

# **Mitrapsylla rupestris sp. nov., a psyllid (Hemiptera, Psylloidea) associated with Poitretia bahiana (Fabaceae) endemic to the Espinhaço mountain range (Brazil, Bahía)**

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Objektyp: **Article**

Zeitschrift: **Alpine entomology : the journal of the Swiss Entomological Society**

Band (Jahr): **5 (2021)**

PDF erstellt am: **30.06.2024**

Persistenter Link: <https://doi.org/10.5169/seals-966043>

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# *Mitrapsylla rupestris* sp. nov., a psyllid (Hemiptera, Psylloidea) associated with *Poiretia bahiana* (Fabaceae) endemic to the Espinhaço mountain range (Brazil, Bahia)

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<http://zoobank.org/F018B488-5FE5-4948-A28F-56E958920321>

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Academic editor: Hannes Baur ♦ Received 24 June 2021 ♦ Accepted 3 August 2021 ♦ Published 1 September 2021

## Abstract

*Mitrapsylla rupestris* sp. nov., associated with *Poiretia bahiana* C. Mueller (Fabaceae, Faboideae, Dalbergieae), is described, diagnosed and illustrated. The new species is morphologically similar to *M. aeschynomenis*, *M. aurantia*, *M. cubana* and *M. didyma* from which it differs in details of the terminalia and the host plant. *Poiretia* constitutes a previously unknown psyllid host. As its host, *Mitrapsylla rupestris* sp. nov. is probably endemic to rock habitats of the Espinhaço Range in eastern Brazil. These rock habitats display a high species diversity but are seriously threatened by human activities. More research on these habitats is urgently needed to design efficient conservation strategies.

## Key Words

Sternorrhyncha, Psyllidae, Ciriaceiminae, systematics, phytophagy, distribution

## Introduction

The Serra do Espinhaço, a mountain range in eastern Brazil (states of Bahia and Minas Gerais), is famous for its high floristic diversity and endemism. Both, species richness and narrow endemism, are mostly concentrated in the “campos rupestres” (= rock fields, rupestrian fields) (Rapini et al. 2008). The disjunct distribution of the rock fields along the Espinhaço Range with extreme environmental conditions and the heterogeneity of habitats are responsible for this huge plant diversity (Ribeiro et al. 2014). The Espinhaço Range harbours around 10% of the angiosperm species known from Brazil even though it covers less than 1.5% of the Brazilian territory (Ribeiro et al. 2014), and up to a third of its plant species are endemic (Giulietti et al. 1987; Carneiro et al. 2009). Examples of taxa that are concentrated in rock fields have been reported from the Apocynaceae, Eriocaulaceae, Melastomataceae and Orchidaceae (Ribeiro et al. 2014).

Much less is known about host specific, phytophagous insects from the Espinhaço Range. The study of Carneiro et al. (2009), showing that in this mountain range, rock fields bear the highest species richness of gall-inducing insects, suggests that the entomofauna of the Espinhaço Range may be similarly diverse and rich in endemics as the flora.

Psylloidea or jumping plant lice are highly host specific phloem-feeders. The world fauna comprises just over 4000 described species but the fauna of the tropics is generally poorly known, and many more species can be expected. From Brazil 160 species have been reported (Burckhardt and Queiroz 2021) but there may be as many as 1000 species (Burckhardt and Queiroz 2012). A recent survey of the psyllid fauna of the Serra do Espinhaço produced many undescribed species, among them also five species from “campos rupestres”. Here we describe one of them, *Mitrapsylla rupestris* sp. nov., associated with *Poiretia bahiana* C. Mueller (Fabaceae, Faboideae,

Dalbergieae), a species that is endemic to rocky habitats in the Espinhaço Range (Müller 1986). *Mitrapsylla* constitutes a neotropical genus of around 50 described species whose Brazilian members were recently revised (Rendón-Mera et al. 2020).

## Material and methods

Material is deposited in the Naturhistorisches Museum, Basel, Switzerland (NHMB) and the Coleção Entomológica Padre Jesus Santiago Moure, Centro Politécnico, Universidade Federal do Paraná, Curitiba, PR, Brazil (UFPR). The morphological terminology follows mostly Halbert and Burckhardt (2020) and Rendón-Mera et al. (2020). Measurements were taken as follows: adult body length from specimens preserved in 70% ethanol, measuring the distance between fore margin of head and tip of forewings when folded over body; the other measurements were taken from slide-mounted specimens. The measurements and ratios are given as range. For the identification of specimens, we used the key of Rendón-Mera et al. (2020) and the psyllid collection of the NHMB. The nomenclature and classification of Psylloidea follows Burckhardt and Queiroz (2021), that of the plants accords with the World Flora Online (2021).

