



## Research article

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# Eight new species of *Dexosarcophaga* Townsend, 1917 (Diptera, Sarcophagidae) from the Neotropical Region

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**Abstract.** Eight new Neotropical species of *Dexosarcophaga* Townsend, 1917 are described, five from Brazil, *Dexosarcophaga phoenix* sp. nov., *Dexosarcophaga jandainae* sp. nov., *Dexosarcophaga patiuorum* sp. nov., *Dexosarcophaga petra* sp. nov., and *Dexosarcophaga sphaera* sp. nov., one from Costa Rica, *Dexosarcophaga limon* sp. nov., one from Ecuador, *Dexosarcophaga napo* sp. nov., and one from Colombia, *Dexosarcophaga pallida* sp. nov. Male and female morphology is documented with photographs and illustrations, including details of the male terminalia for all new species and female terminalia of *Dexosarcophaga phoenix* sp. nov. and *Dexosarcophaga sphaera* sp. nov. With the addition of these new species, 58 species of *Dexosarcophaga* are now known, with records from the American continent spanning from the southern United States to northern Argentina.

**Keywords.** Morphology, taxonomy, flesh flies, Sarcophaginae, Neotropics.

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## Introduction

*Dexosarcophaga* Townsend, 1917 is one of the 46 genera recognized in the subfamily Sarcophaginae (Buenaventura & Pape 2018), and it included 50 valid species prior to this study (Pape 1996; Mello-Patiu 2000; Mello-Patiu & Pape 2000; Silva & Mello-Patiu 2010; Carvalho-Filho & Esposito 2011; Carvalho-

Filho *et al.* 2014, 2018; De-Souza *et al.* 2021). The genus is endemic to the American continent and its geographic distribution is almost exclusively restricted to the Neotropics, with only *D. transita* Townsend, 1917 reaching into the southern part of the Nearctic and *D. cistudinis* (Aldrich, 1916) [if considered as a member of this genus, see below] being exclusively Nearctic (Pape 1996). The biology of the species of this genus is very poorly known. *Dexosarcophaga termitaria* (Lopes, 1939) was described from a single female bred from larvae recovered from a termite nest, and *D. lenkoi* Lopes, 1968 was described based on specimens bred from a nest of carpenter ants (Lopes 1939, 1968). Lopes (1982b: 318) noted that he was unable to rear larvae of *Dexosarcophaga* spp. “in spite of the saprophagous characteristics”, and he provided a personal observation of *D. transita* being attracted to damaged termite nests. The suggestion by Lopes (1968, 1982b) of a possible association with tunnels of wood-boring beetles or other insects was given without any supporting evidence. Méndez (2012) documented that *D. megista* (Hall, 1933) and *D. varennia* (Dodge, 1968) are attracted to damaged aerial termite nests for larviposition, and he referred to this as a “predator-prey association” although without specific details of the larval feeding. Adults of *Dexosarcophaga* have often been collected from decomposing vertebrate carrion, which has led authors to include this genus among necrophagous taxa or even imply a forensic importance (e.g., Buenaventura *et al.* 2009, Ledo *et al.* 2012, Paseto *et al.* 2014, Smania *et al.* 2014, Sousa *et al.* 2015). However, none of these studies reports any breeding records.

*Dexosarcophaga* is one of the most species-rich genera of Neotropical Sarcophagidae, and several new Neotropical taxa have been added in recent decades (Mello-Patiu 2000; Mello-Patiu & Pape 2000; Silva & Mello-Patiu 2010; Carvalho-Filho & Esposito 2011; Carvalho-Filho *et al.* 2014, 2018; De-Souza *et al.* 2021).

Lopes (1975a, 1982b) included *Bezzisca* Lopes, 1975, *Dexosarcophaga* and *Farrimyia* Dodge, 1965 in the subtribe *Dexosarcophagina* Lopes, 1975, thereby proposing shared morphological similarities. Pape (1996) considered *Bezzisca*, *Farrimyia* and *Ectomyia* Dodge, 1968 as junior synonyms of *Dexosarcophaga*. Mello-Patiu & Pape (2000) followed Pape’s (1996) proposal and defined species of *Dexosarcophaga* by the following combination of character states: most postgenal setae black (white setae restricted to posteriormost part); postalar wall setose; presence of a ctenidium composed of normal spines on the male mid femur; male sternite 5 broadly V-shaped; male terminalia black; juxta small; presence of three styli; occipital setae above occipital foramen black; phallus divided into basi- and distiphallus; and female tergite 8 divided, with broad and ventro-laterally truncated halves connected medially by a narrow strip.

Mello-Patiu & Pape (2000) recognized three species-groups in this genus, recovering the genera recognized by Lopes (1975b, 1982b) in *Dexosarcophagina*. The authors did not mention where the monotypic genus *Ectomyia* could be tentatively placed in these groups. Buenaventura & Pape (2018) followed Pape’s (1996) definition of *Dexosarcophaga* in their phylogenetic analysis based on morphological characters, in which *Cistudinomyia* Townsend, 1917 emerged as the sister group to *Dexosarcophaga* and these two groups were recognized as subgenera of a broader *Dexosarcophaga*. In the present paper, eight new species of *Dexosarcophaga* from the Neotropical Region are described, following the broad circumscription of Pape (1996) until a comprehensive phylogenetic analysis of *Dexosarcophaga* clarifies relationships among species of this group of flesh flies.

## Material and methods

Descriptions were based on material from the Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil (MNRJ); the Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil (MZUSP); the Instituto Nacional de Biodiversidad, Costa Rica (INBio), and the Swedish Museum of Natural History, Stockholm, Sweden (NHRS). The first species (*Dexosarcophaga phoenix* sp. nov.) is provided with a detailed description, and the following seven species are described by listing the most

distinctive differences from this species plus, where necessary, any features needed for separation from already described species. The material includes 30 specimens (24 ♂♂, 6 ♀♀), designated as either holo- or paratypes, all of which were lost in the tragic fire of the MNRJ in September 2018 (Kury *et al.* 2018), and they are indicated as “[lost]” in the material examined sections and in the captions to illustrations. A specimen may be designated as the name-bearing type even if it is known to have been lost (ICZN 1999: Article 73.1.4), and should future studies reveal one or more of the taxa described here to represent species-complexes, neotypes may be warranted (Pape *et al.* 2018). Geographic distributions are based on the labels of the type material and given by country, with provinces, states, or departments in parentheses.

Male terminalia were dissected, cleared in a heated 10% KOH solution, and neutralized in an acetic acid-ethanol solution. The dissected terminalia were temporarily mounted in glycerin on glass slides and observed and illustrated using a MOTIC K400® stereo microscope and a ZEISS M80® compound microscope, both equipped with a camera lucida. After examination and illustration, the terminalia were placed in a microvial filled with glycerin and pinned with their respective specimens. Photographs of the habitus and terminalia were taken with a Leica DFC450C digital camera coupled with a Leica M205 stereo microscope. Final composite images were digitally stacked by the software Leica Application Suite ver. 4.8.0. Images were edited using Adobe Photoshop ver. CS6® and Adobe Illustrator ver. CS6® (Adobe Systems, Inc., San Jose, CA). Label data were standardized to facilitate capture.

Terminology follows Cumming & Wood (2017) for external morphology, with the abbreviations ‘T’ and ‘ST’ given for abdominal tergites and sternites, respectively; Mello-Patiu & Pape (2000) for phallic morphology, with the term ‘paraphallus’ adopted from Whitmore *et al.* (2013); and Mello-Patiu & Santos (2001) for female terminalia.

#### **Abbreviations for morphological terms**

ce = cercus  
hy = hypoproct  
ju = juxta  
ls = lateral stylus  
ms = median stylus  
po = postgonite  
pp = paraphallus  
pr = pregonite  
sp = spiracle  
st = sternite  
su = surstylus  
t = tergite  
ve = vesica

## Results

### Taxonomy

Class Insecta Linnaeus, 1758  
Order Diptera Linnaeus, 1758  
Family Sarcophagidae Macquart, 1834  
Genus *Dexosarcophaga* Townsend, 1917

***Dexosarcophaga phoenix* sp. nov.**

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Figs 1–2, 3A–B

### Diagnosis

Vein  $R_1$  bare. Male: scutellum without apical setae; vesica funnel-shaped in ventral view (Fig. 1E); juxta like a cap or flat helmet, spread evenly across the paraphallus (Fig. 1D). Female: the two halves of T8 separated by less than the width of the cercus, each half of T8 with a deep anteromedian incision (Fig. 2A–B).

### Etymology

The species epithet '*phoenix*' should be treated as a noun in apposition. The 'Phoenix' is a mythological, resilient bird that arises from the ashes after having burned itself to death. This characteristic could symbolize a new beginning, like the start over of the Entomological Collection of Museu Nacional, Universidade Federal do Rio de Janeiro, after the tragic fire on 2 Sep. 2018 that destroyed most of its Entomological Collection, including all Sarcophagidae specimens. The new species is named in honor of the entire community of the Museu Nacional, for staying resilient after this tragic fire.

### Material examined

#### Holotype

BRAZIL • ♂; Rio de Janeiro, Itatiaia, Lagoa Azul; 26 Sep. 1954; Albuquerque and Barros leg.; MNRJ [lost].

