

Two continents and two names for a Neotropical colletid bee species (Hymenoptera: Colletidae: Neopasiphaeinae): *Hoplocolletes ventralis* (Friese, 1924)

Eduardo A B Almeida, Fábio B Quinteiro

Neopasiphaeinae bees (Apoidea: Colletidae) are well known for their Amphinotic distribution in the Australian and Neotropical regions. Affinities between colletid taxa in Australia and South America have been speculated for decades, and have been confirmed by recent phylogenetic hypotheses that indicate a biogeographic scenario compatible with a trans-Antarctic biotic connection during the Paleogene. Despite this proximity, no species occurs on both sides of the Pacific Ocean, but the Neotropical species *Hoplocolletes ventralis* (Friese, 1924), which was described as an Australian taxon due to an error in the specimen labels. This mistake was recognized by C.D. Michener 50 years ago. We herein report that the same labeling problem also happened with *Dasycolletes chalceus* Friese, 1924, which remained as a tentatively placed species in the Australian genus *Leioproctus* until now. Moreover, *Dasycolletes chalceus* is interpreted as a synonym of *Dasycolletes ventralis*. We also provide a revised diagnosis for *Hoplocolletes*, describe the male of *H. ventralis* in detail for the first time, including a comparative study of its genitalia and associated sterna.

1 **Two continents and two names for a Neotropical colletid bee species (Hymenoptera:**
2 **Colletidae: Neopasiphaeinae): *Hoplocolletes ventralis* (Friese, 1924)**

3

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9

10 **Abstract**

11 Neopasiphaeinae bees (Apoidea: Colletidae) are known for their Amphinotic distribution in the
12 Australian and Neotropical regions. Affinities between colletid taxa in Australia and South
13 America have been speculated for decades, and have been confirmed by recent phylogenetic
14 hypotheses that indicate a biogeographic scenario compatible with a trans-Antarctic biotic
15 connection during the Paleogene. No neopasiphaeinae species occurs on both sides of the Pacific
16 Ocean, but the Neotropical species *Hoplocolletes ventralis* (Friese, 1924) was described as an
17 Australian taxon due to an error in the specimen labels. This mistake was recognized by
18 C.D.Michener 50 years ago. We herein report that the same labeling problem also happened with
19 *Dasycolletes chalceus* Friese, 1924, which remained as a tentatively placed species in the
20 Australian genus *Leioproctus* until now. Moreover, *Dasycolletes chalceus* is interpreted as a
21 synonym of *Hoplocolletes ventralis*. We also provide a revised diagnosis for *Hoplocolletes*,
22 describe the male of *H. ventralis* in detail for the first time, including a comparative study of its
23 genitalia and associated sterna.

24

25 **Keywords:** Apoidea, Australia, biogeography, Brazil, systematics, taxonomy

26

27

28 **Introduction**

29 Affinities between taxa of Colletidae distributed in Australia and South America have been
30 speculated for decades (Michener, 1965, 1989), and have been confirmed by recent phylogenetic
31 hypotheses that indicate a biogeographic scenario compatible with a trans-Antarctic biotic
32 connection during the Paleogene (Almeida et al., 2012). *Dasycolletes ventralis* Friese, 1924 was
33 described as an Australian colletid species based on a single female specimen labeled as having
34 been collected in Sydney (Australia). The species actually is endemic to Brazil, and there is no
35 species occurring in Australia that could be confused with it. The confusion certainly results
36 from an error in the label, as concluded by Michener (1965: p.41), an interpretation followed by
37 subsequent authors (e.g., Moure, Graf & Urban, 2007; Rasmussen & Ascher, 2008). After the
38 species description, it was moved to the genus *Paracolletes* by Cockerell (1929), and later placed
39 in *Leioproctus* (*Hoplocolletes*), created by Michener (1965) to accommodate it based on clear
40 affinities to other taxa classified as *Leioproctus*, but also recognizing its uniqueness (see also
41 Michener, 1989, 2007). *Hoplocolletes* remains a monotypic taxon in Neopasiphaeinae
42 (Colletidae), having been classified as genus (e.g., Silveira, Melo & Almeida, 2002; Moure, Graf
43 & Urban, 2007; Almeida & Danforth, 2009; Almeida et al., 2012) or as subgenus of *Leioproctus*
44 (e.g., Michener, 1965, 1989, 2007), the former being followed in this paper..