## Results

### Taxonomy

#### *Mitrapsylla* Crawford

**Notes.** With currently 51 described species, the neotropical *Mitrapsylla* constitutes the largest genus of Ciriacreminae (Psyllidae). It occurs from the southern United States in the north to northern Argentina in the south with 40 species reported from Brazil. The genus was reviewed by Rendón-Mera et al. (2020) who provided descriptions of the genus and the Brazilian species, an identification key to males of the Brazilian species and a list of host plants. These belong to the subfamilies Caesalpinioideae, Detarioideae and Faboideae (Fabaceae). The genus is morphologically homogeneous and differences between species are often small.

#### *Mitrapsylla rupestris* sp. nov.

<http://zoobank.org/2214CFA7-2BDB-4BD8-835B-A39FB85D548D>

Figs 4–21, 23

**Type locality.** Brazil, Bahía, Palmeiras, Morro do Pai Inácio, 12.4572°S, 41.4727°W, 1110 m.

**Type material.** *Holotype*. Male. BRAZIL: Bahía, Palmeiras, Morro do Pai Inácio, 12.4572°S, 41.4727°W, 1110 m, 23.iv.2021, D. Burckhardt & D.L. Queiroz #424(1) // *Poiretia bahiana* Fabaceae, rock vegetation //

*Mitrapsylla rupestris* sp. nov., holotype, det. D. Burckhardt, 2021 // UFPR, dry.

**Paratypes.** BRAZIL, 5 males, 6 females, Bahía, same data as holotype (NHMB, UFPR, dry, slide, ethanol 70%, NMB-PSYLL0007048–NMB-PSYLL0007055).

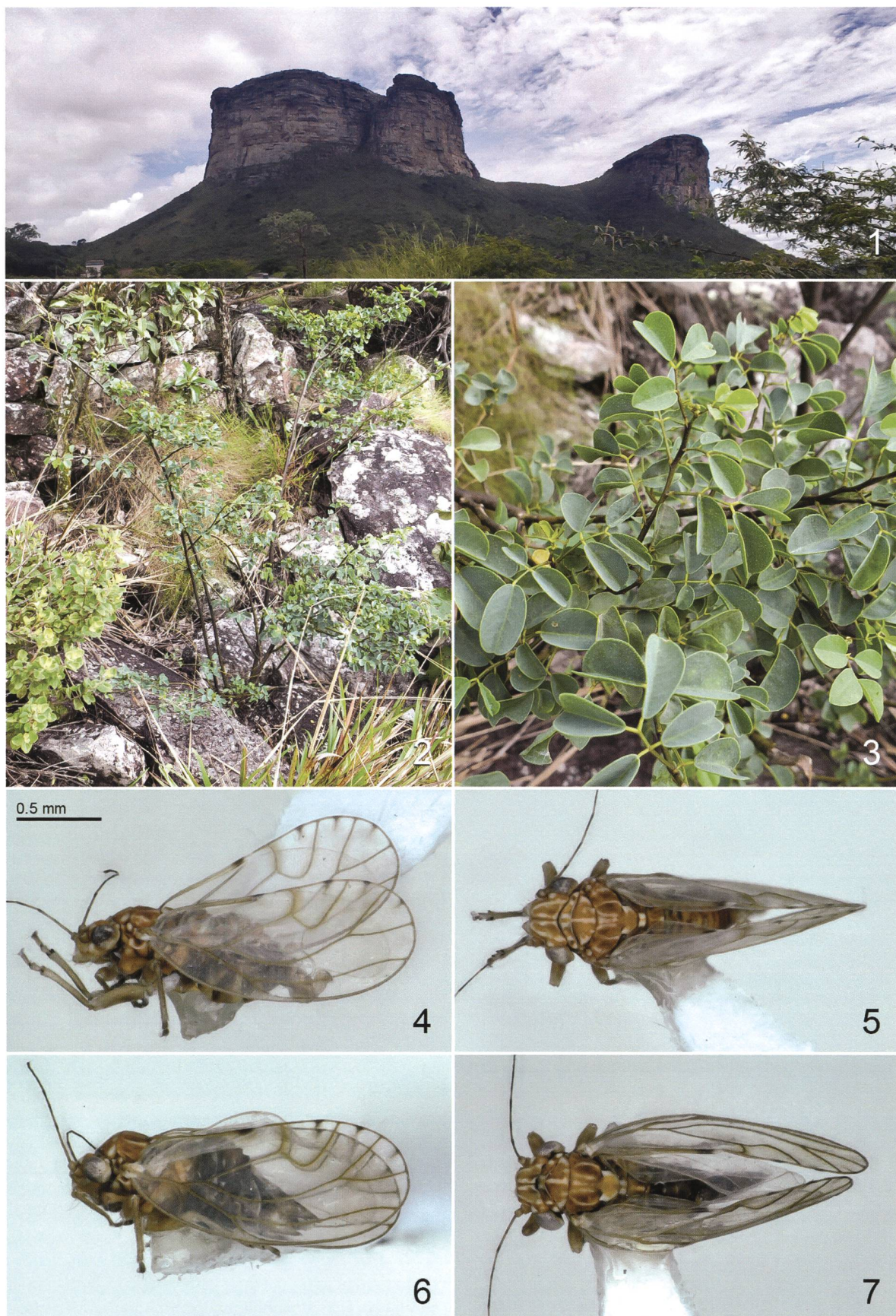
**Material not included in type series.** BRAZIL, 4 first, 2 second instar immatures, Bahía, same data as holotype (NHMB, ethanol 70%, NMB-PSYLL0007056).