#### Paratypes

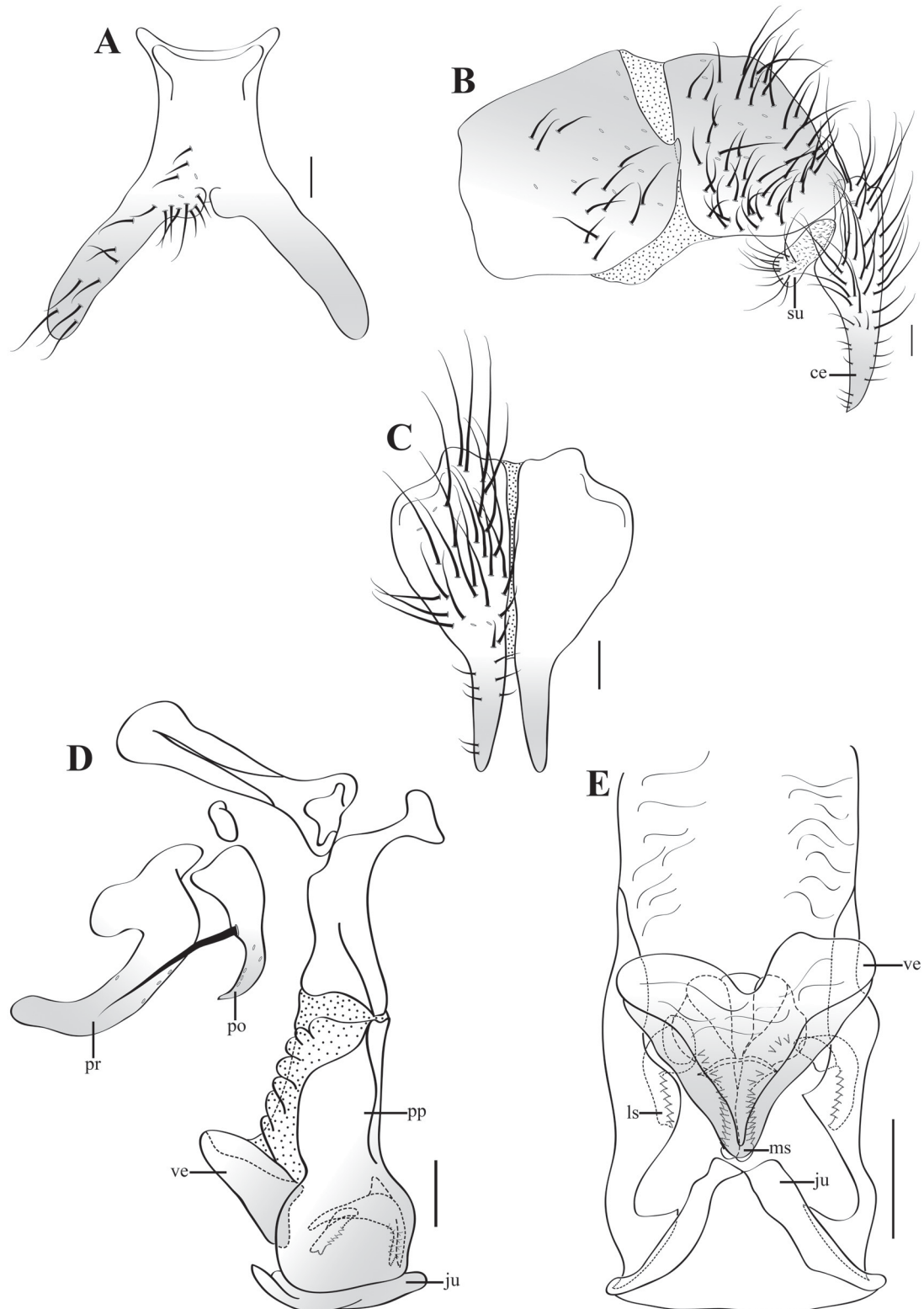
BRAZIL • 1 ♂, 2 ♀♀; Minas Gerais, Nova Lima, Lagoa Grande; 22 Feb. 1970; H.S. Lopes leg.; MNRJ [lost] • 1 ♂; Brasília, Distrito Federal; Nov. 1960; A.B. Guimarães leg.; MNRJ [lost].

### Description

#### Male (n=3)

Length: 6–8 mm.

HEAD. Parafacial, fronto-orbital plate and postocular orbits dark brown, with intense golden pollinosity (Fig. 3A); setae present on lower half of facial ridge; parafacial with row of setulae close to eye, lowermost 1–2 similar in size to subvibrissal setae; frons about  $0.20 \times$  head width at level of ocellar triangle; frontal vitta blackish; 8–11 well-developed frontal setae reaching level of apex of pedicel; rows of frontal setae parallel; reclinate orbital seta present, proclinate orbital setae absent; ocellar setae as developed as upper frontals; outer vertical seta undifferentiated from postocular setae; gena and genal groove with golden pollinosity (Fig. 3A); black setae on gena; postgena with silvery-gray pollinosity, black setae, and white setae restricted to posteriormost part (Fig. 3A); antenna dark brown (Fig. 3A); first flagellomere approximately  $3 \times$  as long as pedicel; arista long plumose on basal  $\frac{3}{4}$ ; palpus blackish (Fig. 3A).



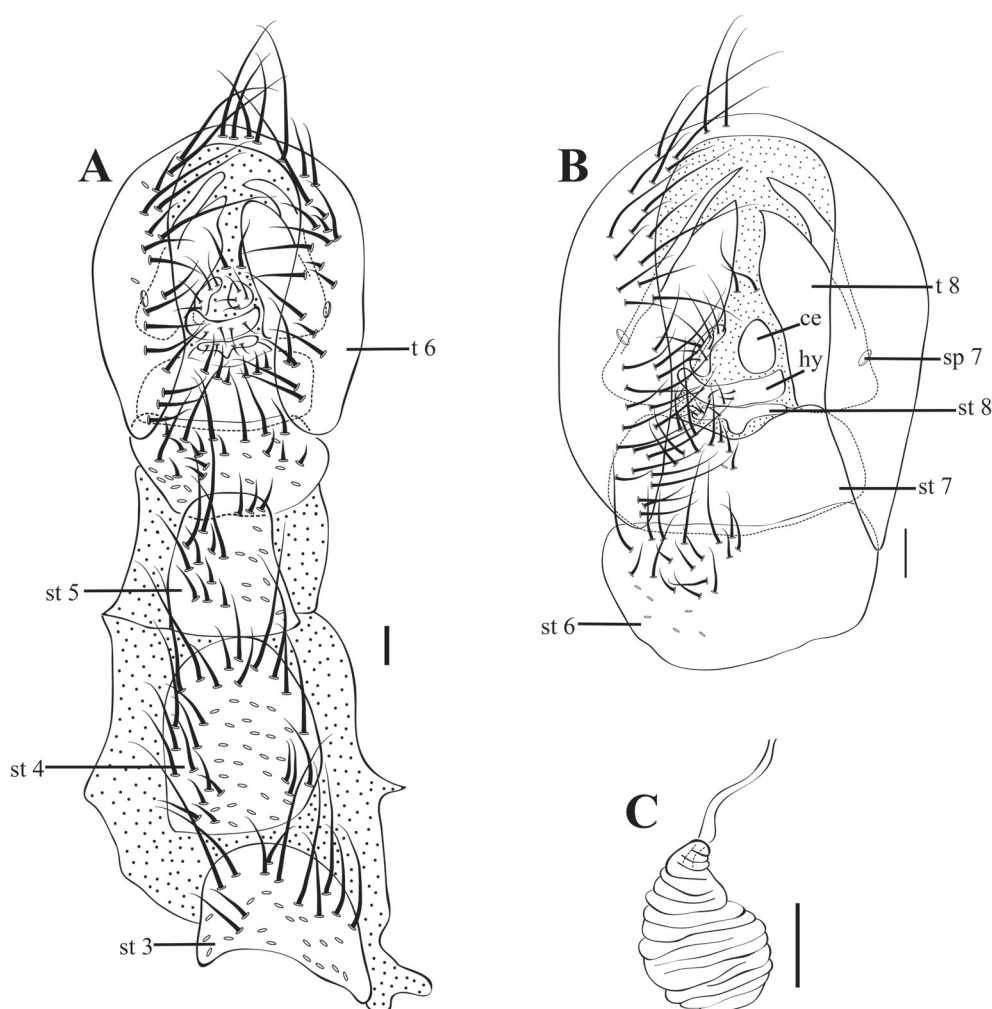
**Fig. 1.** *Dexosarcophaga phoenix* sp. nov., ♂, paratype (MNRJ [lost]), Brazil, Brasília, Distrito Federal. **A.** Sternite 5, ventral view. **B.** Syntergosternite 7+8, epandrium, cercus and surstylus, lateral view. **C.** Cerci, posterior view. **D.** Phallus and associated structures, lateral view. **E.** Distiphallus, ventral view. Abbreviations: see Material and methods. Scale bars=0.1 mm.



**THORAX.** Dark brown with silvery-gray pollinosity (Fig. 3A); chaetotaxy: acrostichals 0–1 + 1, dorsocentrals 3 (the anteriormost shorter) + 4 (two minor anterior), intra-alars 2 + 3, supra-alars 2 (the anterior one shorter) + 3, postpronotals 3, notopleurals 4; postalar wall setulose; postalar callus with 2 setae; scutellum with one pair of basal and one pair of subapical setae, pair of preapical discal setae, apical setae absent; katapisternum with 3 setae almost in straight line; meral setae 8–10; proepisternum bare; prosternum setulose.