45 *Hoplocolletes ventralis* has been recorded in three states in southeastern Brazil: Espírito
46 Santo, Minas Gerais, Rio de Janeiro (Silveira, Melo & Almeida, 2002; Moure, Graf & Urban,

47 2007). Nevertheless, it remains a poorly known genus, with relatively little distributional
48 information, the male undescribed, host-plant preferences unknown, and the only piece of
49 biological information for this species is that it is a soil nesting bee (E. A. B. Almeida,
50 pers. observation). The phylogenetic affinities of *Hoplocolletes* and other neopasiphaeine taxa
51 were uncertain until molecular phylogenetic hypotheses placed this taxon in a clade comprising
52 *Eulonchopria* and *Nomiocolletes* (Almeida & Danforth, 2009; Almeida et al., 2012). Michener
53 (1989: p.630) suggested that *Hoplocolletes* could be part of a "Basal Group", characterized by
54 the fully developed sternal scopa. Based on the phylogenetic hypotheses currently available, it
55 seems that this scopa arose multiple times in the Neopasiphaeine clade, since taxa with this
56 character, *Hoplocolletes*, *Cephalocolletes*, *Reedapis*, and *Tetraglossula* are otherwise not close
57 relatives (Almeida & Danforth, 2009; Almeida et al., 2012).

58 The aim of this work is three fold. To resolve a taxonomic problem related to a new
59 synonymy involving *Hoplocolletes ventralis* and *Dasycolletes chalceus*, which are here
60 interpreted as synonyms. To report that the above mentioned labeling problem that made the
61 taxonomic history of *Hoplocolletes ventralis* problematic also happened with *Dasycolletes*
62 *chalceus* Friese, 1924, which remained as a tentatively placed species in the Australian genus
63 *Leioproctus* until now (Michener, 1965; Cardale, 1993; Almeida, 2008; Rasmussen & Ascher,
64 2008). To increase the knowledge about the morphology and distinctiveness of *Hoplocolletes*,
65 particularly by providing a novel description of the male genital complex for this species.

66

67 **Material & Methods**

68 Part of the material studied is deposited in the Entomological Collection "Prof.
69 J.M.F.Camargo" [RPSP] in Departamento de Biologia (FFLRP/USP, Ribeirão Preto, Brazil).

70 A male specimen of *Hoplocolletes ventralis* was obtained on loan from Entomological
71 Collection "Pe. J. S. Moure" [DZUP], Departamento de Zoologia (UFPR, Curitiba, Brazil),
72 and the female type specimen of *Dasycolletes chalceus* Friese, 1924 was studied and
73 photographed at the entomological collection of Museum für Naturkunde [ZMB] (Berlin,
74 Germany). Photographs of the female specimen of *Dasycolletes ventralis* Friese, 1924,
75 deposited at the American Museum of Natural History (AMNH) collection, were kindly made
76 available for this study.

77 The general morphological terminology follows Michener (2007). Antennal
78 flagellomeres are indicated as F1, F2, etc.; metasomal terga and sterna, respectively, as T1 to T7,
79 and S1 to S8. The density of punctation and intervals between the punctures are based on relative
80 puncture diameter, pd (*e.g.*, <1pd: less than 1x the puncture diameter between the punctures).

81 Color images were obtained on a Zeiss Axiocam 206 color camera associated to a Zeiss
82 Discovery.V12 stereomicroscope, or with an AmScope MU1000A Digital Camera adapted onto
83 a Leica MZ6 stereomicroscope; pictures were assembled with the software Helicon Focus 6.2.

84

85 **Results**

86 The species *Dasycolletes chalceus* was not studied after its original description. It was
87 described in the same publication and same page as *Dasycolletes ventralis* (Friese, 1924: p. 218).
88 After 1924, it was only mentioned in catalogues and revisionary works (*e.g.*, Michener, 1965;
89 Cardale, 1993; Almeida, 2008; Rasmussen & Ascher, 2008), but the type specimen was never
90 studied again. The only exemplar of *Dasycolletes chalceus* located and bearing Friese's original
91 labels is deposited in ZMB (Fig.1). It clearly has all diagnostic characters for *Hoplocolletes* as
92 currently circumscribed, and no differences were found in relation to *Hoplocolletes ventralis*

93 either. Hence, they are herein synonymized. The only known specimen of *Dasycolletes ventralis*
94 bearing Friese's original labels is in the American Museum of Natural History collection (New
95 York, USA) (Fig. 2) and it is the same female studied by Michener (1965) that lead him to
96 conclude that it was not an Australian taxon, as indicated by the collecting labels, but a specimen
97 probably collected in Brazil. The interpretation of Friese's types is a controversial subject and it
98 is likely that the AMNH specimen is a duplicate, not the primary type (Rasmussen & Ascher,
99 2008; J. S. Ascher, pers.comm.). But, so far, it is the only specimen labeled by Friese himself as
100 *Dasycolletes ventralis* available for study. It is worth noting that both specimens were probably
101 collected together, have locality labels that are identical, "Australia \\\ Sydney \\\ 14.9/06". The
102 collector's name is lacking from the *D. chalceus* specimen label but is in the species' description
103 (Friese, 1924: p.218): "von Sydney im September, Frank leg."