**Diagnosis.** Adult head and thorax with pattern consisting of fine whitish lines and dots. Genal processes irregularly conical, subacute apically, 0.5–0.7 times as long as vertex along midline. Forewing with surface spinules usually present in all cells but much reduced, present in cell c+sc at the apex, in  $r_1$  along apical margin, in  $r_2$  in apical half of cell, in  $m_1$  in apical third or half, in  $m_2$  in basal half and near apex of cell, in  $cu_1$  almost completely reduced, in cell  $cu_2$  covering most of the cell but leaving broad spinule-free stripes along the veins; radular spinules present in cells  $m_1$ ,  $m_2$ ,  $cu_1$  and sometimes in  $r_2$ . Paramere, in profile, narrow, clavate; sclerotised ridge apically, more or less in the middle, in dorsal view bearing two small teeth. Distal segment of aedeagus complex, with unipartite dorsal lobe. Female proctiger, in profile, with dorsal outline weakly indented adjacent to circumanal ring, in apical half almost straight or weakly convex; apex narrowly rounded.

**Description.** Adult (Figs 4–7). Colouration. Orange to brown. Head and thorax with pattern consisting of fine whitish lines and dots (Figs 5, 7, 8). Ocelli orange, eyes grey. Antennal segments 3–7 yellow at base, dark brown at apex, dark portion becoming longer from proximal to distal segment; segments 7–10 dark brown. Head, clypeus and thorax yellow in ventral view. Thoracic pleura irregularly brown with dark margins of sclerites (Figs 4, 6). Legs yellow or brown, tarsi greyish brown. Forewing (Figs 10, 12) transparent, colourless or slightly yellowish with small dark brown dots on radular spinules in cells  $m_1$ ,  $m_2$  and  $cu_1$  as well as at apex of clavus; veins light brown with brown tips. Hindwing whitish, transparent. Abdominal sclerites brown with two longitudinal submedian rows of whitish dots on tergites; intersegmental membranes yellow or orange. Apex of paramere and female terminalia black. Young specimens lighter with less expanded dark colour, getting gradually darker with age.

