). In accordance with the most recent catalogues, Central and South America are inhabited by a comprehensive array of 273 ectoparasite species associated with bats. This assemblage comprises 141 species belonging to the Streblidae family, 46 species within Nycteribiidae family, eight flea species, four bedbug species, and 74 mites and tick species (Frank et al., 2014).

It is noteworthy that the families Streblidae and Nycteribiidae have been the primary focus of research in the Neotropical region. As evidenced by various publications, 68 species have been documented in Peru (Minaya et al., 2021), 82 species in Colombia (Dick et al., 2016; Graciolli et al., 2016; Pastrana-Montiel et al., 2019), 130 species in Venezuela (Guerrero, 2019; Guimarães, 1972; Wenzel, 1976) and 119 species in Brazil (Graciolli & Hrycyna, 2023; Hrycyna et al., 2019).

Locally, 59 species of bat ectoparasites have been reported in Ecuador. Among these, 54 correspond to the order Diptera of the families Streblidae and Nycteribiidae; two belong to the order Prostigmata of the families Trombiculidae and Myobiidae; two conform the order Mesostigmata of the families Macronyssidae and Spinturnicidae; finally, one is member of the order Siphonaptera of the family Ischnopsyllidae (Camacho et al., 2014; Correa et al., 2019; Espinoza, 2020; Guerrero, 1997; Guimarães & D'Andretta, 1956; Liu et al., 2020; Salgado, 2019; Stamper, 2012; Tello, 2005). Of these species, five are located on the Ecuadorian Coast and belong to the family Streblidae (Correa et al., 2019; Liu et al., 2020; Tello, 2005).

Of the studies, only Salgado (2019), Stamper (2012) and Tello (2005) focused directly on the study of ectoparasites and bats in Ecuador. It is important to note that research on this topic, and even more so those focused on the Coast, are scattered in time, very scarce, primarily focused on the Streblidae family of Diptera and, therefore, exclude information on other families, orders present in the country and their association with different species of bats. This is due to two essential aspects: the findings of Streblidae in bats are better documented and this is the ectoparasite family with the highest species richness and most abundant in the Western Hemisphere (Calonge-Camargo & Pérez-Torres, 2018; Reeves et al., 2016; Santos et al., 2016).

The present study consists of an extensive and detailed review covering a larger number of bat species, their parasitic bat flies, and several coastal areas duly associated with the host collection site. In this sense, the objective is to identify the diversity of ectoparasites of the families Streblidae and Nycteribiidae associated with bats in some localities on the Coast of Ecuador.

MATERIALS AND METHODS

Sample

The study sample came from the associated collection of ectoparasites of the Mammalogy Section of the Zoology Museum at Pontificia Universidad Católica del Ecuador (QCAZ-M), and specifically, those that registered collection sites on the Ecuadorian Coast were selected. The sample, being conformed by a collection of ectoparasites of bats, contained specimens of different species, so it was necessary to carry out a first revision to isolate the parasitic bat flies of the families Streblidae and Nycteribiidae from the rest of the ectoparasites.

It is worth mentioning that most of the samples were obtained from the project "Caracterización de la Diversidad Biológica y Genética de los Mamíferos del Ecuador" carried out in 2017; a smaller proportion was collected from the project "Prevalencia y Diversidad Genética de Coronavirus en Murciélagos del Ecuador" carried in 2021, and only one specimen came from a different project.

Taxonomic identification

A stereo microscope was used to identify specimens to the genus level; an optical microscope was used to observe in detail the specific structures required for species identification. In this process, morphological keys used included those set forth by Graciolli (2004), Guerrero (1994a, 1994b, 1995a, 1995b, 1996, 1998, 2019), Guimarães & D'Andretta (1956), Jobling (1936), Peterson (1959), Theodor (1967), Wenzel et al. (1966), and Wenzel (1976).

Microscopic photographs were taken based on distinctive taxonomic characters to compare more than two species of the same genus. In this sense, digital images of the whole body were obtained for the genera with only one species; on the other hand, in those belonging to

112 the Streblidae family, the thorax, head, and wings were photographed; finally, for the species of
113 the Nycteribiidae family, photos of the abdomen were taken.
114
115 Host information, including identification to species level and site of capture, was
116 obtained from the databases managed by QCAZ-M
117 (https://bioweb.bio/faunaweb/mammaliaweb/). It is important to clarify that because the
118 identification of some bat specimens was only available to the genus level, it was essential to
119 determine the species. This process consisted of using the taxonomic key of Díaz et al. (2021)
120 and an additional verification by one of the co-authors of this study.
121

122 **RESULTS**

123 **Diversity**

124 We recorded a total of 424 parasitic bat flies, belonging to nine genera, 25 species of the family
125 Streblidae and one genus and two species of the family Nycteribiidae were identified. The most
126 abundant bat fly species were *Trichobius joblingi* (24%) and *Basilia ferrisi* (21%) (Table 1).
127
128 In terms of bat hosts, 145 individuals from two families, 13 genera and 22 species
129 (Phyllostomidae, n = 18; Vespertilionidae, n = 4) were studied. *Carollia brevicauda* (15%),
130 *Carollia perspicillata* (14%) and *Carollia castanea* (12%) were the most abundant species
131 (Table 1; Figure 1).
132
133 In the context of host-parasite interactions, *Trichobius joblingi* and *Speiseria ambigua*
134 were associated with the highest number of host species: five each (Table 1). Similarly, *Carollia*

brevicauda, *Carollia castanea* and *Glossophaga soricina* harbored five species of parasitic flies (Figure 1).

New records

Of the 27 species analyzed, five (19%) are new records for Ecuador, 19 (70%) are confirmed records from the Ecuadorian Coast and three (11%) correspond to previous records. In addition, it was not possible to determine the species level for two morphotypes (Table 1).

Table 1. Host taxon association and parasitic bat flies in some localities of the Ecuadorian Coast.

Parasitic bat flies	N	Host	N
Family Streblidae			
Subfamily Trichobiinae			
Trichobius uniformis[b]	6	*Glossophaga soricina*	4
		Lonchophylla concava	1
Trichobius longipes[b]	1	*Phyllostomus hastatus*	1
Trichobius costalimai[b]	11	*Phyllostomus discolor*	2
Trichobius dugesii[b]	5	*Glossophaga soricina*	4
Trichobius joblingi[c]	100	*Glossophaga soricina*	1
		Carollia brevicauda	18
		Carollia castanea	11
		Carollia perspicillata	17
		Myotis riparius	1
Trichobius parasiticus[b]	2	*Platyrrhinus* sp.	1
Trichobius dugesioides[b]	25	*Trachops cirrhosus*	2
		Lonchorhina aurita	1
		Carollia brevicauda	1
Trichobius flagellatus[a]	14	*Lonchorhina aurita*	2

Trichobius anducei[b]	14	*Carollia brevicauda* *Carollia castanea* *Carollia perspicillata*	4 2 5
Trichobius sp.	1	*Platyrrhinus umbratus*	1
Trichobioides perspicillatus[b]	15	*Phyllostomus discolor* *Carollia castanea*	3 1
Speiseria ambigua[c]	23	*Glossophaga soricina* *Lonchorhina aurita* *Carollia brevicauda* *Carollia castanea* *Carollia perspicillata*	2 1 4 7 7
Paratrichobius longicrus[b]	2	*Artibeus lituratus*	1
Paratrichobius dunni[a]	4	*Uroderma convexum*	1
Megistopoda aranea[b]	8	*Artibeus fraterculus* *Artibeus lituratus* *Platyrrhinus umbratus*	2 1 1
Megistopoda proxima[b]	9	*Sturnira bakeri* *Sturnira ludovici*	6 1
Aspidoptera phyllostomatis[b]	5	*Artibeus fraterculus*	4
Aspidoptera falcata[b]	2	*Sturnira ludovici*	1
Exastinion clovisi[b]	1	*Carollia castanea*	1
Subfamily Streblinae			
Strebla mirabilis[b]	21	*Trachops cirrhosus*	2
Strebla guajiro[c]	16	*Carollia brevicauda* *Carollia perspicillata*	6 4
Strebla hertigi[b]	2	*Phyllostomus discolor* *Phyllostomus hastatus*	1 1
Strebla galindoi[b]	32	*Tonatia bakeri*	5

Strebla machadoi[a]	2	*Micronycteris minuta*	1
Strebla altmani[a]	5	*Lonchorhina aurita*	2
Metelasmus pseudopterus[b]	1	*Artibeus lituratus*	1
Family Nycteribiidae			
Subfamily Nycteribiinae			
Basilia carteri[a]	7	*Myotis albescens*	1
		Myotis nigricans	1
Basilia ferrisi[b]	88	*Glossophaga soricina*	1
		Myotis diminutus	15
		Myotis nigricans	6
		Myotis riparius	12
Basilia sp.	2	*Myotis riparius*	1
Total	424		

N: Number of individuals.
[a]: New report for Ecuador.
[b]: Report confirmed for the Coast region.
[c]: Previous report in the Ecuadorian Sierra and Amazonia.