104

105 ***Hoplocolletes ventralis* (Friese, 1924)**

106 *Dasycolletes ventralis* Friese, H. (1924) [218].

107 Type data: syntype AMNH <F>.

108 Type locality: 'Australia, Sydney'.

109 *Dasycolletes chalceus* Friese, H. (1924) [218], **new synonymy**.

110 Type data: syntype ZMB <F>.

111 Type locality: 'Australia, Sydney'.

112 **Description of male:** Approximate body length: 10 mm; length of forewing: 7.7 mm; maximum
113 width of metasoma (T2): 2.5 mm. *Color:* predominantly black; apical half of mandible, ventral
114 surface of F2-F11, tibiae, femora, trochanters, S2-S3, apical margins of terga dark reddish brown.
115 Tarsi light brown. Tegula, pterostigma and wing veins dark brown; wing membrane brown

116 infumated. *Pubescence*: predominantly pale yellowish or cream on entire body. Face and
117 pronotal lobe with abundant pubescence; clypeus with decumbent to semidecumbent pilosity (0.5
118 mm in length), more erect and shorter on paraocular area and frons (0.3-0.45 mm in length).
119 Mesoscutum with scarce pilosity. Lateral pilosity of mesepisternum semidecumbent and sparse
120 (0.25-0.35 mm in length). *Integumental surface*: punctation coarse and dense on clypeus (≤ 1
121 pd), finer and denser frons (<1 pd), on vertex variable (denser medially, sparser [≤ 1 pd] laterally
122 as well as on gena) integument smooth and shiny between punctures; coarse and dense on
123 mesosoma, sparser toward center of disc of mesoscutum, and inferior on mesepisternum;
124 metapostnotum smooth and shiny, delimited from pronotum by a pit-row; T1 smooth and shiny,
125 with very sparse (2-7 pd) moderately coarse punctation, transversal line of barely aligned
126 punctures delimiting marginal region of T1; on T2 slightly denser than on T1, but punctation
127 leaving broad shiny areas as well; T3 and T4 with basal portion finely and densely punctated,
128 sparser and coarser distad. *Structure* (measurements in mm): head about 1.1x wider than long
129 (2.66:2.43); inner orbits converging below (upper to lower interorbital distance, 1.76:1.47), inner
130 margin almost straight; eye about 3.6x longer than its maximum width in frontal view
131 (1.76:0.48), in lateral view about 1.2x wider than gena (0.74:0.64). Vertex well developed above
132 ocelli (distance between upper margin of lateral ocellus and vertex = 0.53), comparable to
133 ocelloocular distance (0.51); interocellar distance = 0.14; diameter of median ocellus = 0.25.
134 Approximate length of antenna = 4.0, length and maximum width of scape = 0.73, 0.2; of pedicel
135 = 0.16; of F1 = 0.19; F2 about 1.5x wider than long (0.18:0.27); F3 about 1.5x longer than wide
136 (0.30:0.21). Mesoscutum length = 1.83, intertegular distance = 1.75. Genital capsule and male S7
137 and S8 as illustrated in Figs 5-6 (see discussion about the male terminalia below, in the 'Revised
138 Diagnosis' for *Hoplocolletes*).

139

140 *Hoplocolletes* Michener, 1965141 **Revised diagnosis for the genus** (characters apply to both sexes unless otherwise stated).

142 Length 10-12 mm. Body black to dark brown; head and mesosoma with conspicuous coarse
143 punctation; T1 and T2 largely impunctate, smooth and shining (remaining terga rather finely and
144 closely punctate); pubescence short, sparse, blackish to dark brown on female (light yellow to
145 fulvous on male), except on hind legs and metasomal sterna where there are long, pale hairs;
146 metasomal hair bands absent, male clypeus with plumose and semidecumbent pubescence.