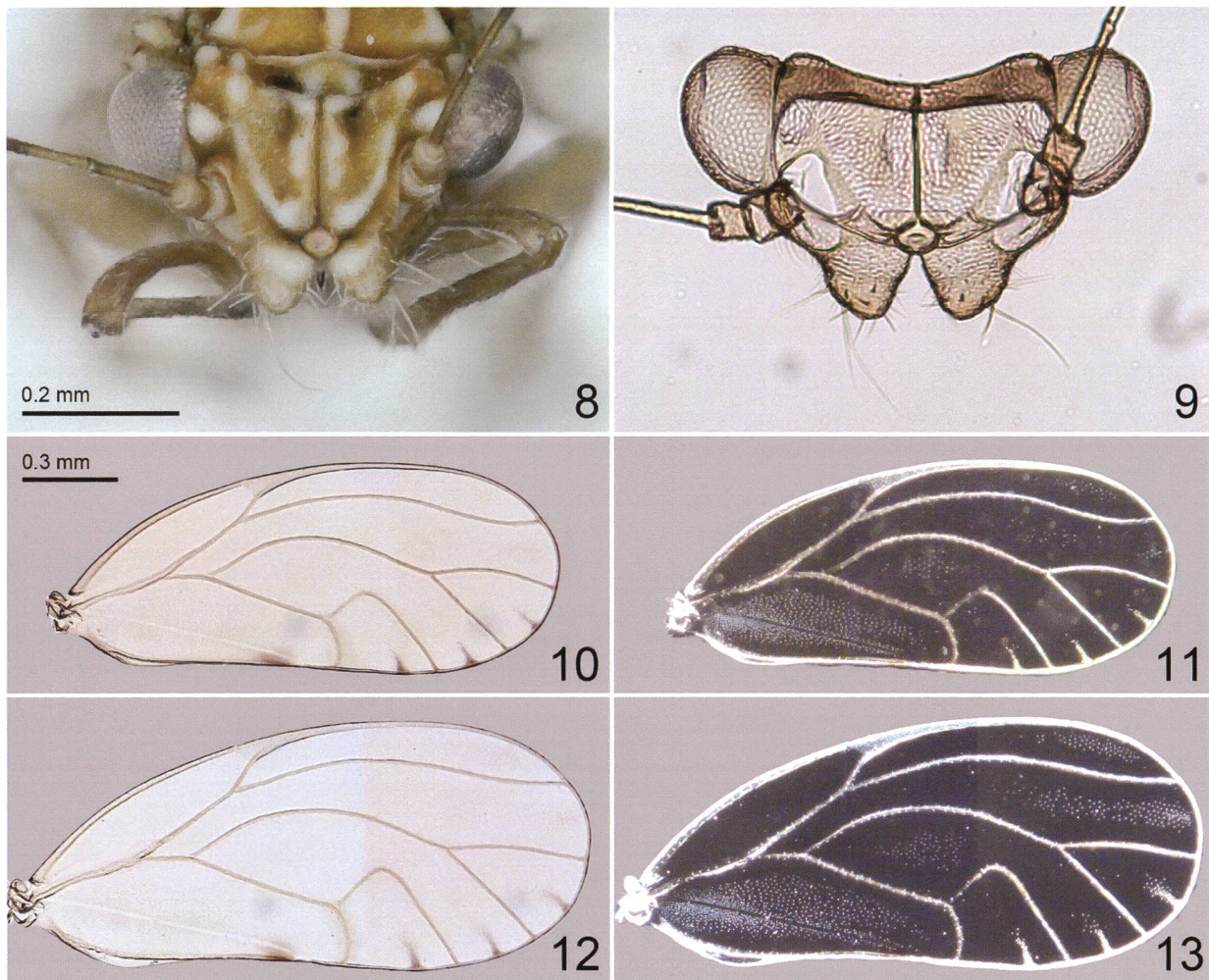
**Structure.** Conforming to the generic description of Rendón-Mera et al. (2020). Body length ♂ 2.0–2.2 mm, ♀ 2.2–2.4 mm (6 ♂, 6 ♀). Head inclined in a 30° angle from longitudinal body axis (Figs 4, 6). Vertex with scaly microsculpture (Fig. 9). Genal processes irregularly conical, subacute apically, 0.5–0.7 times as long as vertex along midline (Figs 8, 9). Antenna 2.1–2.3 times as long as head width. Rostrum short, apical and part of the subapical segments visible in profile, 0.4 times as long as head width. Metatibia 0.7–0.8 times as long as head width. Forewing (Figs 10–13) 2.8–3.1 times as long as head width, 2.2–2.4 times as long as wide; fore margin relatively evenly curved, wing widest near the middle; broadly, evenly rounded apically, wing apex lies in cell





**Figures 1–7.** Habitat, host and habitus of *Mitrapsylla rupestris* sp. nov. **1.** Morro do Pai Inácio (Bahía, Palmeiras), type locality of *M. rupestris* sp. nov.; **2, 3.** *Poretia bahiana*, the host of *M. rupestris* sp. nov., growing in rock habitats (**2**) with detail of glandular leaflets (**3**); **4–7.** habitus, adults **4, 6.** in profile; **5, 7.** in dorsal view; **4, 5.** male; **6, 7.** female. Scale bar: 0.5 mm.

