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A New Species of *Hershkovitzia* (Diptera: Nycteribiidae) from Maranhão, Brazil

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Abstract: *Hershkovitzia* Guimarães & D'Andretta, 1956 belongs to Nycteribiidae, composed of hematophagous species exclusively ectoparasites of bats. The new species was collected from the bat *Thyroptera devivoi* Gregorin, Gonçalves, Lim & Engstrom, 2006 (Chiroptera: Thyropteridae) from Barreirinhas in Maranhão State, Brazil. Herein, we proposed schematic drawings of the abdomen, legs and head. We also proposed an identification key to species of *Hershkovitzia*.

Key words: bat fly, taxonomy, *Thyroptera*, Chiroptera.

INTRODUCTION

Nycteribiidae (Diptera: Hippoboscoidea) is composed of hematophagous flies that are exclusive ectoparasites of bats (Peterson & Wenzel 1987, Graciolli 2010). The family is divided into three subfamilies, including Nycteribiinae, Cyclopodiinae and Archinycteribiinae, with a total of 11 genera and 276 species (Graciolli 2010, Graciolli et al. 2016, Graciolli & Dick 2018). Most genera and species are found in the Old World with nine genera and 223 species, including 66 species reported to *Basilia*. In the New World, only two genera of the subfamily Nycteribiinae are known. *Basilia* Miranda-Ribeiro, 1903, currently contains 116 described species, of which 49 are restricted to the New World. On the other hand, *Hershkovitzia* Guimarães & D'Andretta, 1956, contains four described species (*H. cabala* Peterson & Lacey, 1985; *H. coeca* Theodor, 1967; *H. inaequalis* Theodor, 1967 and *H. primitiva* Guimarães & D'Andretta, 1956), all restricted to the Neotropical Region (Graciolli et al. 2007, 2016, Graciolli & Dick 2018).

Hershkovitzia is morphologically characterized as follows: head laterally compressed, pigmented eyes formed by a single facet, thin pedipalps, and presence of thoracic ctenidium. The abdomen of females has seven dorsal sclerotined plates (syntergites 1+2 and five tergites), seven ventral ones (sternite 1+2 and five sternites), and one genital plate. Males present six dorsal plates (syntergite 1+2 and four tergites), five ventrals (sternite 1+2 and three sternites), a genital plate and phallobase divided longitudinally in two (Guimarães & D'Andretta 1956). Guimarães & D'Andretta proposed *Hershkovitzia* in 1956 in a synopsis of American species of Nycteribiidae. The type species was designated by monotype (*H. primitiva*). Later, three more species were described: *H. coeca*, *H. inaequalis* and *H. cabala*.

The *Hershkovitzia* species parasitize bats of the genus *Thyroptera* Spix, 1823 (Thyropteridae). Currently, the valid species are as follows: *T. tricolor* Spix, 1823; *T. lavali* Pine, 1993; *T. discifera* Lichtenstein & Peters, 1855; *T. devivoi* Gregorin, Gonçalves, Lim & Engstrom, 2006 and *T. wynneae* Velazco, Gregorin, Voss & Simmons,

2014. These species are endemic to Neotropical lowland forest (Solari et al. 2004), and they can be morphologically characterized by suction disk on the feet and the base of the claws on their thumbs (Bezerra et al. 2005). Individuals are usually found in palm leaves, young leaves of *Heliconia* L. and *Calathea* G. Mey (Vonhof & Fenton 2004), dead leaves of *Cecropia* Loefl., and in caves used as daytime shelters. (Esbérard et al. 2007).

In this work, a new species of the genus *Hershkovitzia* is described from the northeast coast of Brazil. Along with the species description, we also provide illustrations and an identification key.

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MATERIALS AND METHODS

Adult flies were collected in Tabocas, Barreirinhas municipality, Maranhão (2º58'38.57"S/43º10'09.92"W and 2º59'56.92"S/43º07'55.22"). The host bat specimens were captured in mist nets and the flies removed with tweezers. The bat flies were preserved in 70% ethanol. Morphological terminology follows Guimarães & D'Andretta (1956) and Graciolli (2010). The plate numbers were used in Arabic and the divisions of the legs in Roman, as proposed by Theodor (1967).