147 Mandible with an ordinary preapical tooth. Inner orbits subparallel (female, Figs 1D, 2C) or
148 converging below (male, Fig.3C). Facial fovea absent; clypeus weakly convex; labrum with
149 apical margin concave medially, elevated zone highest medially, occupying about basal half of
150 labrum (Michener, 1989: Fig.7q). Preoccipital carina absent; malar area linear; clypeus little
151 protuberant. Male flagellum elongate (approximately 3.0 mm long), F2 longer than wide. Vertex
152 produced behind ocelli and eyes (Figs 1A,D, 2A,C, 3A,B,C). Apex of scape of female reaching
153 upper margin of median ocellus (Figs 1D, 2C); antennae arising about middle of face.

154 Dorsolateral angle of pronotum low, rounded, scarcely evident; metapostnotum smooth,
155 marginal line pitted, its basal part slightly longer than metanotum. Femoral scopa sparse, formed
156 by long delicate branched hairs, those behind corbicula and on trochanter long but simple; tibial
157 scopal hairs dividing to form few major branches. Female basitibial plate distinct, hairs short,
158 appressed, different from those of adjacent areas, marginal carinae clearly exposed. Inner hind
159 tibial spur of female coarsely pectinate with 5-6 teeth (Michener, 1989: Fig.7q). Forewing with
160 three submarginal cells, second much shorter than third and receiving recurrent vein beyond
161 middle (Figs 1F, 3A); basal vein of forewing meeting cu-v (Fig.1); stigma large, long, not quite

162 parallel sided, two-thirds as long as costal side of marginal cell, marginal cell longer than
163 distance between its apex and wing apex. T1 dorsally approximately twice wider than long; S3-
164 S5 of female with dense, long (shorter than exposed part of sternum), pale yellow, simple hairs
165 (some hooked at tips) forming band occupying apical half of each sternum, female S2 with
166 similar but sparser hair band (Figs 1C, 2D); S3-S5 of male with a longer hairs near apical
167 margin, S5 with distinct apical fringe.

168 Male genital capsule and associated sterna of *Hoplocolletes ventralis* are illustrated in Figs 5-6
169 along with exemplar species of two other neopasiphaeine genera: *Nomiocolletes joergenseni*
170 (Friese, 1908) and *Reedapis semicyanea* (Spinola, 1851). According to the phylogenetic
171 hypotheses of Almeida & Danforth (2009) and Almeida et al. (2012), *Hoplocolletes* and
172 *Nomiocolletes* are closely related lineages, whereas *Reedapis* is part of a more distantly related
173 clade. The interpretation of homologies for the male terminalia in this comparative context
174 makes the understanding of relevant characters of *Hoplocolletes* more defensible. Apical process
175 of male S7 comprising two lobes on each side: one apicolateral more developed and hairier
176 (Fig.5: lateral lobe - LLb) the other closer to the base of this process (Fig.5: basal lobe - BLb),
177 *Nomiocolletes* is distinctive in having a bilobed lateral lobe; *Hoplocolletes* does not have apical
178 protuberances as found in other Neopasiphaeinae (Fig.5: apical lobe - ALb); apodeme of S7
179 relatively long in relation to the apical process. Median process of male S8 (Fig.5: MPr) similar
180 in length to the remainder of S8; spiculum ordinary (not as produced as in *Nomiocolletes* or
181 *Reedapis*). Gonobase of male genitalia (Fig.6: Gbs) less than 1/4 of total length of genital
182 capsule; gonostylus and gonocoxite (Fig.6: Gns, Gcx) fused on dorsal surface but separable on
183 ventral surface, apex of gonostylus rounded and not bent ventrad (directed mesad and ventrad in

184 *Nomiocolletes* and *Reedapis*); apex of penis valve (Fig.6: PV) bent ventrad, ventral spine well-
185 developed (Fig.6: SPV).

186

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189 provided information about a locality where *Hoplocolletes ventralis* is known to occur in Minas
190 Gerais state, and loaned a male specimen used in this study. We are also indebted to Frank Koch
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193 taking photographs and making them available for this work. Our thanks to John S. Ascher
194 (National University of Singapore) and Gabriel A. R. Melo for valuable discussion on the
195 systematics of neopasiphaeine bees and the work of H.Friese, and to Connal Eardley, Diego S.
196 Porto, and one anonymous reviewer for critically commenting on this manuscript.

197

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234

FIGURE CAPTIONS

235

236 **Figure 1.** Female syntype of *Dasycolletes chalceus* Friese, 1924 deposited at the Museum für
237 Naturkunde collection [ZMB] (photo credit: Eduardo A.B. Almeida): **A** - dorsal habitus (scale
238 bar = 1 mm), **B** - lateral habitus, **C** - magnified view of lateral metassoma, **D** - face, **E** - dorsal
239 view of T3–T6, **F** - dorsal view of wings, **G** - specimen labels.