**WING.** Hyaline, veins dark brown; tegula dark brown; basicosta yellowish; vein  $R_{4+5}$  setulose dorsally on  $\frac{2}{3}$  of distance to crossvein r-m; vein  $R_1$  bare; cell  $r_{4+5}$  open at wing margin; costal spine not differentiated; third costal sector bare ventrally.

**LEGS.** Blackish-brown, pulvilli yellowish-brown (Fig. 3A); mid femur with 2 median anterior setae, row of anteroventral setae, 2 preapical posterior setae, row of posteroventral setae and ctenidium of round spines posteroventrally; mid tibia with 1 median anterior seta, 1 basal posterior seta and 2 posterior setae in apical third; hind trochanter with normal anteromedian setae.



**Fig. 2.** *Dexosarcophaga phoenix* sp. nov., ♀, paratype (MNRJ [lost]), Brazil, Minas Gerais, Nova Lima, Lagoa Grande. **A.** Terminalia and abdominal sternites, ventral view. **B.** Terminalia, ventral view. **C.** Spermatheca, lateral view. Abbreviations: see Material and methods. Scale bars = 0.1 mm.

**ABDOMEN.** Dark brown, with silvery-gray pollinosity (Fig. 3A); T4 with 1 pair of longer median marginal setae and 1 pair of lateral marginal setae; row of about 14 marginal setae on T5; marginal setae of ST2–4 not differentiated from discal setae; ST5 deeply cleft to mid length, like inverted V; arms divergent, with sparse setae; pair of small setulose lobes almost meeting in midline; window absent (Fig. 1A).

**TERMINALIA.** Dark brown to black (Fig. 3A–B); cercus with numerous long setae in basal half and short and sparse setae in apical half; cercal prongs divergent and pointed (Fig. 1B–C); surstylus almost rectangular, with long apical setae (Fig. 1B); pregonite  $2\times$  as long as postgonite, curved like an ‘inverted C’ (Fig. 1D); postgonite with apex pointed and curved and a long seta inserted near middle of anterior margin (Fig. 1D); postgonal apodeme short and oval (Fig. 1D); basiphallus and distiphallus distinctly separated by dorsal membranous strip (Fig. 1D); vesica funnel-shaped in ventral view (Fig. 1E); juxta like cap or flat helmet (Fig. 1D–E); median stylus with enlarged base and apex narrow, slightly longer than lateral stylus, serrated laterally and with base curved towards ventral margin of paraphallus (Fig. 1D–E); lateral stylus narrow, with base slightly curved towards ventral margin of paraphallus and with apical spines (Fig. 1D–E).

#### **Female (n=2)**

Length: 6–8 mm. Differs from male as follows:

Frons about  $0.30\times$  head width at level of ocellar triangle; 2 proclinate orbital setae similar to or slightly longer than reclinate orbital seta; outer vertical seta about  $\frac{3}{4}$  length of inner vertical seta; mid femur without ctenidium; T5 with row of about 12 marginal setae; T6 undivided, broad posteriorly and with row of longer marginal setae at posterior margin (Fig. 2A–B); spiracle 6 in intersegmental membrane and spiracle 7 in tergal plate (Fig. 2A–B); T8 divided into two large and bare halves, separated by less than width of cercus, each half with deep anteromedian incision (Fig. 2A–B); marginal setae of ST2–4 slightly differentiated from discal setae (Fig. 2A); ST5 longer than wide (Fig. 2A); ST7–8 fused (Fig. 2A–B); ST6+ST7 almost rectangular (Fig. 2A–B); numerous marginal setae on ST6 (Fig. 2A–B); ST7 as long as ST6, with numerous setae along posterior margin (Fig. 2A–B); ST8 short, almost as long as ST7 (Fig. 2A–B); epiproct membranous, with one pair of setae (Fig. 2A–B); hypoproct broad (Fig. 2A–B); cercus broad and rounded (Fig. 2A–B); vaginal plate membranous; spermathecae oval and striated (Fig. 2C).

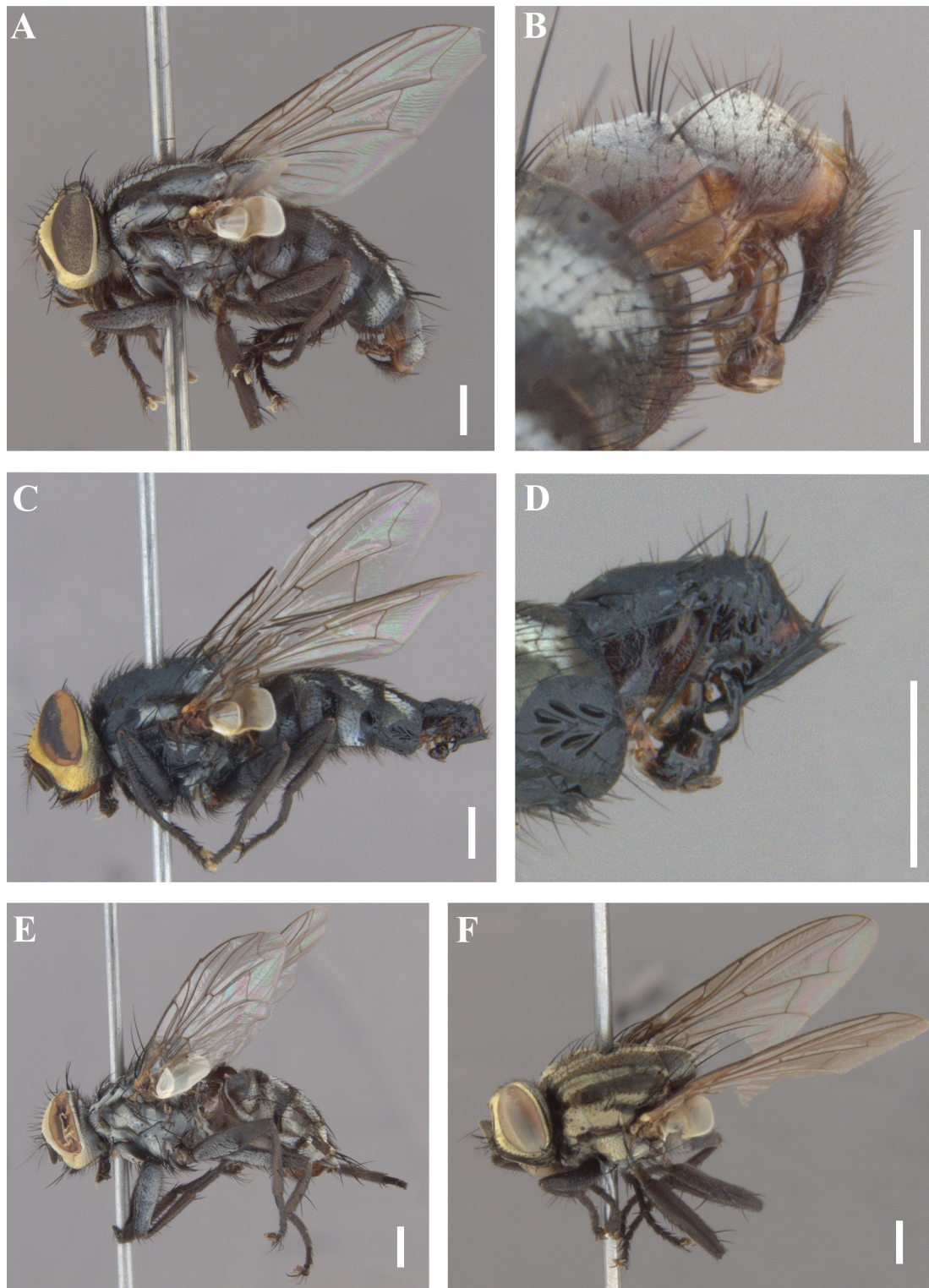
#### **Distribution**

Brazil (Distrito Federal, Minas Gerais, Rio de Janeiro).

#### **Remarks**

*Dexosarcophaga phoenix* sp. nov. is morphologically similar to *D. jandainae* sp. nov. and *D. angrensis* (Lopes, 1975). *Dexosarcophaga phoenix* sp. nov. and *D. jandainae* sp. nov. can be differentiated from *D. angrensis* by the absence of setosity on vein  $R_1$  and by the complete visibility of the juxta in lateral view (Figs 1D, 4D) as opposed to a setose vein  $R_1$  and an indistinct juxta in *D. angrensis* (Silva & Mello-Patiu 2010: figs 46–47). *Dexosarcophaga phoenix* sp. nov. and *D. jandainae* sp. nov. share a helmet-shaped juxta (Figs 1D–E, 4D–E), but they can be differentiated in particular by the shape of the vesica in ventral view, which is broadest proximally and looks like a funnel in *D. phoenix* sp. nov. (Fig. 1E), and is broadest distally and looks like an ‘X’ in *D. jandainae* sp. nov. (Fig. 4E).





**Fig. 3.** *Dexosarcophaga* spp., male habitus and terminalia. **A–B.** *Dexosarcophaga phoenix* sp. nov., holotype (MNRJ [lost]). **A.** Habitus, lateral view. **B.** Terminalia, lateral view. **C–D.** *Dexosarcophaga jandainae* sp. nov., ♂, paratype (MZUSP [lost]), Brazil, Mato Grosso, Chapada dos Guimarães. **C.** Habitus, lateral view. **D.** Terminalia, lateral view. **E.** *Dexosarcophaga patiuorum* sp. nov., ♂, holotype (MNRJ [lost]), habitus, lateral view. **F.** *Dexosarcophaga limon* sp. nov., ♂, holotype (INBio [lost]), habitus, lateral view. Scale bars = 1.0 mm.