The proposed drawings serve as a likeness only for the purpose of species identification. The regions chosen for the drawings are important for species diagnosis: abdomen of female and male (ventral and dorsal), head (dorsal and lateral) and tibia II. The drawings were done freehand in graphite on graph paper with the assistance of a stereomicroscope. The finalization of the drawings was in made on vegetal paper and nanquim and later scanned with an HP Deskjet 2600. Subsequently, the drawings were vectored and edited, using Corel DRAW 2018. Drawings were saved in 1200 dpi quality.

RESULTS

Hershkovitzia mariae Hrycyna, dos Santos, Rebêlo & Graciolli sp. nov.

Hershkovitzia sp.: Santos et al. 2013: 209 (citation). Barbier and Bernard 2017: 4 (citation), 5 (citation and distribution), 7 (citation and ecorregion), 9 (citation). Barbier et al. 2017: 397 (citation).

Zoobank Life Science Identifier (LSID) - urn:lsid:zoobank.org:act:9769A50F-6862-4EDF-8BD9-E111F42535F5

Type-series. Holotype ♀ - *Hershkovitzia mariae* sp. nov. (Gabriela Hrycyna det. III.2018) /Brazil, MA, Barreirinhas, Tabocas, 2º58'38.57''S/43º10'09.92"W, 31 January 2014, host *Thyroptera devivoi* [ZUFMS]. Paratype ♂ - *Hershkovitzia mariae* sp. nov. (Gabriela Hrycyna det. III.2018) /Brazil, MA, Barreirinhas, Tabocas, 2º59'56.92"S/43º07'55.22"W, 21 June 2015, host *Thyroptera devivoi* [ZUFMS].

Type locality: Tabocas, Barrerinhas, state of Maranhão, Brazil.

Type-host: *Thyroptera devivoi* Gregorin, Gonçalves, Lim & Engstrom, 2006.

Depository: Holotype and paratype: Coleção Zoológica de Referência da Universidade Federal do Mato Grosso do Sul, Campo Grande, Brazil.

Etymology: Specific epithet after Dr. Maria Aparecida Vulcano D'Andretta, for her contribution to the genus.

Diagnosis: Each eye with three setae, one seta located in the region between the eye and the others located before the eye. Gena with two setae; post-gena with two short setae. Three setae located anterior to meso-notopleural sutures. Female syntergites 1+2 and tergites 3 and

7 made up a whole plate; tergite 5 and 6 divided into two plates each. Sternite 1+2 consisting of a whole plate; sternites 3, 4, 5 and 6 divided into two plates each. Sternite 7 subtriangular with lateral and median portions with depressions, strongly pigmented and without setae. Male presents all tergites and sternites formed by a whole plate.

Descripton: Head. Dorsal view – eyes with one facet; one seta medial to and near hind margin of each eye, and two setae directly in front of each eye, more evident in male (Fig. 1a). Gena with three setae, two short and one long in the middle. Post-gena with two setae (Fig. 1b). Ventral view – palps on the distal and proximal distend, with 10 setae along palps length, and four longer setae at the distal margin. Thecae wider than long.

Thorax: Dorsal view – Meso-notopleural suture with three setae. Thoracic ctenidium with 10 spines. Thoracic spiracle piriform shape. Ventral view – sternal plate with setae throughout length. Angle between oblique suture greater than 90º. Coxa I as long as wide, flattened, triangular, and without setae on anterior part. Femur I longer than wide, flattened, rectangular, ring visible and with setae throughout length. Tibia I flattened, cylindrical, and with four ventro-distal rows of setae on apical portion. Basitarsus the same size as the next three tarsi. Coxa II short, triangular and with short setae. Femur II and III longer than wide, flattened, rectangular, with setae throughout length. Visible ring, with a row of setae on anterior margin. Tibia II longer than wide, cylindrical, with setae throughout length and distal posterior margin with three rows of setae on apical portion (Fig. 2). Coxa III as wide as long, triangular, with setae throughout length. Tibia III cylindrical, with five rows of setae on apical portion.