240

241 **Figure 2.** Female specimen of *Dasycolletes ventralis* of Friese, 1924 deposited at the American
242 Museum of Natural History collection [AMNH] (photo credit: Hadel Go): **A** - dorsal habitus, **B** -
243 lateral habitus, **C** - face, **D** - magnified view of ventral metasomal scopa, **E** - specimen labels.

244

245 **Figure 3.** Male specimen of *Hoplocolletes chalceus* (Friese, 1924) from Itapina, ES, Brazil
246 [DZUP] (photo credit: Eduardo A.B. Almeida): **A** - lateral habitus, **B** - dorsal habitus, **C** - face, **D**
247 - mesosoma and anterior metasoma; scale bars = 1 mm.

248

249 **Figure 4.** Comparative morphology of male metasomal sterna S7 and S8 (dorsal views shown on
250 left) of *Hoplocolletes ventralis* (Friese, 1924), *Nomiocolletes joergenseni* (Friese, 1908), and
251 *Reedapis semicyanea* (Spinola, 1851). ALb = apical lobe of S7, BLb = basal lobe of S7, LLb =
252 lateral lobe of S7, LPr = lateral process of S8, MPr = median process of S8; scale bars = 0.5 mm.

253 Cladogram represents a hypothesis for the phylogenetic relationships among these three taxa
254 (Almeida & Danforth, 2009).

255

256 **Figure 5.** Comparative morphology of male genitalia (dorsal views shown on left) of

257 *Hoplocolletes ventralis* (Friese, 1924), *Nomiocolletes joergenseni* (Friese, 1908), and *Reedapis*
258 *semicyanea* (Spinola, 1851). ApP = apodeme of penis valve, Cs = cuspis of volsella, Dg =
259 digitus of volsella, Gbs = gonobase, Gcx = gonocoxa, Gns = gonostyle, PV = penis valve, SPV =
260 ventral spine of penis valve; scale bars = 0.5 mm. Cladogram represents a hypothesis for the
261 phylogenetic relationships among these three taxa (Almeida & Danforth, 2009).

1

Female specimen of *Dasycolletes chalceus* Friese, 1924 deposited at the Museum für Naturkunde collection [ZMB].

Female specimen of *Dasycolletes chalceus* Friese, 1924 deposited at the Museum für Naturkunde collection [ZMB] (photo credit: Eduardo A.B. Almeida): A - Dorsal habitus (scale bar = 1 mm), B - lateral habitus, C - face, D - ventral metasomal scopa, E - labels.



Australia
Sydney
14. 9. 06

*Dasycolletes
chalceus:*
910 Fries det.

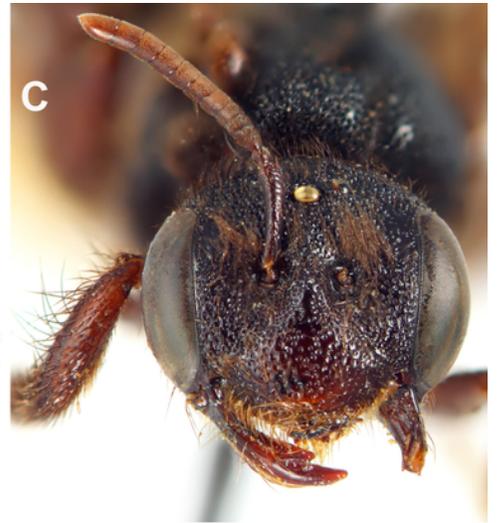
Type

Coll
Fries

2

Female specimen of *Dasycolletes ventralis* of Friese, 1924 deposited at the American Museum of Natural History collection [AMNH].

Female specimen of *Dasycolletes ventralis* of Friese, 1924 deposited at the American Museum of Natural History collection [AMNH] (photo credit: Hadel Go): A - Dorsal habitus, B - lateral habitus, C - face, D - magnified view of ventral metasomal scopa, E - labels.



3

Male specimen of *Hoplocolletes chalceus* (Friese, 1924) from Itapina, ES, Brazil [DZUP].