***Dexosarcophaga jandainae* sp. nov.**

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Figs 3C–D, 4

**Diagnosis**

Vein R<sub>1</sub> bare. Male: scutellum without apical setae; vesica in ventral view X-shaped (Fig. 4E); juxta like a cap or helmet, spread across the paraphallus and strongly projected towards the ventral surface in lateral view, i.e., with the apical part recurving (Fig. 4D). [Female unknown.]

**Etymology**

The species epithet '*jandainae*' ('*jandaina*' + '*ae*'), a feminine genitive, is given in honor of Jandaína Rodrigues dos Santos de Oliveira, sister of the first author.

**Type material**

**Holotype**

BRAZIL • ♂; Mato Grosso, Chapada dos Guimarães, Parque Nacional Chapada dos Guimarães, Trilha Cidade de Pedra; 15°18'06.1" S, 055°50'28.8" W; 21 Jan. 2012; Lamas, Nihei and team leg.; Van Someren trap (papaya); MNRJ [lost].

**Paratype**

BRAZIL • 1 ♂; same locality and collectors as for holotype; 15°17'58.34" S, 055°50'23.65" W; 15 Jan. 2013; active collection; MZUSP [lost].

**Description**

**Male** (n=2)

Length: 7–8 mm. Differs from *D. phoenix* sp. nov. as follows:

Head with 7–9 well-developed frontal setae reaching level of apex of pedicel; acrostichals 3 (weakly differentiated) + 1; intra-alars 2+2, meral setae 7–9; T4 with 2–3 pairs of lateral marginal setae; row of about 12 marginal setae on T5; inner margin of ST5 without lobes or incision (Fig. 4A); cercal prong truncated in lateral view (Fig. 4B); surstylus slightly curved (Fig. 4B); pregonite 1.5 × as long as postgonite (Fig. 4D); postgonite with long seta inserted near slightly dilated region in anteroapical corner (Fig. 4D); vesica X-shaped in ventral view (Fig. 4E); juxta strongly projected towards ventral surface in lateral view (Fig. 4D); median stylus narrow, as long as lateral stylus and with apical spines (Fig. 4D–E); lateral stylus with base twisted towards ventral margin of paraphallus and with apical spines (Fig. 4D–E).

**Female**

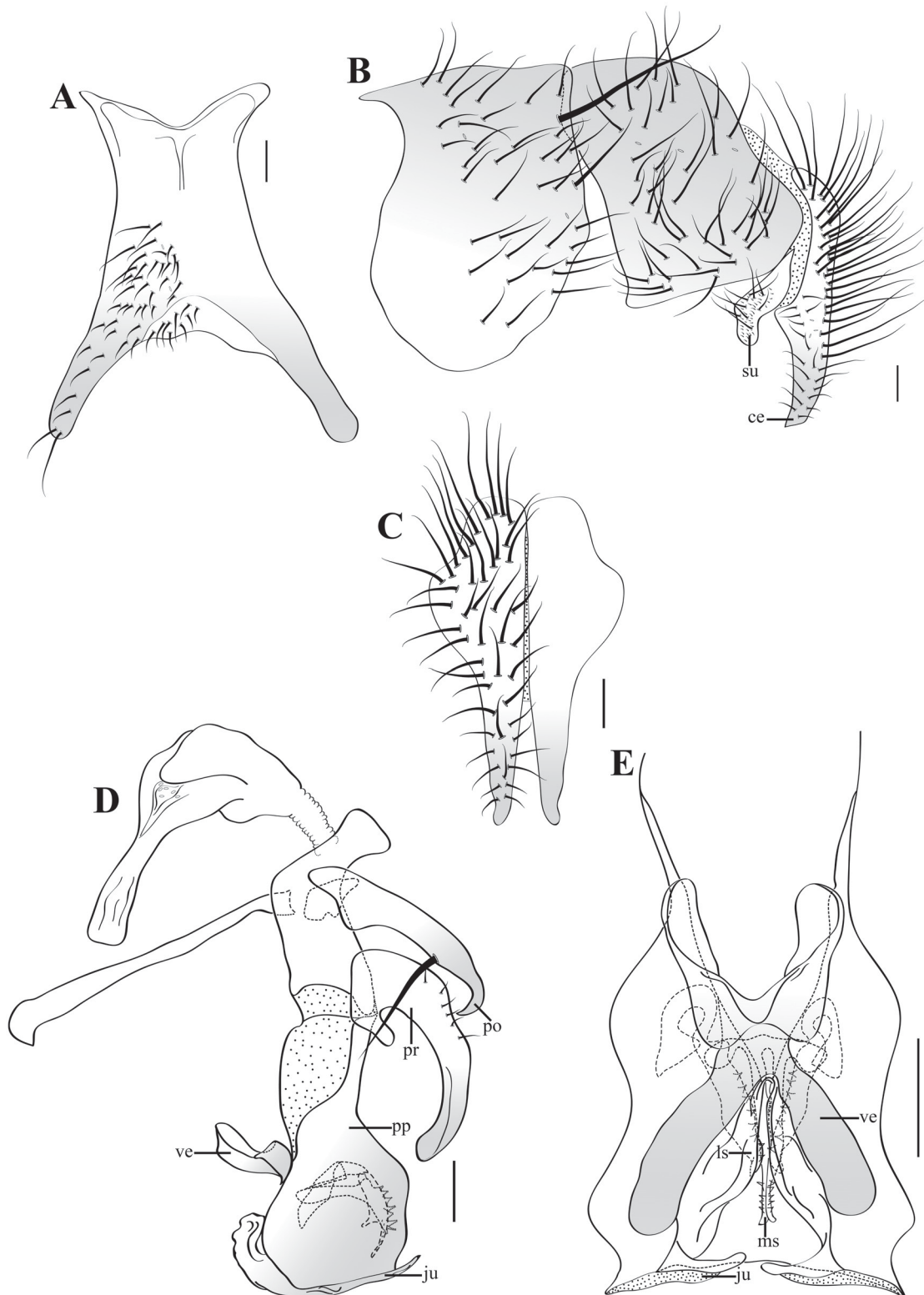
Unknown.

**Distribution**

Brazil (Mato Grosso).

**Remarks**

*Dexosarcophaga jandainae* sp. nov. is morphologically similar to *D. phoenix* sp. nov., but differs as mentioned in the remarks for that species.



**Fig. 4.** *Dexosarcophaga jandainae* sp. nov., ♂, holotype (MNRJ [lost]). **A.** Sternite 5, ventral view. **B.** Syntergosternite 7+8, epandrium, cercus and surstylus, lateral view. **C.** Cerci, posterior view. **D.** Phallus and associated structures, lateral view. **E.** Distiphallus, ventral view. Abbreviations: see Material and methods. Scale bars=0.1 mm.

*Dexosarcophaga patiuorum* sp. nov.

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Figs 3E, 5

**Diagnosis**

Vein R<sub>1</sub> setulose. Male: Scutellum with a pair of apical setae; vesica rectangular with an apical projection in lateral view (Fig. 5C); juxta smooth and recessed within paraphallus (Fig. 5C–D). [Female unknown.]

**Etymology**

The species epithet '*patiuorum*' ('*patiu*' + '*orum*'), a masculine plural genitive, is given in honor of the husband (Claudemir Patiu) and two sons (Fabio Patiu and Felipe Patiu) of the third author.

**Material examined**

**Holotype**

BRAZIL • ♂; Mato Grosso do Sul, Rio Verde; 18°09'39.4" S, 54°09'02.4" W; 30 Aug.–14. Sep. 2012; Lamas, Nihei and team leg.; Malaise trap; MNRJ [lost].

**Description**

**Male** (n = 1)

Length: 8 mm. Differs from *D. phoenix* sp. nov. as follows:

Frons about 0.28 × head width at level of ocellar triangle; 10 well-developed frontal setae reaching level of apex of pedicel; first flagellomere approximately 4 × as long as pedicel; acrostichals 3 (weakly differentiated) + 1; intra-alars 2 + 2, postpronotals 2; meral setae 7–8; vein R<sub>1</sub> setulose; row of about 10 marginal setae on T5; marginal setae of ST2–4 slightly differentiated from discal setae; surstylus almost triangular (Fig. 5A); pregonite 1.5 × as long as postgonite, base narrow, apex broad and anterior margin dilated at middle (Fig. 5C); postgonite broad, with long seta inserted at middle of anterior margin (Fig. 5C); two longitudinal keels along posterior margin of basiphallus, and paraphallus with few short spines along ventral margin (Fig. 5C); vesica rectangular, with apical projection in lateral view (Fig. 5C); juxta smooth and recessed within paraphallus (Fig. 5C–D); median stylus robust, longer than lateral stylus and with base bent dorsally (Fig. 5D); lateral stylus with enlarged base slightly twisted towards ventral margin of paraphallus and with apical spines (Fig. 5C–D).