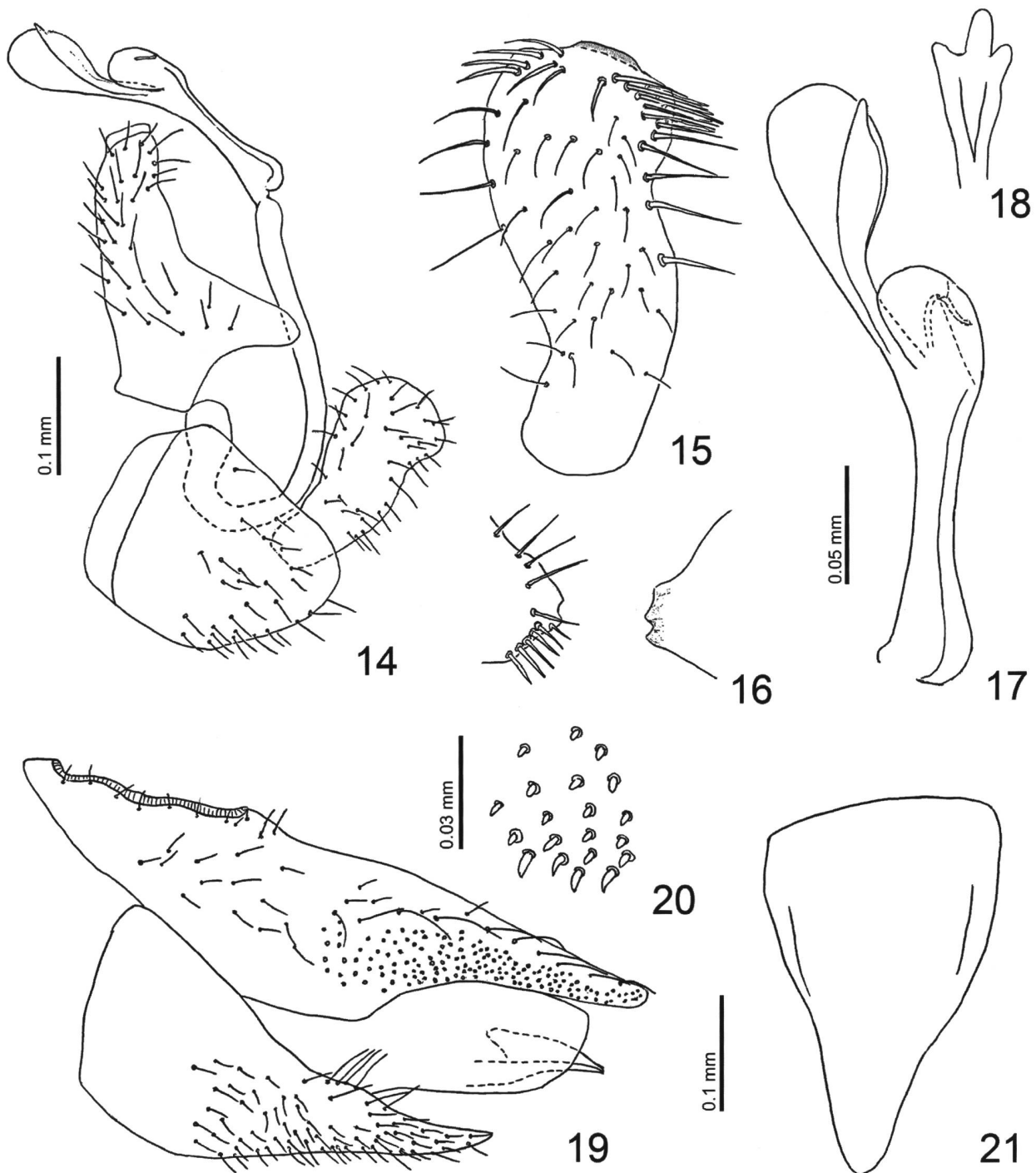




**Figures 8–13.** *Mitropsylla rupestris* sp. nov. **8, 9.** Head, in dorsal view, showing colour pattern (**8**) and microsculpture (**9**); **10–13.** forewing; **10, 12.** bright field, showing venation and colour; **11, 13.** dark field, showing surface spinules; **10, 11.** male; **12, 13.** female. Scale bars: 0.2 mm (**8, 9**); 0.3 mm (**10–13**).