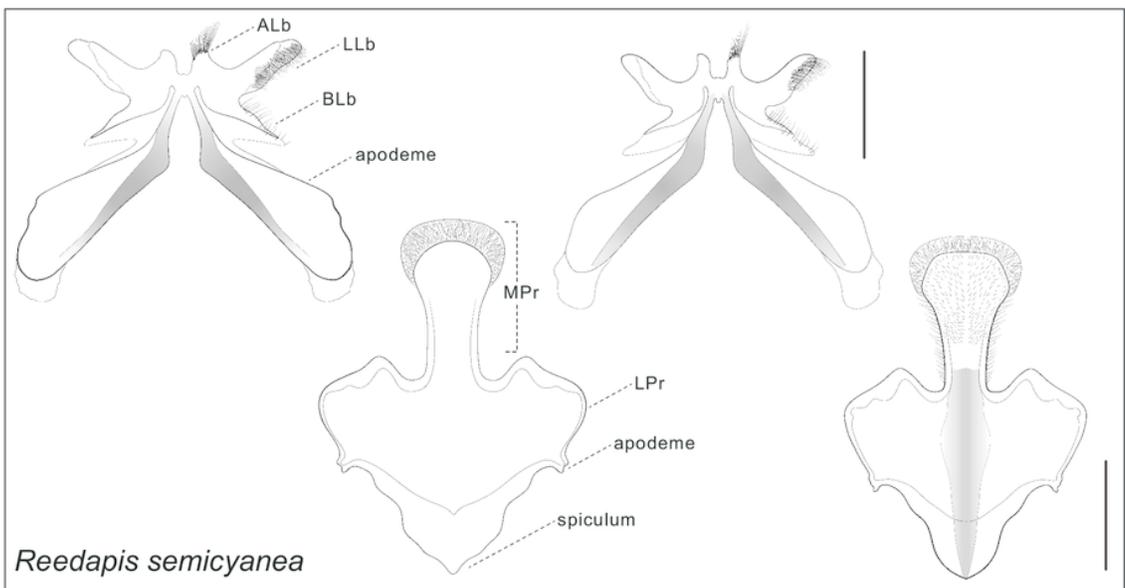
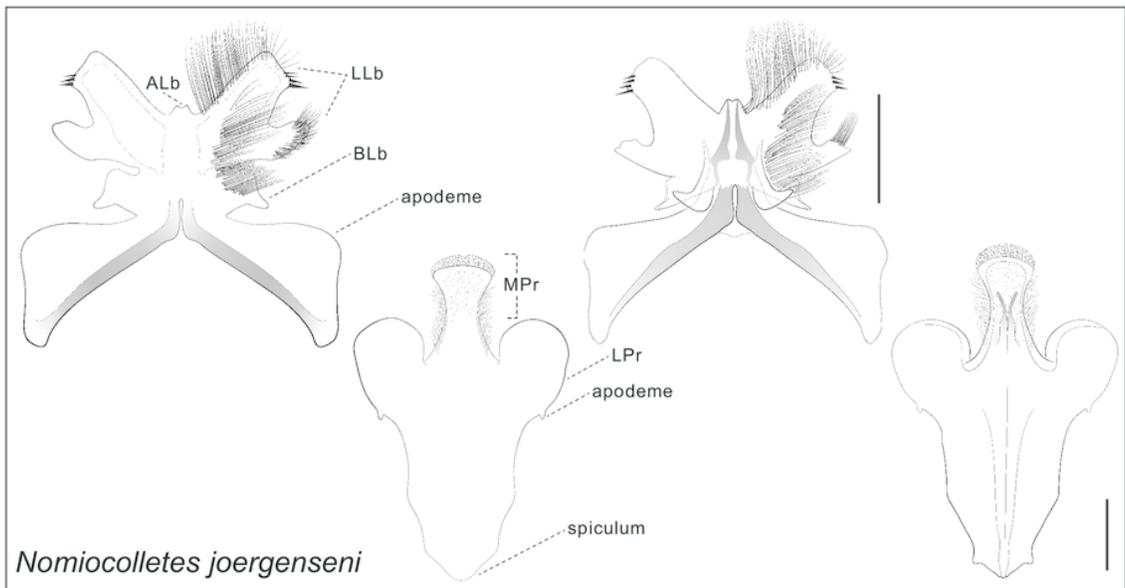
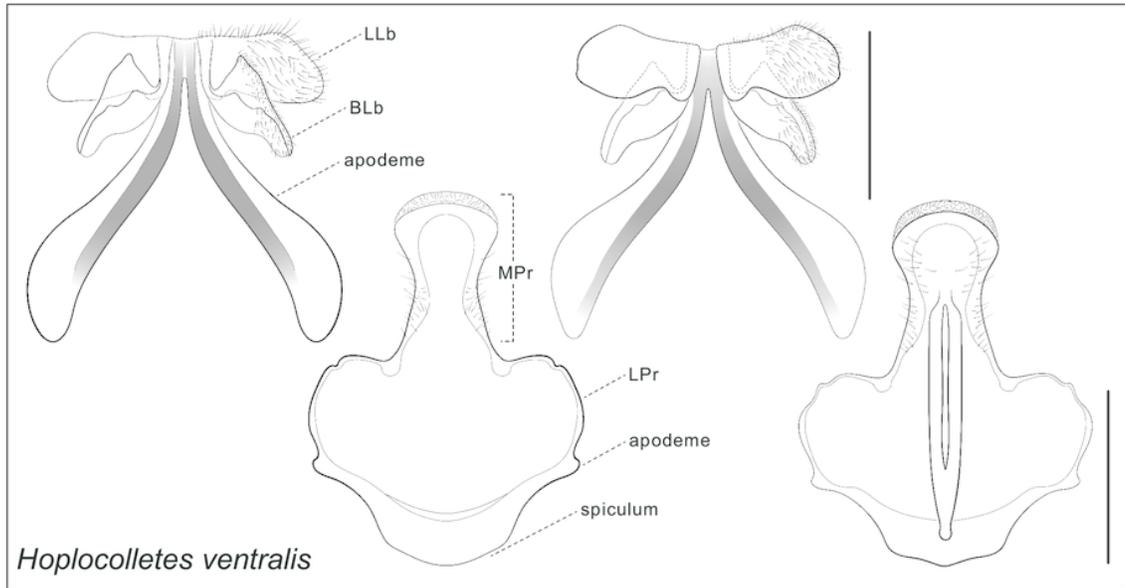
Male specimen of *Hoplocolletes chalceus* (Friese, 1924) from Itapina, ES, Brazil [DZUP] (photo credit: Eduardo A.B. Almeida): A - Lateral habitus, B - dorsal habitus, C - face, D - mesosoma and anterior metasoma; scale bars = 1 mm.