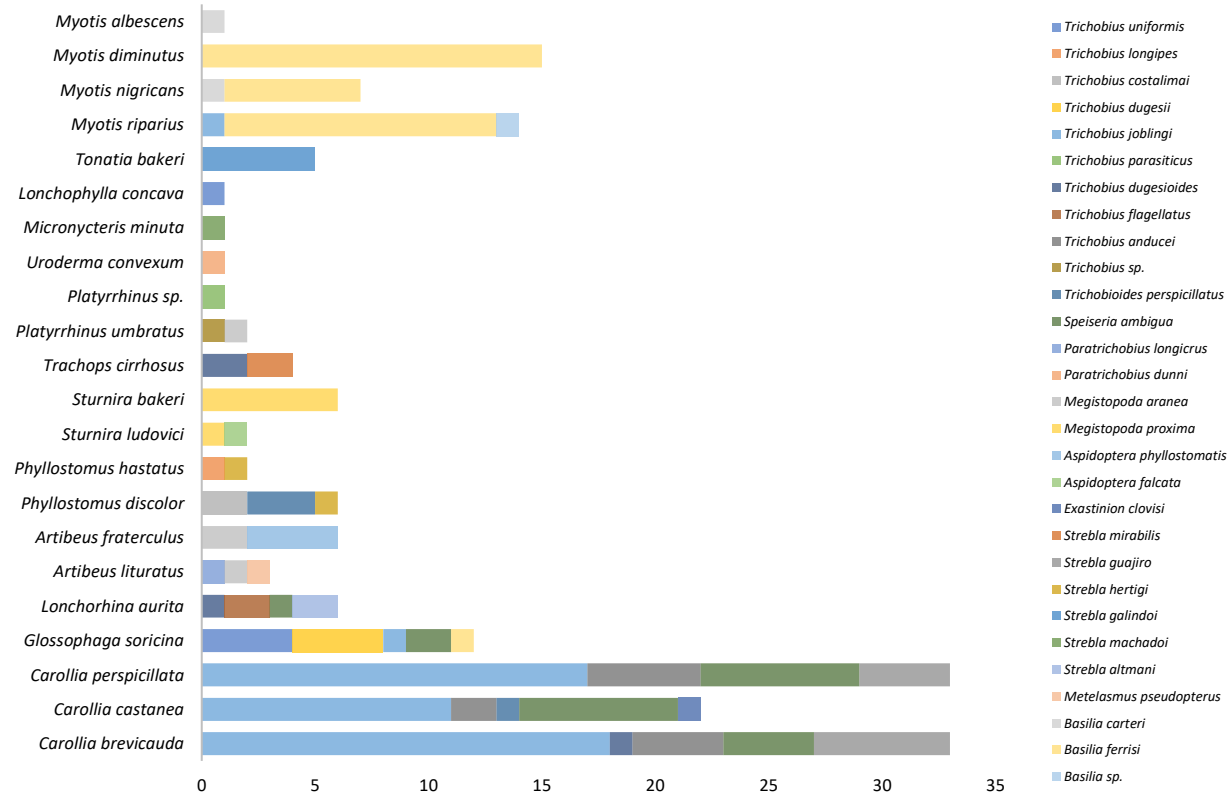
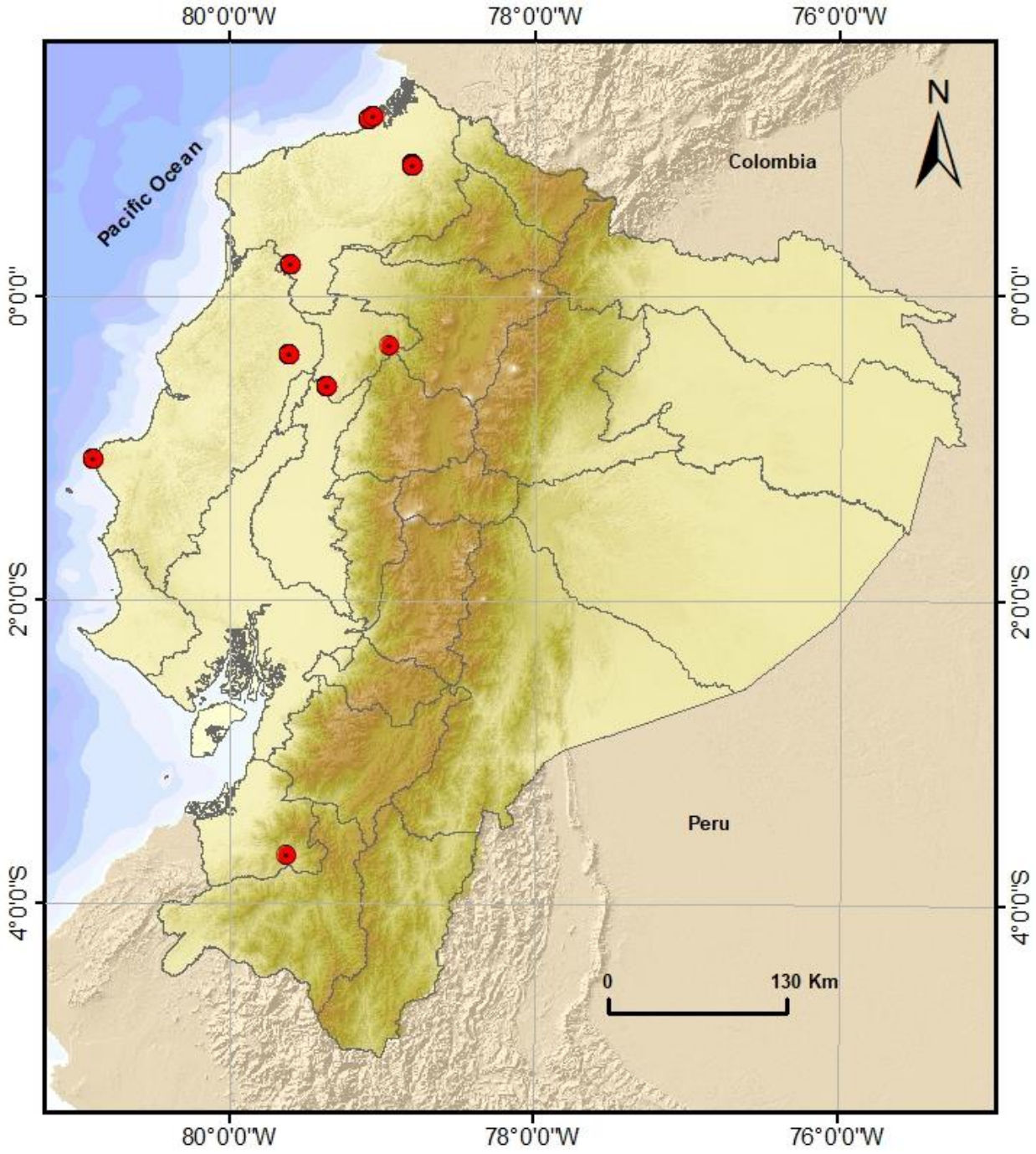


Figure 1. Association of bats and their parasitic bat flies from some localities of the Coast of Ecuador.

We report the presence of Streblidae and Nycteribiidae species in nine localities distributed in Esmeraldas, Santo Domingo de los Tsáchilas, El Oro, Los Ríos and Manabí provinces (Figure 2); these last two correspond to new distribution data for *Strebla altmani*, *Speiseria ambigua* and *Trichobius joblingi*.