$r_2$ ; pterostigma relatively short, at base slightly narrower than adjacent part of cell  $r_1$ ; cell  $cu_1$  0.8–0.9 times higher than wide. Surface spinules usually present in all cells but much reduced, present in cell  $c+sc$  at the apex, in  $r_1$  along apical margin, in  $r_2$  in apical half of cell, in  $m_1$  in apical third or half, in  $m_2$  in basal half and near apex of cell, in  $cu_1$  almost completely reduced, in cell  $cu_2$  covering most of the cell but leaving broad spinule-free stripes along the veins; in females (Fig. 13) areas with surface spinules more expanded than in males (Fig. 11) where they are much reduced; radular spinules present in cells  $m_1$ ,  $m_2$  and  $cu_1$ , sometimes with also a few indistinct spinules in  $r_2$ . Terminalia as in Figs 13–20. Male proctiger (Fig. 14) 0.3–0.4 times as long as head width, with narrow, relatively straight posterior lobes in basal third. Paramere (Figs 14, 15), in profile, clavate, irregularly expanding towards apex; anterior margin weakly, irregularly concave proximally to kink in distal quarter; apex broadly irregularly rounded; posterior margin weakly, irregularly convex in proximal two thirds and distal third, slightly indented at distal third; outer face with long fine setae, sparser in anterior half, denser in posterior half

(Fig. 14); inner face with long bristles along fore margin in apical half, sparse proximally, dense apically, with a group of long stout, densely spaced bristles near apex anteriorly and posteriorly, and with a few sparse long bristles along hind margin; remainder covered in long setae; sclerotised apical ridge, more or less in the middle (Figs 15, 16). Distal segment of aedeagus (Fig. 17) complex, with unipartite dorsal lobe; dorsal lobe, in profile, ovoid; ventral process hardly upturned, its apical expansion ovoid to subglobular, larger than dorsal lobe, lateral tubercles long, situated near apex, dorsally (Figs 17, 18); sclerotised end tube of ductus ejaculatorius short, weakly sinuous. Female proctiger (Fig. 19) 1.0 times as long as head width, dorsal outline weakly indented adjacent to circumanal ring, weakly concave otherwise almost straight or weakly convex; apex narrowly rounded; with moderately long setae around circumanal ring and in proximal half laterally, distal half with a submedian longitudinal row of long setae on each side and densely spaced peg setae (Fig. 20) laterally; circumanal ring 0.3–0.4 times as long as proctiger, consisting of two unequal rows of pores. Female subgenital plate 0.5 times as long



**Figures 14–21.** *Mitrapsylla rupestris* sp. nov., terminalia. **14.** Male terminalia, in profile; **15.** inner face of paramere; **16.** dorsal view of parameres, setae on right paramere omitted (anterior = up); **17.** distal portion of aedeagus; **18.** ventral lobe of distal portion of aedeagus with lateral tubercles, in ventral view; **19.** female terminalia, in profile; **20.** peg setae on female proctiger; **21.** female subgenital plate, in ventral view. Scale bars: 0.1 mm (**14**, **19**, **21**); 0.05 mm (**15–18**); 0.03 mm (**20**).

as proctiger, pointed apically; densely beset with moderately long setae in distal two thirds except for a seta-free “window” in apical third laterally; in ventral view (Fig. 21) weakly narrowing in proximal half, strongly narrowing in distal half; apex subacute.

Measurements (in mm; 2 ♂, 2 ♀). Head width ♂ 0.56–0.58, ♀ 0.60; antenna length ♂ 1.24–1.26, ♀ 1.30–1.32; forewing length ♂ 1.60–1.64, ♀ 1.68; male proctiger

length 0.20–0.22; paramere length 0.20; length of distal segment of aedeagus 0.26–0.28; female proctiger length 0.60–0.62.

Fifth instar immature unknown, only first and second instars available.

**Etymology.** From Latin *rupe* = rock, referring to its occurrence in rock habitats; *rupestris* is an adjective in the nominative case, feminine.





**Figures 22, 23.** *Poiretia bahiana*. **22.** Plant with folded leaflet (arrow) housing immatures; **23.** immatures of *Mitrapsylla rupestris* sp. nov. (arrows).

**Distribution.** Brazil (Bahía) where it is probably endemic to the Serra do Espinhaço.

**Host plant, biology and habitat.** *Poiretia bahiana* C. Mueller (Fabaceae, Fabioideae, Dalbergieae) (Figs 2, 3). The immatures (Fig. 23, arrows) develop in the fold of the still partially doubled leaflets (Fig. 22, arrow). The host grows in rock habitats (Figs 1, 2).