**Female**

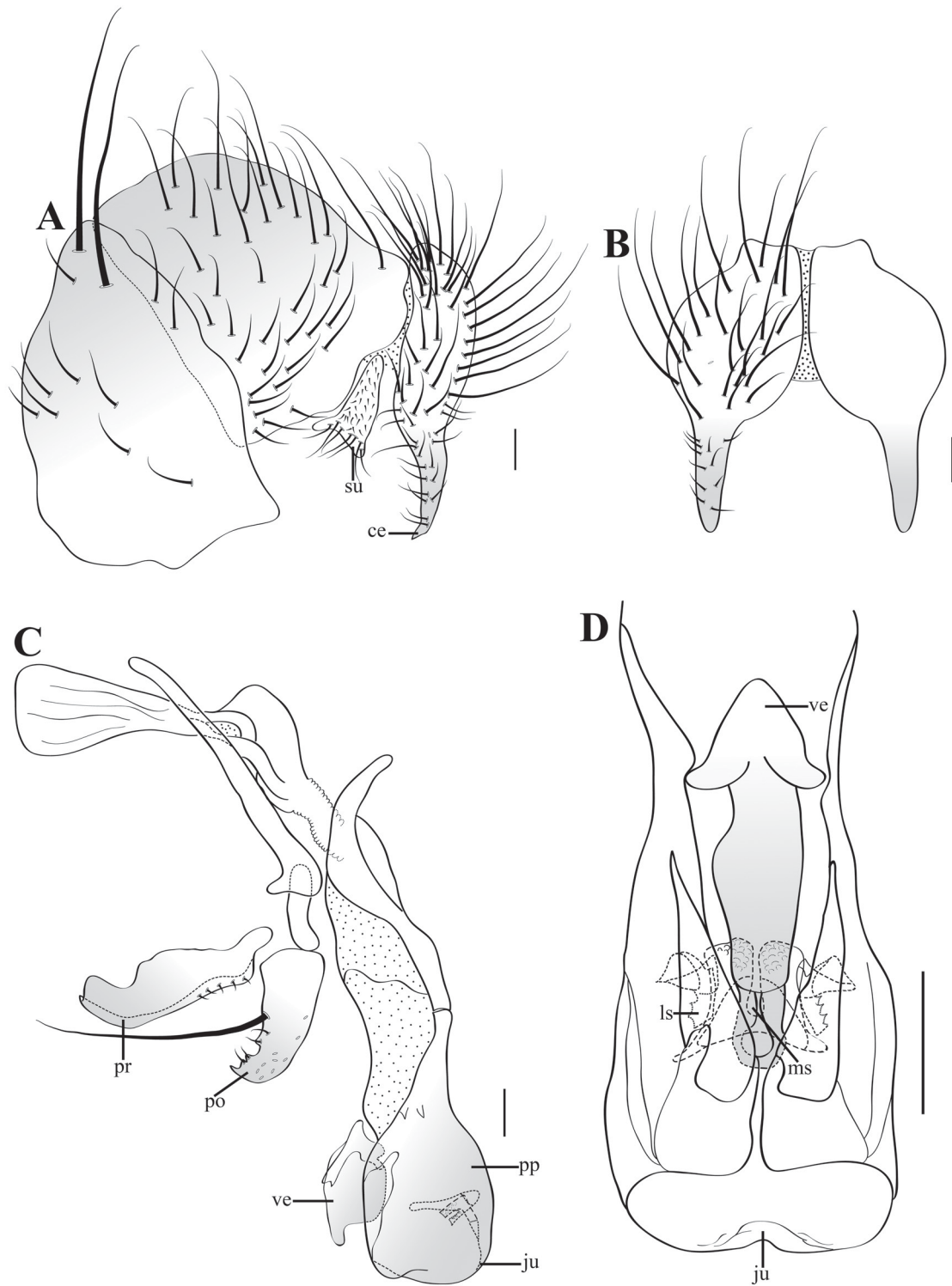
Unknown.

**Distribution**

Brazil (Mato Grosso do Sul).

**Remarks**

*Dexosarcophaga patiuorum* sp. nov. is morphologically similar to *D. guyi* Mello-Patiu, 2000 by having basiphallus with two longitudinal keels and paraphallus with short spines (Fig. 5C; Mello-Patiu 2000: figs 4, 7). These two species can be differentiated by the following features: vesica rectangular, with an apical projection in lateral view (Fig. 5C), and paraphallus with short spines on ventral margin (Fig. 5C) in *Dexosarcophaga patiuorum* sp. nov., versus vesica triangular in lateral view and paraphallus with short spines on dorsal margin (Mello-Patiu 2000: figs 4, 7) in *Dexosarcophaga guyi*.



**Fig. 5.** *Dexosarcophaga patiuorum* sp. nov., ♂, holotype (MNRJ [lost]). **A.** Syntergosternite 7+8, epandrium, cercus and surstylus, lateral view. **B.** Cerci, posterior view. **C.** Phallus and associated structures, lateral view. **D.** Distiphallus, ventral view. Abbreviations: see Material and methods. Scale bars=0.1 mm.



***Dexosarcophaga limon* sp. nov.**

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Figs 3F, 6

**Diagnosis**

Vein  $R_1$  bare. Male: scutellum with a pair of reduced apical setae; vesica with a ventral, sclerotized lobe (Fig. 6D–E); juxta folding around tip of paraphallus and with numerous spine-like processes (Fig. 6D–E). [Female unknown.]

**Etymology**

The species epithet '*limon*' should be treated as a noun in apposition. The name refers to the province where the type locality of the new species is located.

**Material examined**

**Holotype**

COSTA RICA • ♂; Limón, 15 km S of Siquierres, Las Brisas, Nairi-Barbilla nr Rio Dantas; alt. 300–500 m; 21–28 Aug. 1996; Gustafsson, Pape and Viklund leg.; INBio [lost].

**Description**

**Male** (n=1)

Length: 8 mm. Differs from *D. phoenix* sp. nov. as follows:

Frons about  $0.25 \times$  head width at level of ocellar triangle; 10 well-developed frontal setae reaching level of apex of pedicel; first flagellomere approximately  $4 \times$  as long as pedicel; thorax with slightly yellowish-silver pollinosity (Fig. 3F); intra-alars 2+2, postpronotals 2; meral setae 5–7; scutellum with pair of reduced apical setae; abdomen dark brown, with golden pollinosity; T5 with row of 12 marginal setae; cercus with pointed apex (Fig. 6B–C); surstylus trapezium-shaped in lateral view (Fig. 6B); pregonite almost straight,  $1.5 \times$  length of postgonite and with broad base (Fig. 6D); vesica consisting of membranous and sclerotized areas and with ventral dark lobe with 2–3 spines (Fig. 6D–E); juxta equipped with numerous spines (Fig. 6D–E); median stylus with enlarged base and narrow apex, slightly shorter than lateral stylus, base curved towards ventral and dorsal margins of paraphallus and with apical spines (Fig. 6D–E); lateral stylus with base slightly curved towards ventral margin of paraphallus and with apical spines (Fig. 6D–E).

**Female**

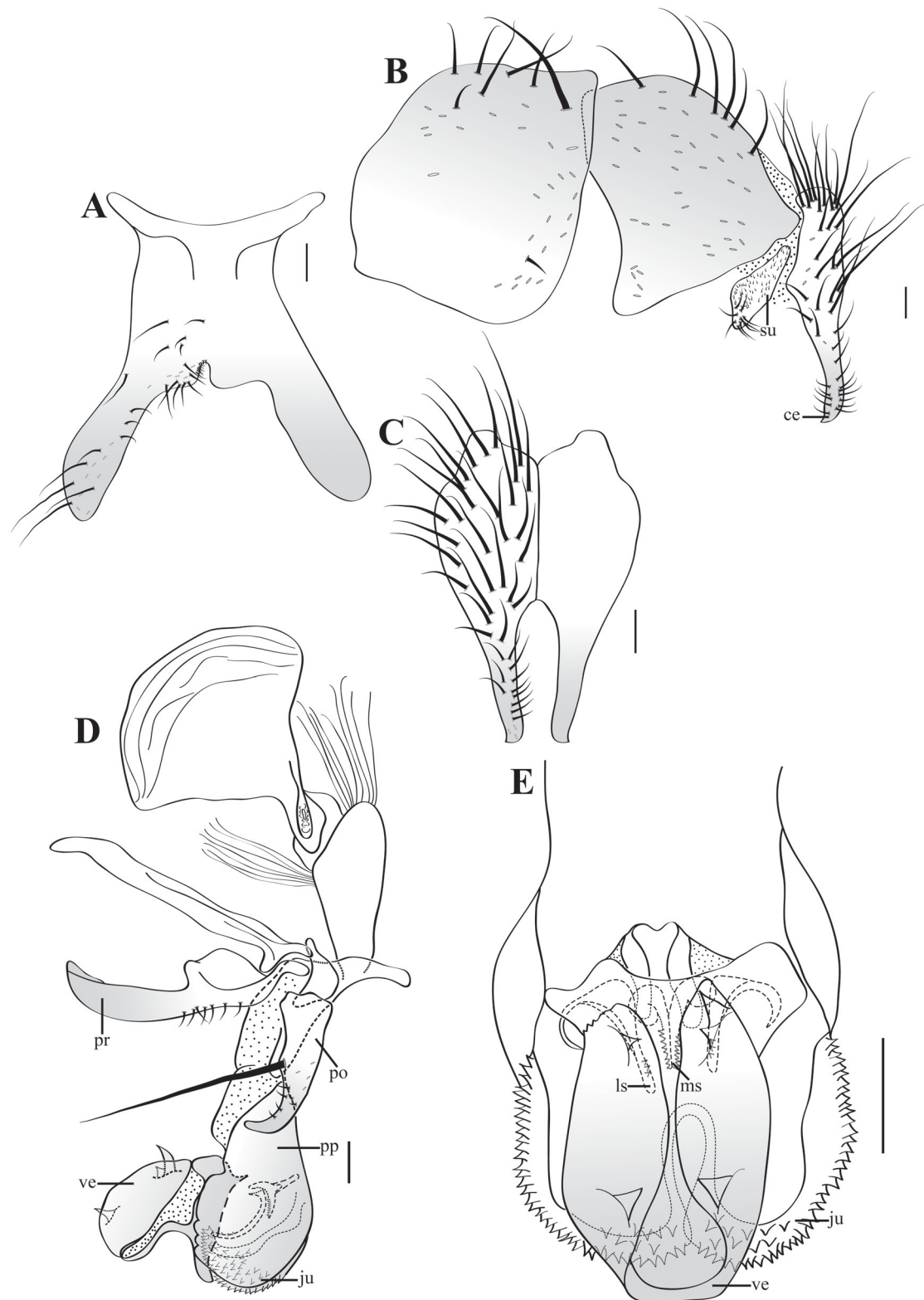
Unknown.