156

157 **Figure 2.** Collection localities of bats and their ectoparasites in the provinces of Esmeraldas,

158 Manabí, Santo Domingo de los Tsáchilas, Los Ríos and El Oro.

159

160 **Annotated list of ectoparasite species**

The list below is structured by family, subfamily, genus and species. In addition, the order is aligned with that proposed by Guerrero (2019) in one of his most current works on the family Streblidae. In that sense, the species of the family Nycteribiidae are organized alphabetically, and the details of each are divided into three sections: the first includes relevant information on the material examined, the second corresponds to diagnostic characters, and the third provides information on host-parasite interactions according to bibliographic records, as well as relevant findings.

Family Streblidae Kolenati, 1863

Subfamily Trichobiinae Jobling, 1936

Genus *Trichobius* Gervais, 1844

Trichobius uniformis Curran, 1935

Figure 3A

Material examined

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 23.XI.2021, 1♂, 1♀ ex *Glossophaga soricina*; 25.XI.2021, 1♂, 1♀ ex *Glossophaga soricina*; 26.XI.2021, 1♂ ex *Lonchophylla concava*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 22.VII.2017, 1♂ ex *Glossophaga soricina*.

Identification

The species was identified from the presence of setae on the basal angle of vein 6 of the wing. In addition, vein R1 is straight, and each occipital lobe has a tubercle on the posterior edge (Guerrero, 1994a).

Remarks

Trichobius uniformis is a characteristic species of the genus *Glossophaga*, particularly associated with *Glossophaga soricina* (Cuxim-Koyoc et al., 2018; Wenzel, 1976), which is the same host reported from Ecuador (Stamper, 2012). We report for the first time the association with *Lonchophylla concava*.

Trichobius longipes (Rudow, 1871)

Figure 3B

Material examined

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 25.VII.2017, 1♂ ex *Phyllostomus hastatus*.

Identification

This species is distinguished by short setae along the anterior margin of the prescutum and long ones along the midline. Also, those found in the lateral rows are longer compared to those found in the center (Guerrero, 1994a, 2019).

Remarks

Although *Phyllostomus hastatus* is the characteristic host of *Trichobius longipes* (Wenzel, 1976), several species of the family Phyllostomidae have been reported as hosts in Ecuador (Stamper, 2012).

Trichobius costalimai Guimarães, 1938

Figure 3C

Material examined

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 27.XI.2021, 2♂, 2♀ ex *Phyllostomus discolor*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 21.VII.2017, 7♂ ex *Phyllostomus discolor*.

Identification

It is possible to differentiate between 10 to 12 setae in the anterolateral region of the prescutum and short setae between the transverse and median sutures of the mesonotum. These characteristics are exclusive to this species (Guerrero, 1994a).

Remarks

Phyllostomus discolor is the main host of *Trichobius costalimai* (Wenzel, 1976), also occurring in Ecuador (Stamper, 2012).

Trichobius dugesii Townsend, 1891

Figure 3D

Material examined

Esmeraldas • Eloy Alfaro, La Tola, Finca Cocadilla; 1°11’29.2”N, 79°03’07.7”W; 5 m a.s.l.; 21.VIII.2017, 1♂, 2♀ ex *Glossophaga soricina*. • Eloy Alfaro, La Tola, Centro de Interpretación Majagual; 1°10’23.0”N, 79°04’45.8”W; 11 m a.s.l.; 19.VIII.2017, 1♀ ex *Glossophaga soricina*; 22.VIII.2017, 1♀ ex *Glossophaga soricina*.

Identification

The antescutellar setae of *Trichobius dugesii* are shorter, and the setae of the prescutum are gradually reduced towards the discal area. Also, behind the lateral lobe of tergum 1+2, no long setae are evident in females, but in males, sternum 6 is present (Guerrero, 1995a).

Remarks

Glossophaga soricina is considered the main host of *Trichobius dugesii* (Dick & Gettinger, 2005). However, in Ecuador, it is also found on *Artibeus lituratus* and *Carollia brevicauda* (Stamper, 2012).

Trichobius joblingi Wenzel, 1966

Figure 3E

Material examined

Esmeraldas • Eloy Alfaro, La Tola, Finca Cocadilla; 1°11’29.2”N, 79°03’07.7”W; 5 m a.s.l.; 21.VIII.2017, 2♂ ex *Carollia perspicillata*. • Eloy Alfaro, La Tola, Centro de Interpretación Majagual; 1°10’23.0”N, 79°04’45.8”W; 11 m a.s.l.; 21.VIII.2017, 1♂ ex *Glossophaga soricina*, 1♂ ex *Carollia perspicillata*. • Eloy Alfaro, Luis Vargas Torres, Playa de Oro; 0°52’33.0”N, 78°47’40.7”W; 113 m a.s.l.; 25.VIII.2017, 1♂, 3♀ ex *Carollia perspicillata*. • Quinindé, Rosa Zárate, Jaboncillo, Finca La Esperanza; 0°12’54.3”N, 79°35’54.9”W; 100 m a.s.l.; 09.IX.2021, 4♂, 5♀ ex *Carollia brevicauda*, 1♂ ex *Carollia castanea*, 3♂, 1♀ ex *Carollia perspicillata.* Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 20.XI.2021, 2♂, 1♀ ex *Carollia brevicauda*; 25.XI.2021, 3♂, 2♀ ex *Carollia brevicauda*; 26.XI.2021, 4♂ ex *Carollia brevicauda*; 20.XI.2021, 1♀ ex *Carollia castanea*; 24.XI.2021, 3♂ ex *Carollia castanea*; 25.XI.2021, 1♂ ex *Carollia castanea*; 26.XI.2021, 1♂, 2♀ ex *Carollia castanea*; 19.XI.2021, 1♂, 1♀ ex *Carollia perspicillata*; 23.XI.2021, 3♂, 5♀ ex *Carollia perspicillata*; 24.XI.2021, 1♂, 1♀ ex *Carollia perspicillata*; 26.XI.2021, 1♂, 2♀ ex *Carollia perspicillata*; 19.XI.2021, 1♂ ex *Myotis riparius*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 22.VII.2017, 6♂, 6♀ ex *Carollia brevicauda*; 23.VII.2017, 1♂, 2♀ ex *Carollia brevicauda*; 25.VII.2017, 4♂, 2♀ ex *Carollia brevicauda*; 21.VII.2017, 2♂, 1♀ ex *Carollia castanea*; 24.VII.2017, 3♂, 3♀ ex *Carollia castanea*; 22.VII.2017, 2♂, 5♀ ex *Carollia perspicillata*; 23.VII.2017, 1♂ ex *Carollia perspicillata*; 25.VII.2017, 3♂ ex *Carollia perspicillata*.

Identification

It is possible to differentiate *Trichobius joblingi* by the combination of short and long setae on the antescutellar row and prescutellar setae that gradually shorten to the discal area. Behind the lateral lobe of tergum 1+2 there are two to five long setae in females, while sternum 6 is observed in the males (Guerrero, 1995a).

Remarks

According to Wenzel (1976), *Carollia perspicillata* is the characteristic host of *Trichobius joblingi*, although in Ecuador it is also reported in 10 species of the families Phyllostomidae and Vespertilionidae (Stamper, 2012; Tello, 2005). In this study, *Glossophaga soricina* is reported for the first time in association with *Trichobius joblingi* in Ecuador; association with *Myotis riparius* was also documented.

Trichobius parasiticus Gervais, 1844

Figure 3F

Material examined

El Oro • Zaruma, Zaruma, Cerro Zaruma Urcu; 3°41’01.6”S, 79°37’21.4”W; 1126 m a.s.l.; 2♂ ex *Platyrrhinus* sp.

Identification

The mesonotum of *Trichobius parasiticus* has distinctive characteristics that make it easy to recognize, such as long setae on the anterolateral angles of the prescutum, short setae arranged in a row anterior to the transverse suture and the antescutellar row (Guerrero, 1995a).

Remarks

According to Wenzel (1976), the primary host of *Trichobius parasiticus* is *Desmodus rotundus*, but it has also been documented in *Glossophaga soricina* in Ecuador (Stamper, 2012).

Trichobius dugesioides Wenzel, 1966

Figure 3G

Material examined

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35'19.8"S, 79°21'39.8"W; 150 m a.s.l.; 21.VII.2017, 2♂, 2♀ ex *Trachops cirrhosus*; 25.VII.2017, 1♂, 1♀ ex *Carollia brevicauda*, 2♂ ex *Lonchorhina aurita*; 26.VII.2017, 9♂, 8♀ ex *Trachops cirrhosus*.