**Comments.** *Mitrapsylla rupestris* sp. nov. resembles *M. aeschynomenis* Rendón-Mera, Burckhardt, Cavichioli & Queiroz, 2020, *M. aurantia* Rendón-Mera, Burckhardt, Cavichioli & Queiroz, 2020, *M. cubana* Crawford, 1914, and *M. didyma* Rendón-Mera, Burckhardt, Cavichioli & Queiroz, 2020, in the apically weakly expanded paramere, in profile, bearing the sclerotised apical ridge medially and in the unipartite dorsal lobe on the distal portion of the aedeagus. *Mitrapsylla rupestris* sp. nov. differs from the four species in the lateral tubercles on the ventral aedeagal process which are situated near the apex (rather than near the middle), and in the female proctiger which is dorsally straight or weakly convex in apical half (rather than weakly sinuous) and narrowly rounded apically (rather than obliquely truncate). In *M. aeschynomenis* and *M. aurantia*, the antennae and the genal processes are slightly shorter: antenna length/ head width ratio < 2.1 versus > 2.1 in *M. rupestris* sp. nov.; length ratio of genal processes/ vertex < 0.5 versus > 0.5 in *M. rupestris* sp. nov. From the former, *M. rupestris* sp. nov. differs also in the slightly more acute genal process-

es and from the latter in the more spaced surface spinules of the forewing. In the key of Rendón-Mera et al. (2020), *M. rupestris* sp. nov. runs to couplet 31 together with *M. cubana* and *M. didyma* from which it differs the shape of the sclerotised ridge of the paramere in dorsal view. In the last two species, the ridge bears one big posterior tooth, while in *M. rupestris* sp. nov. it forms two small teeth. From the former it differs in the apically slightly more expanded paramere and from the latter in the slightly shorter postero-apical lobe of the paramere. It differs also in the host association: *M. aeschynomenis* develops on *Aeschynomene*, which belongs to the same tribe as *Poiretia* (Dalbergieae), *M. cubana* and *M. didyma* are associated with *Desmodium*, which is a member of the more distantly related Desmodieae within the same subfamily (Faboideae). The host of *M. aurantia* is unknown.

## Discussion and conclusions

Hosts are known for 34 of the 51 previously known *Mitrapsylla* species (Rendón-Mera et al. 2020). They belong to 12 genera of Fabaceae of the three subfamilies Caesalpinioideae (Cassieae: *Cassia* and *Senna*), Detarioideae (Detarieae: *Copaifera*) and Fabioideae (Dalbergieae: *Aeschynomene*, *Andira*, *Machaerium* and *Pterogyne*; Desmodieae: *Desmodium*; Dipterygeae: *Pterodon*; Exostyleae: *Holocalyx*; Phaseoleae: *Periandra*; and

Sophoreae: *Sophora*). *Poiretia bahiana* (tribe Dalbergieae), the host of *M. rupestris* sp. nov., constitutes a previously unknown psyllid host. All *Mitrapsylla* species for which hosts are known are either monophagous on a single host species or oligophagous on several species of the same host genus. In terms of host taxon and range, *M. rupestris* sp. nov. fits the general pattern of *Mitrapsylla*.

True endemism in psyllids is probably rare and apparently restricted distributions may merely reflect incomplete faunistic knowledge. Among the 40 *Mitrapsylla* species previously reported from Brazil, 26 have a relatively wide geographic distribution and are also known from outside of Brazil or have been recorded from two or more states in Brazil (Rendón-Mera et al. 2020). Of the remaining 14 species, 10 are known from only a single municipality. Whether these species are endemic or just reflect insufficient sampling cannot be judged without more fieldwork. For three of the 10 species the hosts are known: *M. aeschynomensis* (on *Aeschynomene paniculata*), *M. hamata* Rendón-Mera, Burckhardt, Cavichioli & Queiroz, 2020 (on *Machaerium amplum*) and *M. pterogynis* Rendón-Mera, Burckhardt, Cavichioli & Queiroz, 2020 (on *Pterogyne nitens*). All three hosts are widely distributed suggesting that the associated psyllids also may be. *Mitrapsylla rupestris* sp. nov., in contrast, is probably narrowly endemic as it is monophagous on *Poiretia bahiana*, an endemic of rock habitats of the Serra do Espinhaço (Müller 1986).