Female. Abdomen: Tergites and sternites with numerous setae throughout length. All plates with distal margin and row of setae of unequal length. Dorsal view – Syntergite 1+2, tergites 3 and 4 entire. Tergite 5 and 6 with two

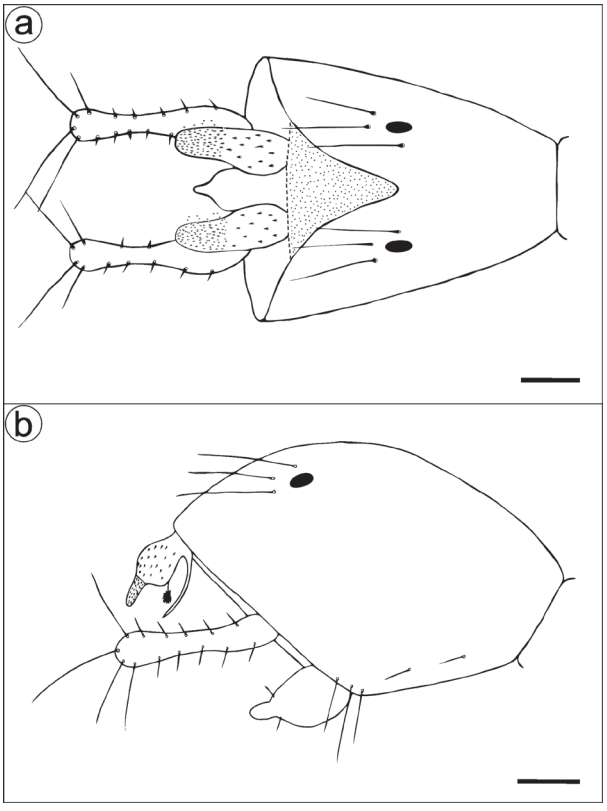

Figure 1. a) Head, female (Holotype), dorsal view, *Hershkovitzia mariae* sp. nov. (Scale bar = 11.7 mm approx.). b) Head, female (Holotype), lateral view, *Hershkovitzia mariae* sp. nov. (Scale bar = 11.7 mm approx.).

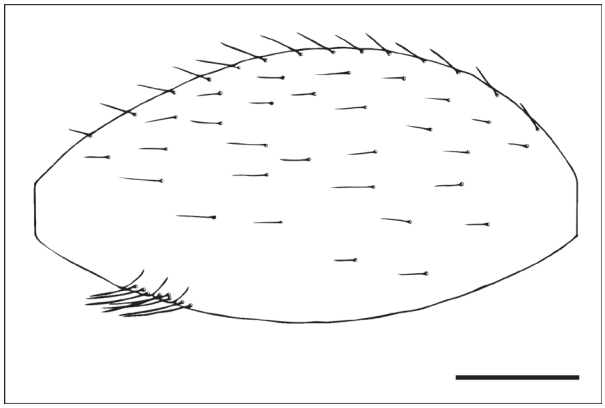

Figure 2. Tibia II, lateral view, *Hershkovitzia mariae* sp. nov. (Scale bar = 1 mm approx.).

plates each. Tergite 7 short and with four setae along the plate. Tergite 7 with two rectangular side lobes and 4-5 setae in each lateral prominence (Fig. 3a). Ventral view – Sternite 1+2 rectangular with round margin. Ctenidium with 35 spines. Sternites 3, 4 and 5 with two plates each. Sternites 6 with two subtriangular plates. Sternite 7 subtriangular, with posterior margin almost straight and depressions on lateral and median portion of plate (Fig. 3b).

Male. Abdomen: Tergites and sternites with numerous setae throughout length. Dorsal view – All plates with distal margin with row of setae of unequal length. Syntergite 1+2 long and triangular. Tergite 3 to 6 entire. Microtrichia on anal plate and setae only on posterior margin (Fig. 4a). Ventral view - Sternite 1+2, ctenidium with 50 spines, covers the entire back margin of the plate. Sternite 3 to 5 as whole plate. Sternite 5 with concavity on median posterior margin and with round lateral margins. Lateral margin with a set of setae more sclerotized than the other setae on lateral abdomen (Fig. 4b).