Identification

Trichobius dugesioides can be identified by the row of antescutellar setae slightly longer than those preceding it. In addition, sternite 7 has 13 to 14 setae in females, and tergite 9 has 17 to 18 setae in males (Guerrero, 1998).

Remarks

Trachops cirrhosus is the main host species of this parasite (Wenzel, 1976). However, in Ecuador, its association with *Trachops cirrhosus* and *Phyllostomus elongatus* has been evidenced (Stamper, 2012). This is the first report in Ecuador where *Lonchorhina aurita* and *Carollia brevicauda* are parasitized by *Trichobius dugesioides*.

Trichobius flagellatus Wenzel, 1976

Figure 3H

Material examined

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 19.XI.2021, 3♂, 7♀ ex *Lonchorhina aurita*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 25.VII.2017, 2♂, 2♀ ex *Lonchorhina aurita*.

Identification

In this species, the setae of the antescutellar row are the same size as those preceding them. Also, very small setae are found behind the lateral lobes of tergum 1+2 of females and males have 22 to 25 setae on tergum 9 (Guerrero, 1995a).

Remarks

Lonchorhina aurita is the main host of *Trichobius flagellatus* (Wenzel, 1976).

Trichobius anducei Guerrero, 1998

Figure 3I

Material examined

Esmeraldas • Eloy Alfaro, Luis Vargas Torres, Playa de Oro; 0°52’33.0”N, 78°47’40.7”W; 113 m a.s.l.; 25.VIII.2017, 1♂ ex *Carollia perspicillata*.

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 20.XI.2021, 1♀ ex *Carollia brevicauda*; 23.XI.2021, 1♀ ex *Carollia perspicillata*;

24.XI.2021, 1♂, 1♀ ex *Carollia brevicauda*, 1♀ ex *Carollia castanea*; 26.XI.2021, 1♂ ex *Carollia perspicillata*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 22.VII.2017, 1♂ ex *Carollia brevicauda*; 23.VII.2017, 1♀ ex *Carollia brevicauda*; 25.VII.2017, 1♂, 1♀ ex *Carollia castanea*, 3♂ ex *Carollia perspicillata*.

Identification

Females of *Trichobius anducei* differ in having a more extended band of setae on the lateral margin of the abdomen, as well as 9 to 11 setae on sternite 7. In contrast, the tergite 9 of males has 11 to 12 setae (Guerrero, 1998).

Remarks

Trichobius anducei parasitizes mainly *Carollia perspicillata* (Guerrero, 2019; Hiller et al., 2021); however, *Carollia brevicauda* has been reported in association with *Trichobius anducei* in Ecuador (Stamper, 2012). Furthermore, in this study, we document for the first time that *Trichobius anducei* parasitizes *Carollia castanea.*

Trichobius sp. *(*Complex *dugesii)*

Figure 3J

Material examined

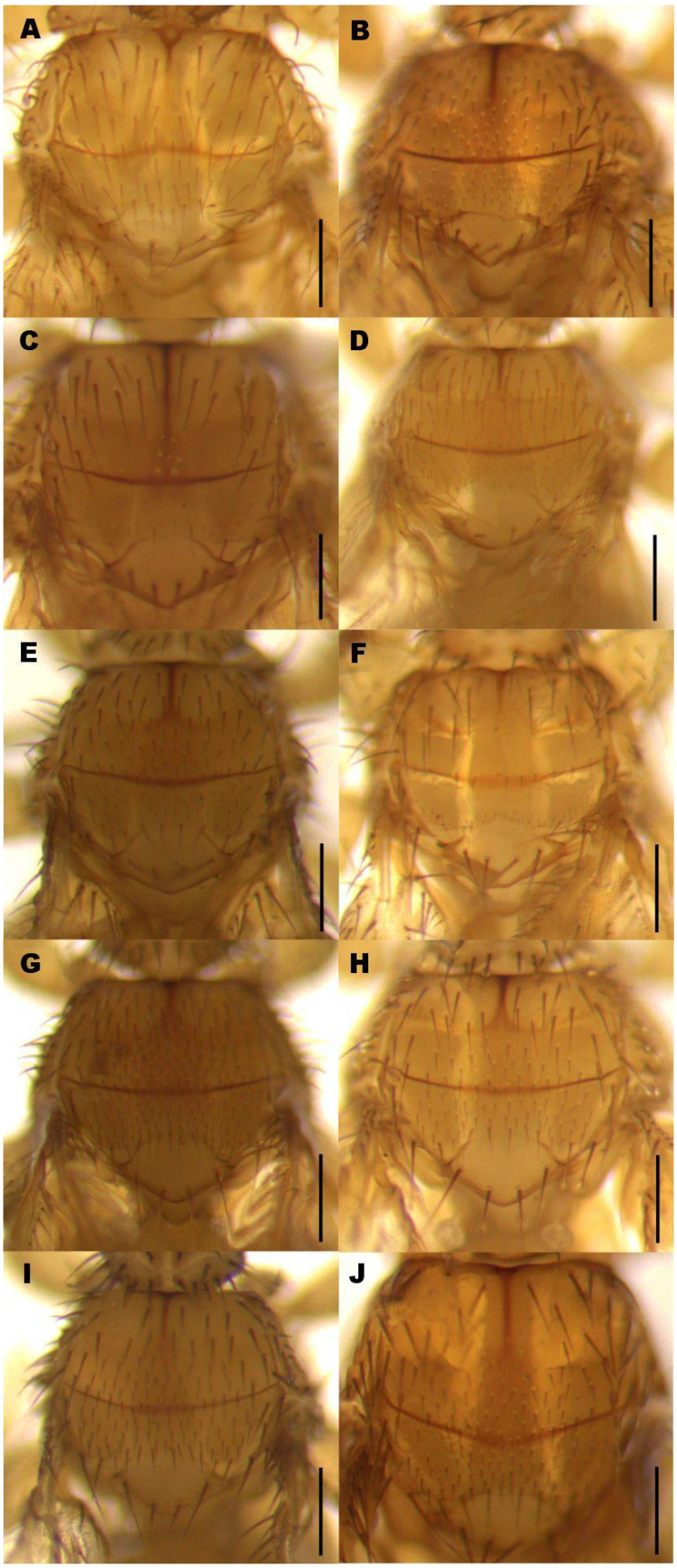
Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 19.XI.2021, 1♂ ex *Platyrrhinus umbratus*.

Remarks

This specimen could not be identified at the species level. However, it has specific characteristics close to *Trichobius angulatus* such as the angled transverse suture, prescutellar setae shortening

343 towards the center and setae of the antescutellar row longer than the predecessors (Guerrero,

344 1995a).



345

Figure 3. Dorsal view of the thorax. A) *Trichobius uniformis*; B) *Trichobius longipes*; C) *Trichobius costalimai*; D) *Trichobius dugesii*; E) *Trichobius joblingi*; F) *Trichobius parasiticus*; G) *Trichobius dugesioides*; H) *Trichobius flagellatus*; I) *Trichobius anducei*; J) *Trichobius* sp. Scale bars: A – I = 0.2 mm; J = 0.3 mm.

Genus *Trichobioides* Wenzel, 1966

Trichobioides perspicillatus (Pessôa & Galvao, 1937)

Figure 4

Material examined

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22'31.4"S, 79°36'16.3"W; 200 m a.s.l.; 23.XI.2021, 5♂, 2♀ ex *Phyllostomus discolor*; 26.XI.2021, 1♂ ex *Carollia castanea*; 27.XI.2021, 2♂, 2♀ ex *Phyllostomus discolor*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35'19.8"S, 79°21'39.8"W; 150 m a.s.l.; 21.VII.2017, 2♂, 1♀ ex *Phyllostomus discolor*.

Identification

There is only one species in the genus *Trichobioides*. Although it is very similar to *Trichobius*, the difference lies in the median suture that extends to the transverse suture but does not unite. Also, a row of short and long antescutellar setae is present (Guerrero, 1994b).