**Distribution**

Costa Rica (Limón).

**Remarks**

*Dexosarcophaga limon* sp. nov. is morphologically similar to *D. petra* sp. nov. and *D. paulistana* (Lopes, 1982) by having a vesica with a rounded lobe in lateral view (Figs 6D, 7D; Lopes 1982a: fig. 58). *Dexosarcophaga limon* sp. nov. and *D. petra* sp. nov. can be differentiated from *D. paulistana* by the distally completely rounded vesica (Figs 6D, 7D) and with a digitiform projection distally in *D. paulistana* (Lopes 1982a: fig. 58). Males of *D. limon* sp. nov. can be differentiated from those of *D. petra* sp. nov. by the following features: ST5 with arm-like processes almost parallel-sides in middle part, apically rounded, and almost half as long as sternite (Fig. 6A), cercus almost straight in lateral view (Fig. 6B), and juxta with small spines apically (Fig. 6D–E). In *D. petra* sp. nov., these features appear



**Fig. 6.** *Dexosarcophaga limon* sp. nov., ♂, holotype (INBio [lost]). **A.** Sternite 5, ventral view. **B.** Syntergosternite 7+8, epandrium, cercus and surstylus, lateral view. **C.** Cerci, posterior view. **D.** Phallus and associated structures, lateral view. **E.** Distiphallus, ventral view. Abbreviations: see Material and methods. Scale bars=0.1 mm.

as follows: ST5 with arm-like processes gradually tapering, apically pointed and distinctly shorter than half of sternite, and with two small but distinct lobes projecting near the midline (Fig. 7A); apical half of cercus curved anteriorly (Fig. 7B), and juxta with small spines only at base (Fig. 7D–E).

***Dexosarcophaga petra* sp. nov.**

urn:lsid:zoobank.org:act:8111ED83-4557-480F-999C-B35B14922B24

Figs 7, 8A

**Diagnosis**

Vein R<sub>1</sub> bare. Male: scutellum with a pair of reduced apical setae; vesica rounded with an apical projection in lateral view and rectangular with two projections in inferior part and two thorny projections in superior part in ventral view (Fig. 7D–E); juxta with spines at base (Fig. 7D–E). [Female unknown.]

**Etymology**

The species epithet ‘*petra*’ should be treated as a noun in apposition. The name is a Latin noun ‘*petra*’, meaning ‘stone’ (= ‘pedra’ in Portuguese) and refers to the type locality of the new species (Trilha Cidade de Pedra).

**Material examined**

**Holotype**

BRAZIL • 1 ♂; Mato Grosso, Parque Nacional Chapada dos Guimarães, cerrado, Trilha Cidade de Pedra, mirante; 15°24′21.8″ S, 055°50′07.5″ W; 9 Mar.–18 Apr. 2012; Lamas, Nihei and team leg.; Malaise trap; MNRJ [lost].

**Paratypes**

BRAZIL • 1 ♂; same collection data as for holotype; 18 Apr.–2 Jul. 2012; MZUSP [lost] • 1 ♂; Rio de Janeiro, Angra dos Reis, Japuhya [date not given]; J. Lane and H.S. Lopes leg.; MNRJ [lost].

**Description**

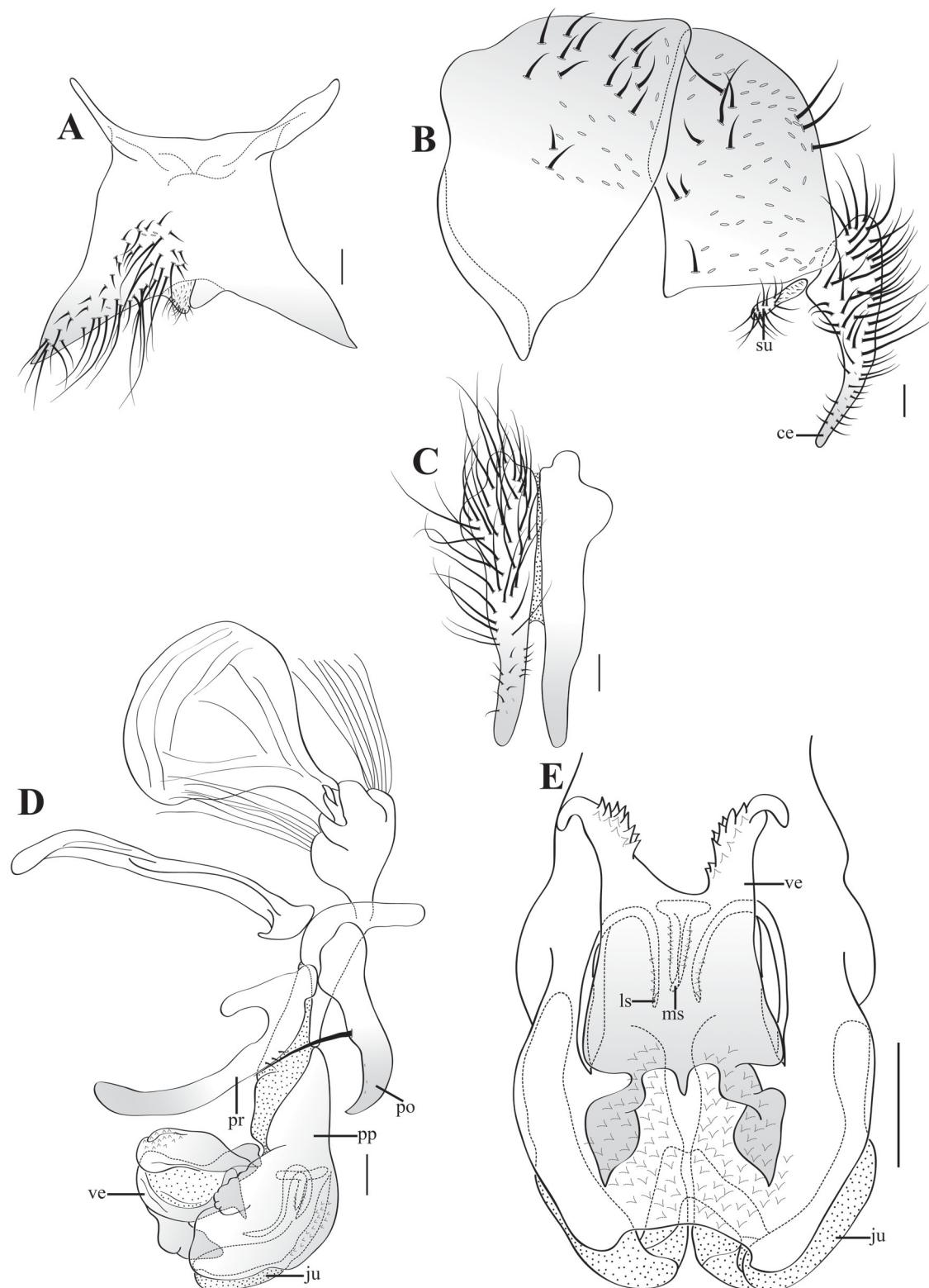
**Male** (n=3)

Length: 7–11 mm. Differs from *D. phoenix* sp. nov. as follows:

Frons about 0.18 × head width at level of ocellar triangle; 9–12 well-developed frontal setae reaching level of apex of pedicel; gena and genal groove with slightly yellowish-silver pollinosity; intra-alars 2+2; meral setae 7–9; scutellum with pair of reduced apical setae; T4 with 1–2 pairs of lateral marginal setae; row of about 10 marginal setae on T5; arms of ST5 about half of basal length and inner margin with distinctly projected lobes (Fig. 7A); cercus with apical half curved anteriorly (Fig. 7B); cercal prong rounded (Fig. 7B–C); surstylus narrow, with long setae in apical half (Fig. 7B); vesica with membranous and sclerotized areas, rounded in lateral view with apical projection, rectangular in ventral view with two projections in proximal part and two thorny projections in distal part (Fig. 7D–E); juxta membranous and with spines proximally (Fig. 7D–E); median stylus narrow, with apical spines, shorter than lateral stylus and with base expanded towards ventral and dorsal margins of paraphallus (Fig. 7D–E); lateral stylus narrow, base twisted towards ventral margin of paraphallus and with apical spines (Fig. 7D–E).