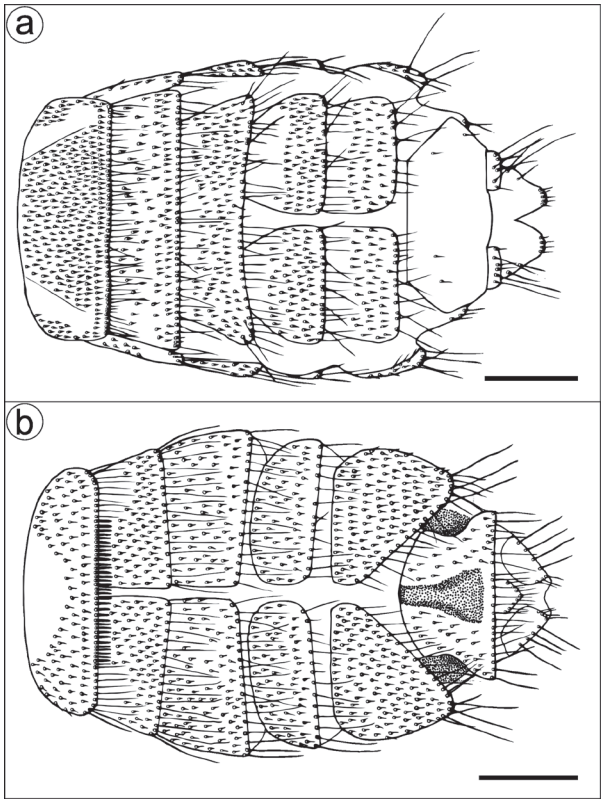

Figure 3. a) Abdomen, female (Holotype), dorsal view, *Hershkovitzia mariae* sp. nov. (Scale bar = 0.5 mm approx.). b) Abdomen, female (Holotype), ventral view, *Hershkovitzia mariae* sp. nov. (Scale bar = 0.5 mm approx.).

Identification Key to species of *Hershkovitzia* Guimarães & D'Andretta

Females

1. - Row of abdominal ctenidium covers the entire posterior margin of sternite 1+2. Tibia II with two rows in the median portion. Right angle between oblique sutures.....2

- Row of abdominal ctenidium covers one third of the posterior margin of sternite 1+2. Tibia II with three rows in the apical portion. Obtuse angle between oblique sutures.....4

2. - Absent eyes. Sternite 7 with hexagonal shape and median region without setae. Meso-notopleural suture with two setae on each side. Gena with two setae..... ***Hershkovitzia coeca* Theodor.**

- Present eyes. Sternite 7 with rounded posterior margin. Meso-notopleural suture with more than two associated setae.....3

3. - Each eye with two associated setae, one located anteriorly and one posteriorly. Meso-notopleural suture with three associated setae. Whole tergites. Post-gena without setae. Gena with two setae.....***Hershkovitzia cabala* Peterson & Lacey.**

- Each eye with two associated setae, both of which are located anterior to the eyes. Meso-notopleural suture with three associated setae. Tergite 6 divided. Post-gena with three short setae. Gena with three setae.....***Hershkovitzia primitiva* Guimarães & D'Andretta.**

4. - Each eye with four associated setae, all located anterior to the eyes. Meso-notopleural

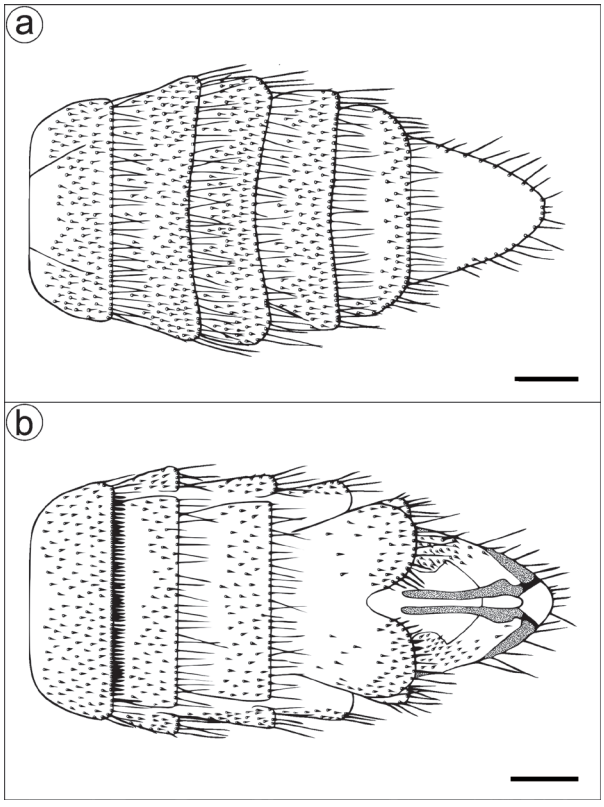

Figure 4. a) Abdomen, male (Paratype), dorsal view, *Hershkovitzia mariae* sp. nov. (Scale bar = 0.2 mm approx.). b) Abdomen, male (Paratype), ventral view, *Hershkovitzia mariae* sp. nov. (Scale bar = 0.2 mm approx.).

suture with four associated setae. Tergites 4, 5 and 6 divided. Sternites 3, 4, 5 and 6 divided. Sternite 7 subtriangular with the posterior margin almost straight and the median portion of the plate showing depressions. Post-gena with five short setae. Gena with six setae..... ***Hershkovitzia inaequalis* Theodor.**