Remarks

According to Wenzel (1976), *Trichobioides perspicillatus* is the parasite commonly associated with *Phyllostomus discolor*, a situation also evidenced by Stamper (2012) in Ecuador. An important fact to highlight is that in the present investigation, it was possible to identify an undocumented association between *Carollia castanea* and *Trichobioides perspicillatus*.



Figure 4. *Trichobioides perspicillatus*. Scale bars = 2 mm.

Genus *Speiseria* Kessel, 1925

Spesieria ambigua Kessel, 1925

Figure 5

Material examined

Esmeraldas • Eloy Alfaro, La Tola, Finca Cocadilla; 1°11’29.2”N, 79°03’07.7”W; 5 m a.s.l.; 21.VIII.2017, 1♂, 1♀ ex *Glossophaga soricina*, 1♀ ex *Carollia perspicillata*. • Eloy Alfaro, La Tola, Centro de Interpretación Majagual; 1°10’23.0”N, 79°04’45.8”W; 11 m a.s.l.; 21.VIII.2017, 1♂ ex *Carollia perspicillata*. • Eloy Alfaro, Luis Vargas Torres, Playa de Oro; 0°52’33.0”N, 78°47’40.7”W; 113 m a.s.l.; 25.VIII.2017, 1♀ ex *Carollia castanea*, 1♂, 1♀ ex *Carollia perspicillata.*

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 19.XI.2021, 1♂ ex *Lonchorhina aurita*; 20.XI.2021, 1♂, 1♀ ex *Carollia castanea*; 23.XI.2021, 1♂ ex *Carollia castanea*; 24.XI.2021, 1♂ ex *Carollia brevicauda*, 1♀ ex *Carollia castanea*, 1♂ ex *Carollia perspicillata*; 25.XI.2021, 1♂ ex *Carollia castanea*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 22.VII.2017, 3♂, 2♀ ex *Carollia brevicauda*, 1♀ ex *Carollia castanea*; 25.VII.2017, 1♂, 1♀ ex *Carollia perspicillata*.

Identification

In this species, females are distinguished by having tergum 7 longer than the supra-anal plate and with parallel sides. In contrast, males exhibit strongly curved postgonites and tergum 9 between nine and ten setae (Guerrero, 1994b).

Remarks

According to Wenzel (1976), *Speiseria ambigua* infests mainly *Carollia perspicillata*, but in Ecuador, it has also been found in several species of the family Phyllostomidae and with greater incidence in bats of the genus *Carollia* (Stamper, 2012; Tello, 2005). Additionally, during the research, it was possible to document a new association with *Glossophaga soricina* in Ecuador.



Figure 5. *Speiseria ambigua*. Scale bars = 2 mm.

Genus *Paratrichobius* Costa Lima, 1921

Paratrichobius longicrus (Miranda-Ribeiro, 1907)

Figure 6A

Material examined

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 25.VII.2017, 1♂, 1♀ ex *Artibeus lituratus*.

Identification

The relevant characteristics of this species are the rounded anterior angles on the pronotum and the internal face of the profemurs covered only by small setae accompanied by a row of six thick spines (Guerrero, 1994b).

Remarks

Artibeus lituratus is the characteristic host of *Paratrichobius longicrus* (Dick & Gettinger, 2005; Wenzel,1976), and the same host has been reported in Ecuador (Stamper, 2012).

Paratrichobius dunni (Curran, 1935)

Figure 6B

Material examined

Manabí • Manta, San Lorenzo, Refugio de Vida Silvestre Marino Costera Pacoche; 1°04’00.91”S, 80°53’20.00”W; 118 m a.s.l.; 09.IX.2017, 1♂, 3♀ ex *Uroderma convexum*.

Identification

Paratrichius dunni was identified by the straight anterior angles of the pronotum and its profemurs, with two to three short spines extending parallel to a line of six thick spines on the inner side (Guerrero, 1994b).

Remarks

It is mainly found in species of the genus *Uroderma*, especially in *Uroderma bilobatum* (Guerrero, 2019; Hiller et al., 2021).

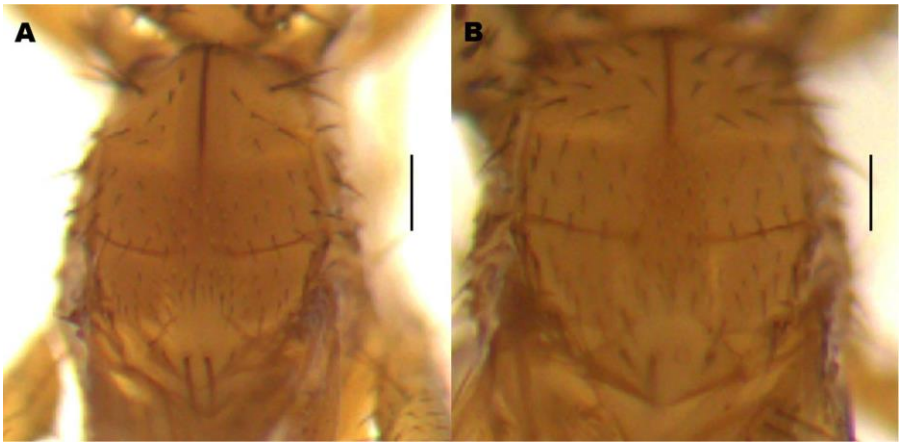


Figure 6. Dorsal view of the thorax A) *Paratrichobius longicrus*; B) *Paratrichobius dunni*. Scale bars = 0.3 mm.

Genus *Megistopoda* Macquart, 1852

Megistopoda aranea (Coquillet, 1899)

Figure 7A

Material examined

Manabí • Manta, San Lorenzo, Refugio de Vida Silvestre Marino Costera Pacoche; 1°04’00.91”S, 80°53’20.00”W; 118 m a.s.l.; 09.IX.2017, 1♂, 1♀ ex *Artibeus fraterculus*. • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 19.XI.2021, 3♂, 1♀ ex *Platyrrhinus umbratus*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 22.VII.2017, 1♂, 1♀ ex *Artibeus lituratus*.

Identification

This species has narrow wings with four longitudinal veins, long hind legs, and a scutellum with two macrosetae (Guerrero, 1994b).

Remarks

Dick & Gettinger (2005) state that *Artibeus fimbriatus* and *Artibeus jamaicensis* are the primary hosts of *Megistopoda aranaea*. However, Stamper (2012) indicates that in Ecuador, it has been reported in association with several species of the family Phyllostomidae. In addition, in the study, it was possible to document the association with *Platyrrhinus umbratus* for the first time.

Megistopoda proxima (Seguy, 1926)

Figure 7B

Material examined

Esmeraldas • Quinindé, Rosa Zárate, Jaboncillo, Finca La Esperanza; 0°12’54.3”N, 79°35’54.9”W; 100 m a.s.l.; 09.IX.2021, 1♂ ex *Sturnira bakeri*.

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 25.XI.2021, 3♀ ex *Sturnira bakeri*; 26.XI.2021, 1♀ ex *Sturnira bakeri*; 26.XI.2021, 1♀ ex *Sturnira ludovici*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 22.VII.2017, 1♂ ex *Sturnira bakeri*; 25.VII.2017, 1♀ ex *Sturnira bakeri*; 27.VII.2017, 1♀ ex *Sturnira bakeri*.

Identification

Megistopoda proxima is distinguished by its broad wings with six longitudinal veins and the scutellum with four macrosetae (Guerrero, 1994b).

Remarks

Dick and Gettinger (2005) mention that *Sturnira lilium* is the main host of *Megistopoda proxima*. However, in Ecuador, it is also found in different species of the genus *Sturnira* (Stamper, 2012).

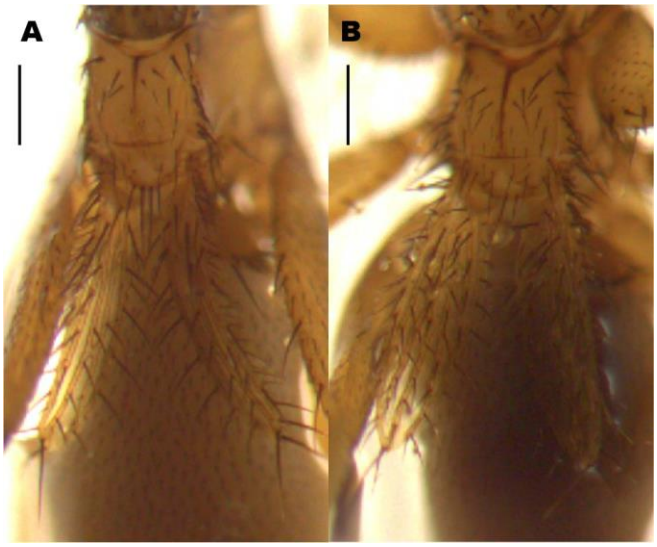


Figure 7. Wings and dorsal view of the thorax. A) *Megistopoda aranea*; B) *Megistopoda proxima*. Scale bars = 0.2 mm.