**Female**

Unknown.



**Fig. 7.** *Dexosarcophaga petra* sp. nov., ♂, paratype (MNRJ [lost]), Brazil, Rio de Janeiro, Angra dos Reis. **A.** Sternite 5, ventral view. **B.** Syntergosternite 7+8, epandrium, cercus and surstylus, lateral view. **C.** Cerci, posterior view. **D.** Phallus and associated structures, lateral view. **E.** Distiphallus, ventral view. Abbreviations: see Material and methods. Scale bars=0.1 mm.



**Distribution**

Brazil (Mato Grosso, Rio de Janeiro).

**Remarks**

*Dexosarcophaga petra* sp. nov. is morphologically similar to *D. limon* sp. nov. (see remarks under that species). There are also similarities with *D. malaisei* Dodge, 1968 and *D. salgada* De-Souza, Souza, Soares & Carvalho-Filho, 2020 (De-Souza *et al.* 2021). Males of these species have cercus curved and vesica mostly rounded. Lopes (1975c) reviewed the morphology of *D. malaisei* and commented that the terminalia of the holotype were lost apart from syntergosternite 7+8 (= “first genital segment”). However, since the species does not have paratypes and the illustrations of the phallus provided by Dodge (1968: figs 17–18) are sketchy and insufficient for recognizing *D. malaisei*, we cannot make a detailed morphological comparison between these three nominal species. Consequently, either *D. petra* or *D. salgada* could be a junior synonym of *D. malaisei*, but we will here rely particularly on the shape of the male pregonite and cercus as illustrated by Dodge (1968: fig. 17). The evenly curved or C-shaped pregonite and the cercus that is straight over most of its length and curved in the distal fourth appear sufficiently different from both *D. petra* (pregonite with middle part straight; cercus bent rather than curved) and from *D. salgada* (pregonite with only distal part curved; cercus evenly curved) to reject conspecificity. Therefore, we consider *D. petra* and *D. salgada* as valid nominal species until future studies produce material from the type locality of *D. malaisei* (i.e., Barro Colorado, Panama), allowing a better resolution of this question. *Dexosarcophaga petra* and *D. salgada* can be separated by the following differences in the shape of the vesica in particular: broadest proximally (lateral view), with broad median fissure, without median knob-like projections and with an apical projection in lateral view (Fig. 7D) in *D. petra*, versus broadest distally, with narrow median fissure, a pair of median knob-like projections and without an apical projection in lateral view in *D. salgada* (De-Souza *et al.* 2021: fig. 3g–i).

***Dexosarcophaga sphaera* sp. nov.**

urn:lsid:zoobank.org:act:E5DD7085-DF04-4E1F-BDFD-BFA0BEE94A79

Figs 8B–D, 9–10

**Diagnosis**

Vein R<sub>1</sub> bare. Male: scutellum with a pair of reduced apical setae; vesica like a small sclerotized plate (Fig. 9D–E); juxta like a narrow band (Fig. 9D–E). Female: the two halves of T8 widely separated by at least four times the width of cercus, each half pointed in its median part (Fig. 10A–B).

**Etymology**

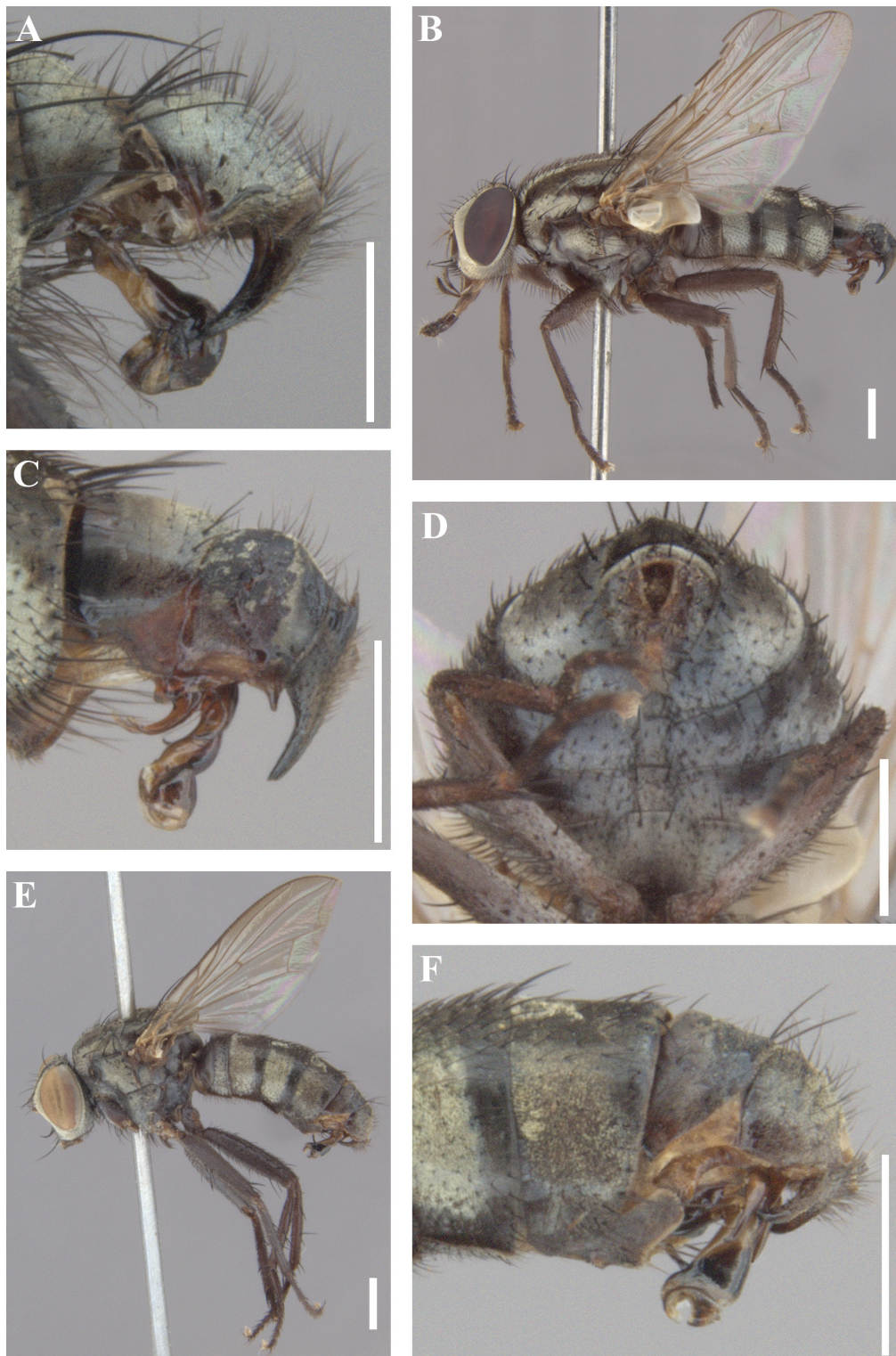
The species epithet ‘*sphaera*’ should be treated as a noun in apposition. The name is a Latin noun ‘*sphaera*’, meaning ‘ball’ and alluding to the spherical paraphallus.

**Material examined****Holotype**

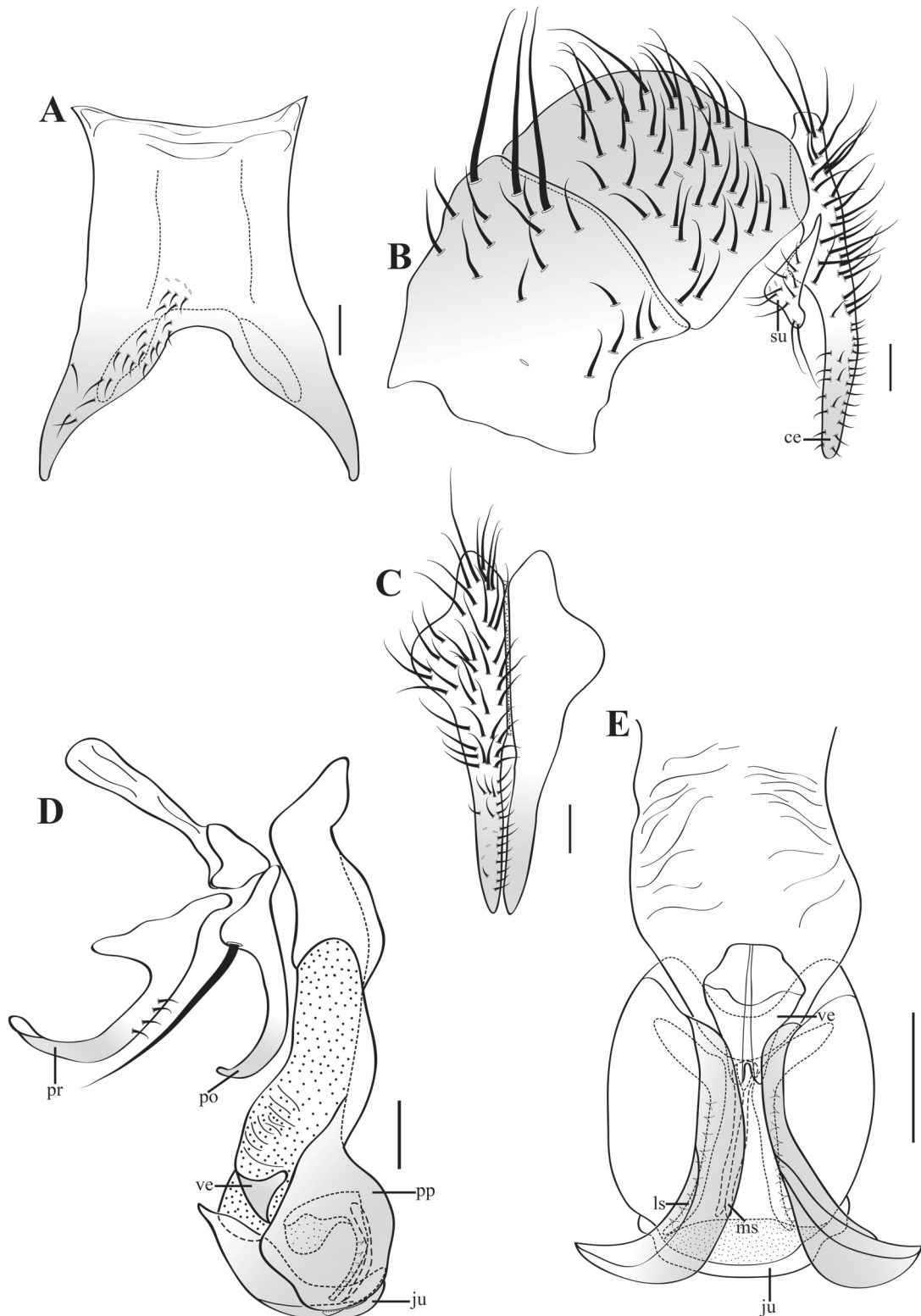
BRAZIL • ♂; Roraima, Surumu; Sep. 1966; M. Alvarenga leg.; MNRJ [lost].