4

Comparative morphology of male metasomal sterna S7 and S8 (dorsal views shown on left) of *Hoplocolletes ventralis* (Friese, 1924) and related neopasiphaeine taxa.

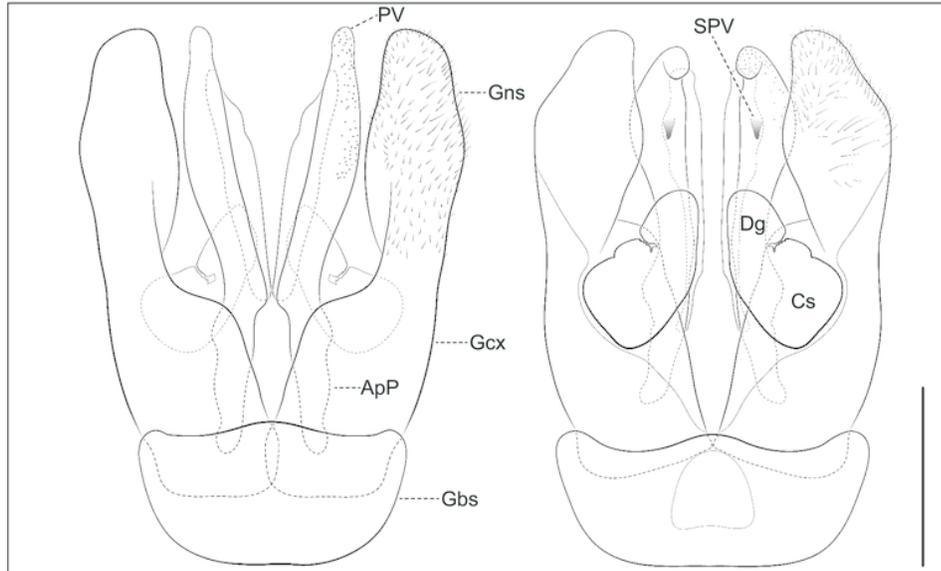
Comparative morphology of male metasomal sterna S7 and S8 (dorsal views shown on left) of *Hoplocolletes ventralis* (Friese, 1924), *Nomiocolletes joergenseni* (Friese, 1908), and *Reedapis semicyanea* (Spinola, 1851). ALb = apical lobe of S7, BLb = basal lobe of S7, LLb = lateral lobe of S7, LPr = lateral process of S8, MPr = median process of S8; scale bars = 0.5 mm. Cladogram represents a hypothesis for the phylogenetic relationships among these three taxa (Almeida & Danforth, 2009).