Genus *Aspidoptera* Coquillett, 1899

Aspidoptera phyllostomatis (Perty, 1833)

Figure 8A

Material examined

Manabí • Manta, San Lorenzo, Refugio de Vida Silvestre Marino Costera Pacoche; 1°04’00.91”S, 80°53’20.00”W; 118 m a.s.l.; 09.IX.2017, 2♂, 2♀ ex *Artibeus fraterculus*; 11.IX.2017, 1♀ ex *Artibeus fraterculus*.

Identification

Unlike *Aspidoptera falcata*, the mesepisternum of this species exhibits long setae on the dorsal side and shorter on the periphery. Likewise, the supra-anal plate of females has a short seta; in males, the postgonites are slightly curved (Guerrero, 1995b).

Remarks

Aspidoptera phyllostomatis is mainly found in *Artibeus jamaicensis* (Wenzel, 1976). However, in Ecuador, it has been reported in other species of the genus *Artibeus* (Stamper, 2012).

Aspidoptera falcata Wenzel, 1976

Figure 8B

Material examined

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 26.XI.2021, 1♂, 1♀ ex *Sturnira ludovici*.

Identification

In contrast to *Aspidoptera phyllostomatis*, this species has a more setose appearance and the setae on the dorsal surface of the mesepisternum are long. In addition, in females, the supra-anal plate includes six apical macrosetae and a short seta on each side of the anterior ones; on the other hand, males have very curved postgonites (Wenzel et al., 1966; Wenzel,1976).

Remarks

Although *Sturnira lilium* is the primary host of *Aspidoptera falcata* (Dick & Gettinger, 2005), most of the parasitized species in Ecuador belong to the genus *Sturnira* (Stamper, 2012).

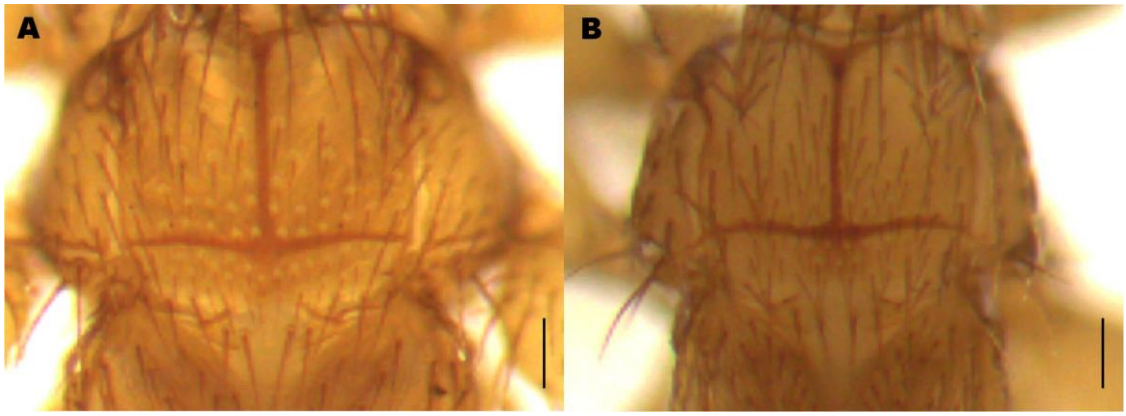


Figure 8. Dorsal view of the thorax. A) *Aspidoptera phyllostomatis*; B) *Aspidoptera falcata*. Scale bars = 0.3 mm.

Genus *Exastinion* Wenzel, 1966

Exastinion clovisi (Pessôa & Guimarães, 1936)

Figure 9

Material examined

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 19.XI.2021, 1♀ ex *Carollia castanea.*

Identification

This species is characterized by the presence of eight setae on the scutum, and a very setose area on sternum 2 that extends anteriorly to the middle. In addition, females have a group of five setae on the abdominal connexivum that are longer than the following ones (Wenzel, 1976).

Remarks

The present study is the first to document that *Exastinion clovisi* parasitizes *Carollia castanea*, and Stamper (2012) also evidenced its association with *Glossophaga soricina* in Ecuador. The characteristic host is known to be *Anoura geoffroyi* (Guerrero, 2019).



Figure 9. *Exastinion clovisi*. Scale bars = 1 mm.

Subfamily Streblinae Jobling, 1936

Genus *Strebla* Wiedemann, 1824

Strebla mirabilis (Waterhouse, 1879)

Figure 10A

Material examined

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 21.VII.2017, 1♂ ex *Trachops cirrhosus*; 26.VII.2017, 8♂, 12♀ ex *Trachops cirrhosus*.

Identification

Unlike other species, *Strebla mirabilis* has eyes with several facets, a pointed anterior end of the postvertex that forms an angle close to 90 degrees and, finally, all setae are strong. In addition,

the metatibia has two to three macrosetae; and on the mesonotum, between the transverse and pigmented suture, three rows of setae are located (Guerrero, 2019; Wenzel et al., 1966).

Remarks

Although *Strebla mirabilis* is commonly associated with *Trachops cirrhosus* (Wenzel, 1976), hosts in Ecuador include several species of the family Phyllostomidae (Stamper, 2012).

Strebla guajiro (García & Casal, 1965)

Figure 10B

Material examined

Esmeraldas • Quinindé, Rosa Zárate, Jaboncillo, Finca La Esperanza; 0°12’54.3”N, 79°35’54.9”W; 100 m a.s.l.; 09.IX.2021, 1♂ ex *Carollia brevicauda*. • Eloy Alfaro, La Tola, Finca Cocadilla; 1°11’29.2”N, 79°03’07.7”W; 5 m a.s.l.; 21.VIII.2017, 1♂ ex *Carollia perspicillata*. • Eloy Alfaro, La Tola, Centro de Interpretación Majagual; 1°10’23.0”N, 79°04’45.8”W; 11 m a.s.l.; 21.VIII.2017, 1♀ ex *Carollia perspicillata*. • Eloy Alfaro, Luis Vargas Torres, Playa de Oro; 0°52’33.0”N, 78°47’40.7”W; 113 m a.s.l.; 25.VIII.2017, 1♀ ex *Carollia perspicillata*.

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 25.XI.2021, 1♂, 1♀ ex *Carollia brevicauda*; 26.XI.2021, 1♀ ex *Carollia perspicillata*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 22.VII.2017, 5♂, 4♀ ex *Carollia brevicauda*.

Identification

The anterior end of the postvertex of *Strebla guajiro* is more rounded than in other species and forms an angle of fewer than 90 degrees. All its setae are strong, and two to three rows are found

between the transverse and pigmented suture, as well as two or three macrosetae on the metatibia (Guerrero, 1996; Wenzel et al., 1966).

Remarks

Strebla guajiro is mainly associated with *Carollia perspicillata* (Dick & Gettinger, 2005; Wenzel, 1976). In the case of Ecuador, it usually also parasitizes several species of the family Phyllostomidae, especially bats of the genus *Carollia* (Stamper, 2012; Tello, 2005).

Strebla hertigi Wenzel, 1966

Figure 10C

Material examined

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 23.XI.2021, 1♀ ex *Phyllostomus hastatus*; 27.XI.2021, 1♂ ex *Phyllostomus discolor*.

Identification

Strebla hertigi has a distinctive subquadrate postvertex, the anterior end of which forms an angle greater than 120 degrees; in addition, the internal setae of the occipital plates are short; there are three rows of setae located between the transverse and pigmented sutures on the mesonotum; finally, the metatibia has two to three macrosetae (Guerrero, 1996; Wenzel et al., 1966).

Remarks

Strebla hertigi is a characteristic parasite of *Phyllostomus discolor* (Wenzel, 1976). According to Stamper (2012), this species is associated with *Phyllostomus discolor* and *Phyllostomus hastatus* in Ecuador.