The flora of the “campos rupestres” of the Espinhaço Range is extremely species rich with a high degree of endemism (Ribeiro et al. 2014). The psyllids seem to reflect this pattern. Apart from *Mitrapsylla rupestris* sp. nov., we found in these rock fields also two *Isogonoceraia* spp. (Psyllidae, Ciriaceminae) on *Chamaecrista* (Fabaceae), one *Heteropsylla* sp. (Psyllidae, Ciriaceminae) on *Calliandra* (Fabaceae) and one *Trioza* sp. (Triozidae) on *Eugenia* (Myrtaceae). The four species are undescribed, probably host specific and endemic to “campos rupestres” of the Serra do Espinhaço. Despite their floristic and faunistic interest, there is a lack of studies of the mountainous regions of Brazil, which harbour some of the most threatened plant ecosystems (Bünger et al. 2014). Studies on the flora and fauna are urgently required for designing efficient measures for the sustainable conservation of this unique biome.

## Acknowledgements

We thank Hannes Baur, David Ouvrard and Diana Rendón-Mera for their careful review of a previous manuscript draft. We are grateful to the botanists Alexandre Gibau de

Lima, Ana Paula Fortuna Perez, Jorge Antonio Silva Costa and Rubens Teixeira de Queiroz for their invaluable help with the identification of the plant samples. Collecting permits were granted by IBAMA/SISBIO: number 11832 and 65696-3.

## References

- Bünger MO, Stehmann JR, Oliveira-Filho AT (2014) Myrtaceae throughout the Espinhaço Mountain Range of centraleastern Brazil: floristic relationships and geoclimatic controls. *Acta Botanica Brasilica* 28(1): 109–119. <https://doi.org/10.1590/S0102-33062014000100011>
- Burckhardt D, Queiroz DL (2012) Commented checklist of the jumping plant-lice (Hemiptera: Psylloidea) from Brazil. *Zootaxa* 3571: 26–48. <https://doi.org/10.11646/zootaxa.3571.1.2>
- Burckhardt D, Queiroz DL (2021) Psylloidea. In: *Catálogo Taxonômico da Fauna do Brasil*. PNUD. <http://fauna.jbrj.gov.br/fauna/faunadobrasil/97523> [accessed 23 June 2021]
- Carneiro MAA, Borges RAX, Araújo APA, Fernandes GW (2009) Insetos indutores de galhas da porção sul da Cadeia do Espinhaço, Minas Gerais, Brasil. *Revista Brasileira de Entomologia* 53(4): 570–592. <https://doi.org/10.1590/S0085-56262009000400007>
- Crawford DL (1914) A monograph of the jumping plant-lice or Psyllidae of the New World. *Bulletin of the United States National Museum* 85: 1–186. <https://doi.org/10.5479/si.03629236.85.1>
- Giulietti AM, Menezes NL, Pirani JR, Meguro M, Wanderley MGL (1987) Flora da Serra do Cipó, Minas Gerais: Caracterização e lista de espécies. *Boletim de Botânica da Universidade de São Paulo* 9: 1–152. <https://doi.org/10.11606/issn.2316-9052.v9i0p1-151>
- Halbert SE, Burckhardt D (2020) The psyllids (Hemiptera: Psylloidea) of Florida: newly established and rarely collected taxa and checklist. *Insecta Mundi* 0788: 1–88. [https://centerforsystematicentomology.org/insectamundi/0788\\_HalbertandBurckhardt\\_2020.pdf](https://centerforsystematicentomology.org/insectamundi/0788_HalbertandBurckhardt_2020.pdf)
- Müller C (1986) Espécies novas do gênero *Poiretia* Vent. – Leguminosae. *Revista Brasileira de Botânica* 9: 23–30.
- Rapini A, Ribeiro PL, Lambert S, Pirani JR (2008) A flora dos campos rupestres da Cadeia do Espinhaço. *Megadiversidade* 4: 16–24.
- Rendón-Mera DI, Burckhardt D, Queiroz DL, Cavichioli RR (2020) Taxonomy and host-plant relationships of the psyllid genus *Mitrapsylla* (Hemiptera: Psylloidea: Psyllidae) in Brazil. *Zootaxa* 4887(1): 1–100. <https://doi.org/10.11646/zootaxa.4887.1.1>
- Ribeiro PL, Rapini A, Damascena LS, van den Berg C (2014) Plant diversification in the Espinhaço Range: Insights from the biogeography of *Minaria* (Apocynaceae). *Taxon* 63: 1253–1264. <https://doi.org/10.12705/636.16>
- World Flora Online (2021) An online flora of all known plants. <http://www.worldfloraonline.org/> [accessed 23 June 2021]