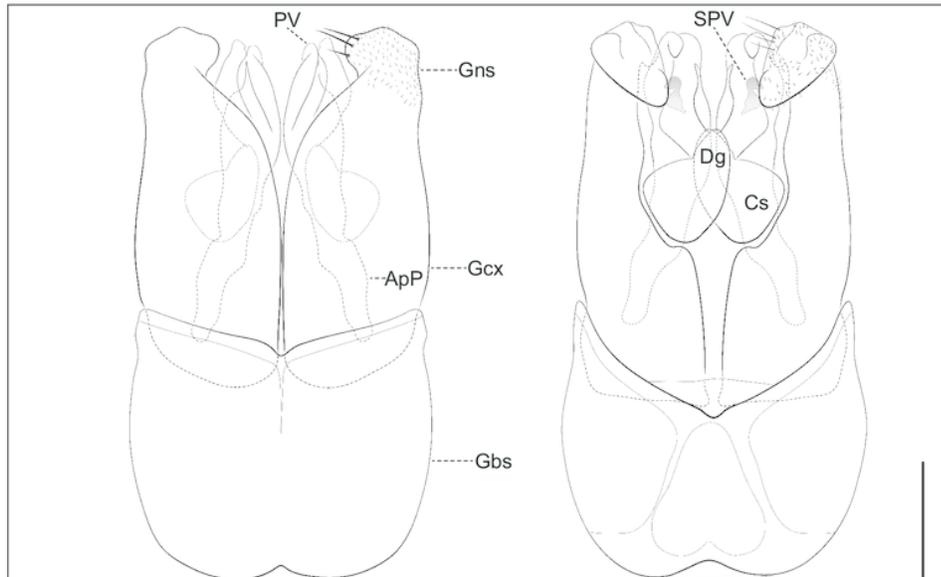
5

Comparative morphology of male genitalia (dorsal views shown on left) of *Hoplocolletes ventralis* (Friese, 1924) and related neopasiphaeine taxa.

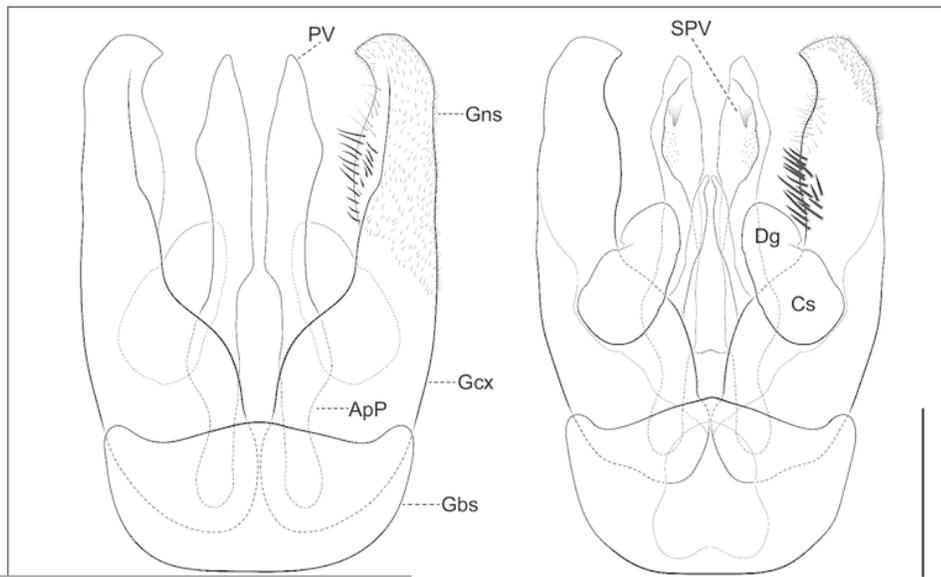
Comparative morphology of male genitalia (dorsal views shown on left) of *Hoplocolletes ventralis* (Friese, 1924), *Nomiocolletes joergenseni* (Friese, 1908), and *Reedapis semicyanea* (Spinola, 1851). ApP = apodeme of penis valve, Cs = cuspis of volsella, Dg = digitus of volsella, Gbs = gonobase, Gcx = gonocoxa, Gns = gonostyle, PV = penis valve, SPV = ventral spine of penis valve; scale bars = 0.5 mm. Cladogram represents a hypothesis for the phylogenetic relationships among these three taxa (Almeida & Danforth, 2009).



Hoplocolletes ventralis



Nomiocolletes joergenseni



Reedapis semicyanea