Strebla galindoi Wenzel, 1966

Figure 10D

Material examined

Esmeraldas • Eloy Alfaro, Luis Vargas Torres, Playa de Oro; 0°52’33.0”N, 78°47’40.7”W; 113 m a.s.l.; 25.VIII.2017, 19♂, 13♀ ex *Tonatia bakeri*.

Identification

It is possible to recognize this species by several characteristics: it has eight facets on the eyes; the anterior end of the postvertex forms an angle greater than 120 degrees; its setae are thin and elongated; before the pigmented suture on the mesonotum, a row of longer setae stands out; finally, it has three large setae on the metatibia (Guerrero, 1996).

Remarks

Tonatia bidens is the characteristic host of *Strebla galindoi* (Wenzel, 1976). In Ecuador, this species parasitizes those of the genus *Tonatia* (Stamper, 2012).

Strebla machadoi Wenzel, 1966

Figure 10E

Material examined

Santo Domingo de los Tsáchilas • Santo Domingo, Alluriquín, La Unión del Toachi; 0°19’14.2”S, 78°57’08.8”W; 811 m a.s.l.; 09.IX.2017, 2♂ ex *Micronycteris minuta*.

Identification

Strebla machadoi has eyes with a single facet, a postvertex with a pointed anterior end forming an angle of fewer than 45 degrees, and two dorsal rows containing six to eight setae longer than the rest on the metatibia (Guerrero, 1996; Wenzel et al., 1966).

Remarks

Mycronicteris minuta is the primary host of *Strebla machadoi* (Wenzel, 1976).

Strebla altmani Wenzel, 1966

Figure 10F

Material examined

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 19.IX.2021, 2♂, 1♀ ex *Lonchorhina aurita*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 25.VII.2017, 1♂, 1♀ ex *Lonchorhina aurita*.

Identification

This species is distinguished by the following characteristics: six facets are identified on the eyes; the anterior end of the postvertex is pointed and forms an angle close to 90 degrees; the internal setae of the occipital plates are very short and thin; between the transverse and pigmented suture of the mesonotum there are two to three rows of setae; finally, two of the setae of the metatibia are noticeably longer (Guerrero, 1996).

Remarks

Lonchorhina aurita is the characteristic host of *Strebla altmani* (Guerrero, 2019).

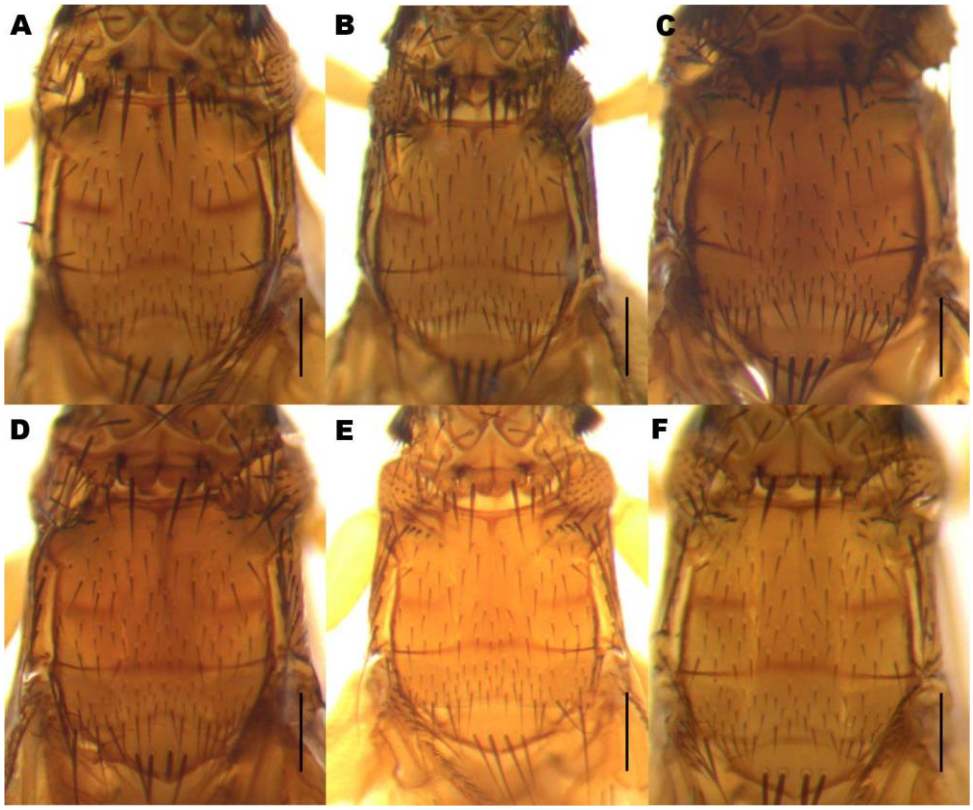


Figure 10. Dorsal view of the thorax, postvertex and occipital lobes. A) *Strebla mirabilis*; B) *Strebla guajiro*; C) *Strebla hertigi*; D) *Strebla galindoi*; E) *Strebla machadoi*; F) *Strebla altmani*. Scale bars: A, B, D = 0.5 mm; E, F = 0.3 mm; C = 0.6 mm.

Genus *Metalasmus* Coquillett, 1907

Metelasmus pseudopterus Coquillett, 1907

Figure 11

Material examined

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 23.IX.2021, 1♀ ex *Artibeus lituratus*.

Identification

According to Guerrero (2019), only one species of the genus *Metelasmus* has been determined so far. Its characteristics include the following: well-developed frontoclypeus; large postvertex, with triangular anterior margin and flattened posterior margin and two strong setae; it also has a hook-shaped postgena with a remiform seta; complete ctenidium; small wings with reduced venation; posterior tibiae with very small setae and, finally, setae that completely covering the dorsal connexivum (Guerrero, 2019; Jobling, 1936).

Remarks

Metelasmus pseudopterus was reported by Wenzel (1976) as a characteristic parasite of *Artibeus jamaicensis*. In Ecuador, it also parasitizes some species of *Artibeus* (Stamper, 2012).



Figure 11. *Metelasmus pseudopterus*. Scale bars = 3 mm.

Family Nycteribiidae Samouelle, 1819

Subfamily Nycteribiinae Samouelle, 1819

Genus *Basilia*. Miranda-Ribeiro, 1903

Basilia carteri Scott, 1936

Figure 12A

Material examined

Esmeraldas • Quinindé, Rosa Zárate, Jaboncillo, Finca La Esperanza; 0°12’54.3”N, 79°35’54.9”W; 100 m a.s.l.; 09.IX.2021, 1♂, 1♀ ex *Myotis nigricans*.

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 24.XI.2021, 2♂, 3♀ ex *Myotis albescens*.

Identification

Females of *Basilia carteri* are differentiated by tergite 1 having eight to nine long setae on the posterior margin, while tergite 2 has a subcodiform shape with very few disc-like setae. Conversely, males exhibit a sternite V with two asymmetrical rows of setae (Graciolli, 2004).

Remarks

Basilia carteri has been documented in association with *Myotis albescens*, *Myotis levis*, *Myotis nigricans*, *Myotis riparius,* and *Tadarida brasiliensis* (Autino et al., 2009).

Basilia ferrisi Schuurmans Stekhoven, 1931

Figure 12B

Material examined

Esmeraldas • Eloy Alfaro, La Tola, Finca Cocadilla; 1°11’29.2”N, 79°03’07.7”W; 5 m a.s.l.; 20.XII.2017, 1♂ ex *Glossophaga soricina*. • Eloy Alfaro, La Tola, Centro de Interpretación Majagual; 1°10’23.0”N, 79°04’45.8”W; 11 m a.s.l.; 23.VIII.2017, 1♀ ex *Myotis nigricans*. • Eloy Alfaro, Luis Vargas Torres, Playa de Oro; 0°52’33.0”N, 78°47’40.7”W; 113 m a.s.l.; 23. VIII.2017, 1♀ ex *Myotis riparius*; 25.VIII.2017, 8♂, 26♀ ex *Myotis riparius*.

Manabí • El Carmen, El Carmen, Comunidad El Zapote; 0°22’31.4”S, 79°36’16.3”W; 200 m a.s.l.; 26.XI.2021, 2♂, 1♀ ex *Myotis riparius*.