- Each eye with three associated setae, two anterior arrows and one between the eyes. Tergites 5 and 6 divided. Sternites 3, 4, 5 and 6 divided. Meso-notopleural suture with three associated setae. Post-gena with two setae. Gena with two setae.....***Hershkovitzia mariae* sp. nov.**

Male

1. – Row of abdominal ctenidium covers all posterior margin of sternite 1+2. Meso-notopleural suture with three associated setae.....2

- Row of abdominal ctenidium covers one third of the posterior margin of sternite 1+2. Meso-notopleural suture with two or four associated setae.....3

2. - Each eye with two associated setae, all located anterior to the eye. 14 thoracic ctenidium. Post-gena with three short setae. Gena with three setae.....***Hershkovitzia primitiva* Guimarães & D'Andretta.**

- Each eye with three associated setae, two anterior setae and one seta between the eyes. 10 thoracic ctenidium. Post-gena with two setae. Gena with two.....***Hershkovitzia mariae* sp. nov.**

3. – Each eye with four associated setae, all located anteriorly. Four setae in meso-notopleural suture. Ten thoracic ctenidium. Six setae in the gena. Post-gena with five short setae..... ***Hershkovitzia inaequalis* Theodor.**

4. - Each eye with two selected setae, one seta located in the anterior region and one in the posterior region. Meso-notopleural suture with three associated setae. Eleven thoracic ctenidium. Post-gena with 5 short setae. Gena with two setae.....***Hershkovitzia cabala* Peterson & Lacey.**

DISCUSSION

As previously noted in the key, *Hershkovitzia* females can be divided into two groups. The first group is characterized by having a row of abdominal ctenidium covering the entire posterior margin of sternite 1+2, in addition to tibia II with two rows in the median portion.

This group is composed of *H. primitiva*, *H. coeca* and *H. cabala*. *Hershkovitzia coeca* differs from the other two species by the absence of eyes. In addition to other characters highlighted in the key, *H. cabala* differs by having all tergites composed of one plate, and *H. primitiva* differs by having tergite 6 divided into two plates.

Hershkovitzia inaequalis and *Hershkovitzia mariae* sp. nov compose the second group. This group is characterized by a row of ctenidium in sternite 1 + 2 covering only one third of the posterior margin, apart from tibia II with three rows in the apical portion. *H. inaequalis* can be differentiated by having tergite 4 and sternites 3, 4, 5 and 6 divided into plates. On the other hand, tergite 4 of *Hershkovitzia mariae* sp. nov. is composed of a single plate. In *H. inaequalis*, the row of ctenidium has 45 thin spines, and in *Hershkovitzia mariae* sp. nov., we observe 35 spines, thick and dense.

Hershkovitzia inaequalis and *Hershkovitzia mariae* sp. nov. have characteristics that can be seen in males and females. The head in *H. inaequalis* features four setae in each eye, while *Hershkovitzia mariae* sp. nov. has three setae in each eye. In *H. inaequalis*, the setae are located anterior to the eye, while in *Hershkovitzia mariae* sp. nov., two setae are located anterior to the eye, and the other seta is located between the eyes. (Fig 1a).

Hershkovitzia males are similar to *Basilia* males (Guimarães & D'Andretta 1956). However, they have very subtle characteristics, making their characterization and differentiation difficult. The male of *Hershkovitzia mariae* sp. nov., as with the other species of the genus, has inconsistent features with respect to the abdomen. The head, thorax and legs are similar to those of the female.

Hershkovitzia mariae sp. nov. is known exclusively for parasitizing *Thyroptera devivoi* and represents the first record of parasitism on this species. Other species of *Hershkovitzia* are already known to *T. discifera* (*H. primitiva*), *T. tricolor* (*H. cabala*), and *T. lavali* (*H. inaequalis*) (Guimarães & D'Andretta 1956, Theodor 1967, Peterson & Lacey 1985, Graciolli et al. 2007, Graciolli 2010).

Hershkovitzia mariae sp. nov. is known only to Barrerinhas, state of Maranhão. This region represents the northern limit of the Cerrado in Brazil (Santos et al. 2013). This species is the first registered to the genus *Hershkovitzia* for the Cerrado biome (tropical savannah), while the other species occur in the Amazon rainforest (Graciolli et al. 2007, Graciolli & Dick 2018).

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