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 20.VII.2017, 6♂, 15♀ ex *Myotis diminutus*; 24.VII.2017, 5♂, 6♀ ex *Myotis diminutus*; 27.VII.2017, 1♂, 7♀ ex *Myotis diminutus*; 27.VII.2017, 3♂, 5♀ ex *Myotis nigricans*.

Identification

Tergite 1 of females is very long in this species and has six to nine bristles on the posterior margin. In contrast, the sternite V of males is slightly rounded and with a small notch in the middle (Guimarães & D'Andretta, 1956; Peterson, 1959).

Remarks

Basilia ferrisi is associated with *Carollia brevicauda*, *Histiotus montanus*, *Myotis nigricans,* and *Myotis keaysi* (Raigosa et al., 2020); however, in Ecuador, it has been reported to parasitize bats of the genus *Myotis* and *Platyrrhinus matapalensis* (Stamper, 2012). In addition, in this study, we report for the first time the association with *Myotis diminutus* and *Glossophaga soricina*.

Basilia sp. (Group *ferruginea*)

Figure 12C

Material examined

Los Ríos • Buena Fe, Patricia Pilar, Centro Científico Río Palenque; 0°35’19.8”S, 79°21’39.8”W; 150 m a.s.l.; 21.VII.2017, 2♀ ex *Myotis riparius*.

Remarks

It was not possible to identify its species; however, the bilobed tergite 2 is a characteristic of the *ferruginea* group (Theodor, 1967).



Figure 12. Dorsal view of the abdomen. A) *Basilia carteri*; B) *Basilia ferrisi*; C) *Basilia* sp. Scale bars: A = 0.7 mm; B = 0.9 mm; C = 1 mm.

DISCUSSION

Ecuador, known for its remarkable biodiversity (Mittermeier et al., 2011), lacks comprehensive information about specific taxonomic groups such as the parasitic bat flies from the families Streblidae and Nycteribiidae. Most of the known records come from localities in Amazonia, and only five species have been documented in the few studies conducted on the Coast (Camacho et al., 2014; Correa et al., 2019; Guerrero, 1997; Guimarães & D'Andretta, 1956; Liu et al., 2020; Stamper, 2012; Tello, 2005). This study aims to address this knowledge gap by providing valuable insights. Our findings contribute significantly to the understanding of these groups, as we have documented new records for Ecuador, four from the family Streblidae (*Trichobius flagellatus*, *Paratrichobius dunni*, *Strebla machadoi*, *Strebla altmani*) and one from the family

Nycteribiidae (*Basilia carteri*), bringing the species richness to 59. In addition, their geographic range has expanded, as they had previously only been documented in countries such as Argentina, Panama, Mexico and Venezuela (Cuxim-Koyoc et al., 2018; Guerrero, 2019; Hiller et al., 2021; Oscherov et al., 2012). Notably, in the coastal region, the species count has shown a substantial increase from 5 to 29.

Stamper (2012), documented 42 species of bat flies in Ecuador, 19 of which we report in this study. However, Stamper's study provided only general locality descriptions without additional information that could establish a direct association between each specimen and its collection site. This lack of specific data has raised concerns regarding the accurate distribution patterns of these species. Our research considers these findings as confirmed records specifically within the Ecuadorian coastal region, offering more precise insights into their distribution. *Trichobius joblingi*, *Speiseria ambigua*, and *Strebla guajiro* had already been documented in Morona Santiago, Orellana, Pastaza, Cotopaxi, Pichincha, Esmeraldas, and Santo Domingo de los Tsáchilas (Tello, 2005). This study extends the records to Manabí and Los Ríos.

The most abundant fly parasite was *Trichobius joblingi*, and some of the factors influencing these results are probably due to the fact that it is a generalist species (Barbier & Bernard, 2017; Tlapaya-Romero et al., 2015), which has been reported parasitizing several bat species (de Groot et al., 2020; Santos et al., 2016; Soares et al., 2017). Additionally, previous research mentions that parasite abundance is related to host abundance (Ascuntar-Osnas et al., 2020; Cuxim-Koyoc et al., 2015). *Carollia perspicillata* is the main host (Wenzel, 1976), and in the present investigation, it is documented among the most abundant bat species, along with

Carollia brevicauda and *Carollia castanea*, all widely distributed on the Ecuadorian Coast (Tirira, 2017).

Bat flies are highly host-specific, that is, they parasitize a single bat species (Dick & Gettinger, 2005; Wenzel et al., 1966; Wenzel, 1976;). However, we report some novel interactions, such as the association of one bat fly species with multiple host species, as well as the presence of several bat fly species on the same host, which have also been documented in previous research (Barbier & Graciolli, 2016; da Silva et al., 2023; Durán et al., 2017; França et al., 2013; Lira-Olguin et al., 2020; Menezes et al., 2021). Factors such as sample contamination, transfers due to disturbance at the time of capture (Dick, 2007; Fritz, 1983) and accidental transfers when bat hosts share roosts with other species (Aguiar & Antonini, 2016; Barbier & Bernard, 2017; Hernández-Martínez et al., 2019; ter Hofstede et al., 2004), could explain these findings. It is important to clarify that the aim of the present study did not include at any time to assess specificity or factors influencing host-parasite associations. Therefore, these aspects were not explored to avoid misinterpretations, but relevant association findings that may be the subject of future research were documented.

It is important to point out that during the taxonomic identification process there were certain limitations since it was not possible to determine the species level in three individuals, due to taxonomical publications with ambiguous descriptions and outdated illustrations. The taxonomic keys used for the Streblidae family are the result of very complete works that include the description of a large number of species. On the other hand, the information on the family Nycteribiidae is scattered; in fact, most of the available works describe mainly females and

relegate the identification of males to the background. Several of these problems coincide with those described by Lira-Olguin et al. (2020) and Trujillo-Pahua & Ibáñez-Bernal (2019, 2020), demonstrating the need for further research on this taxon.

According to studies by Barbier & Bernard (2017) and Dick & Gettinger (2005), the great variety of bat fly species is correlated with host diversity. Under this premise, we consider that the current species richness of the families Streblidae and Nycteribiidae is still underestimated since 179 species of bats have been reported in Ecuador (Tirira et al., 2022), 120 of them in the Coast (Brito et al., 2023; Carrera et al., 2010). Along the same lines, in countries of the region with a similar number of bat species, there are even twice as many records of flies that parasitize them, in contrast to those documented at the national level. A notable example is Brazil, which has 181 species of bats (Garbino et al., 2022) and 119 species of the family Streblidae and Nycteribiidae (Graciolli & Hrycyna, 2023; Hrycyna et al., 2019); it also ranks among the nations with the highest number of publications on the taxonomic group under discussion (Urbieta et al., 2022). This shows that there are several species to be identified and, therefore, it is relevant to propose more studies such as the one carried out throughout this research.

The natural history collections reflect the planet's biota over time (Bradley et al., 2014). Therefore, the results of this research, obtained based on museum specimens and associated data, provide valuable information on this taxonomic group in the country, which evidences the importance of the collections and the need to continue collecting more specimens as possible.

Future research should include the analysis of specimens in other regions and from different families, as well as the use of molecular techniques that facilitate species identification and validate the findings of host-parasite interaction reported in this study. Undoubtedly, works such as this one contributes to expanding the knowledge of the diversity of parasitic bat flies in the country and consolidate the basis for future research to address ecological and evolutionary questions due to the close relationship of bat flies with their hosts (Brown et al., 2022; Hiller et al., 2020). They are also important in the public health area since bat flies are reservoirs of viruses and bacteria and could act as vectors of zoonotic pathogens (Lee et al., 2021; Morse et al., 2012; Ramirez-Martinez et al., 2021).

CONCLUSION

The study contributed to increasing the knowledge of the diversity of parasitic bat flies as well as broadening their distribution. The document also consolidates baseline information on host-parasite associations and establishes the first collection with the largest number of identified bat fly species of the Streblidae and Nycteribiidae families in the Ecuadorian coastal region.

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Conflict of Interest Statement

The authors declare that they have no conflicts of interest.

Author contributions

KPT: design of the research plan, analysis of the information, taking photographs and drafting of the manuscript.

KPT and APC: identification of ectoparasites, peer review and elaboration of the database.

MAC: design of the research plan, logistical support, and manuscript review.

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