**Paratypes**

BRAZIL • 1 ♂: same collection data as for holotype; MNRJ [lost] • 2 ♂♂; Minas Gerais, Uberlândia, Clube Caça e Pesca Itororó, Cerrado Campo Sujo; 18°58′59.48″ S, 48°17′50″ W; 24 Jul. 2005; J. Mendes leg.; MNRJ [lost] • 1 ♂; Pernambuco, Tamandaré; R.F.R. Carmo leg.; MNRJ [lost] • 1 ♂, 4 ♀♀; Brasília, Distrito Federal, Fazenda Vargem Bonita; 29 Jul. 1968; R. Kano leg.; MNRJ [lost] • 1 ♂; Brasília, Distrito Federal; alt. 1000 m; 15–30 May 1957; Barros-Albuquerque leg.; MNRJ [lost].



**Fig. 8.** *Dexosarcophaga* spp., ♂ and ♀, habitus and terminalia. **A.** *Dexosarcophaga petra* sp. nov., ♂, paratype (MNRJ [lost]), Brazil, Mato Grosso, Chapada dos Guimarães, terminalia, lateral view. **B–D.** *Dexosarcophaga sphaera* sp. nov., paratypes (MNRJ [lost]), Brazil, Brasília, Distrito Federal, Fazenda Vargem Bonita. **B.** ♂, habitus, lateral view. **C.** ♂, terminalia, lateral view. **D.** ♀, terminalia, ventral view. **E–F.** *Dexosarcophaga napo* sp. nov., ♂, paratype (NHRS [lost]), Ecuador, Napo Prov. **E.** Habitus, lateral view. **F.** Terminalia, lateral view. Scale bars = 1.0 mm.



**Fig. 9.** *Dexosarcophaga sphaera* sp. nov., ♂, paratype (MNRJ [lost]), Brazil, Minas Gerais, Uberlândia. **A.** Sternite 5, ventral view. **B.** Syntergosternite 7+8, epandrium, cercus and surstylus, lateral view. **C.** Cerci, posterior view. **D.** Phallus and associated structures, lateral view. **E.** Distiphallus, ventral view. Abbreviations: see Material and methods. Scale bars=0.1 mm.

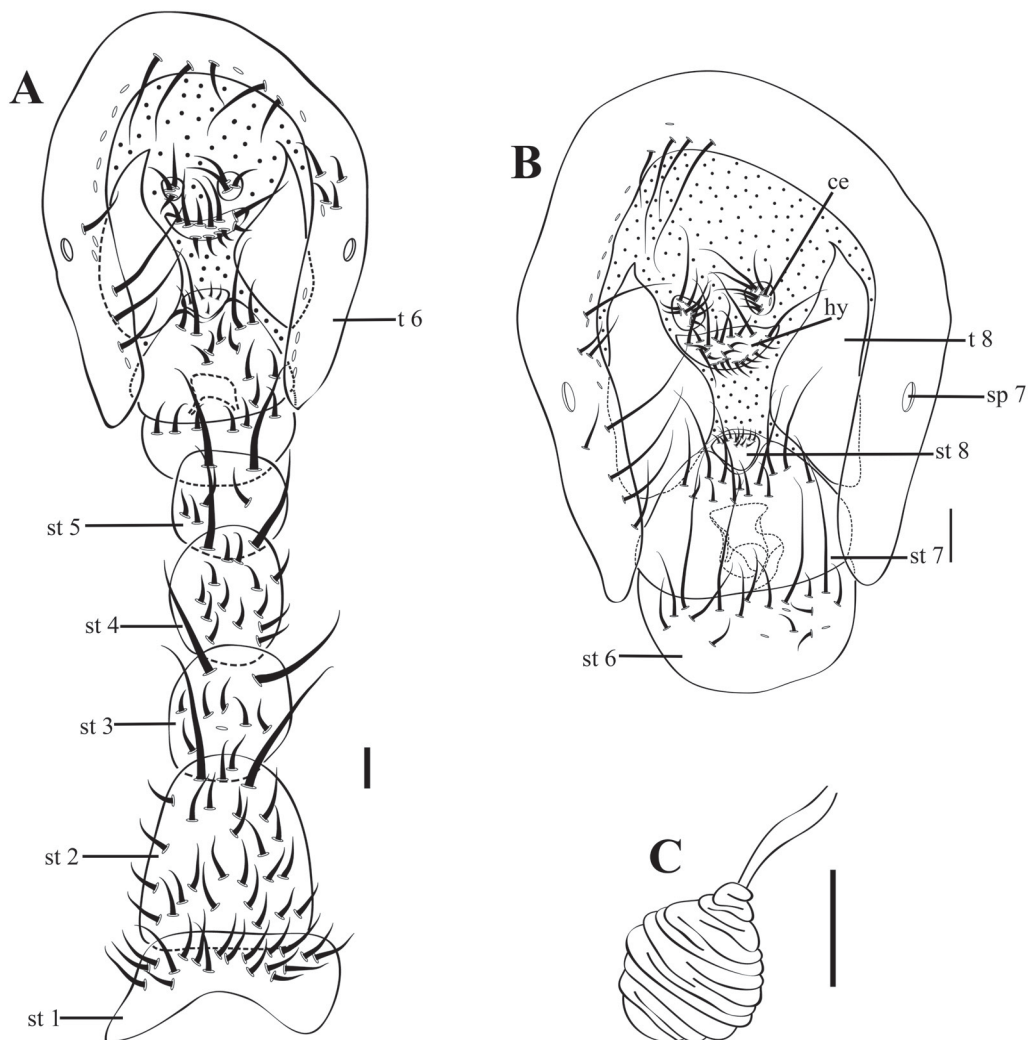


## Description

### Male (n=7)

Length: 6–9 mm. Differs from *D. phoenix* sp. nov. as follows:

Frons about  $0.18 \times$  head width at level of ocellar triangle; 7–10 well-developed frontal setae reaching level of apex of pedicel; gena and genal groove with slightly yellowish-silver pollinosity (Fig. 8B); first flagellomere approximately  $4 \times$  as long as pedicel; thorax with slightly yellowish-silver pollinosity (Fig. 8B); intra-alars 2+2; meral setae 8–11; scutellum with pair of reduced apical setae; abdomen dark brown, with slightly yellowish-silver pollinosity (Fig. 8B); T4 with 2 pairs of lateral marginal setae; row of about 12 marginal setae on T5; inner margin of ST5 without lobes or an incision but with elongate pad-shaped protrusion (Fig. 9A); cercal prong rounded in lateral view (Fig. 9B); surstylus almost triangular (Fig. 9B); pregonite as long as postgonite (Fig. 9D); postgonite with long seta inserted near the slightly dilated anterobasal corner (Fig. 9D); vesica in lateral view in shape of small sclerotized triangular plate (Fig. 9D–E); juxta like narrow band (Fig. 9D–E); median stylus narrow, as long as



**Fig. 10.** *Dexosarcophaga sphaera* sp. nov., ♀, paratype (MNRJ [lost]), Brazil, Brasília, Distrito Federal, Fazenda Vargem Bonita). **A.** Terminalia and abdominal sternites, ventral view. **B.** Terminalia, ventral view. **C.** Spermatheca, lateral view. Abbreviations: see Material and methods. Scale bars=0.1 mm.



lateral stylus (Fig. 9D–E); lateral stylus with base expanded towards ventral margin of paraphallus and equipped with spines apically (Fig. 9D–E).

#### **Female (n=4)**

Length: 6–9 mm; frons about  $0.29 \times$  head width at level of ocellar triangle; scutellum without apical setae; T5 with 10 marginal setae; T8 divided into two large and bare halves, widely separated by at least  $4 \times$  as wide as cercus, each half pointed in its median part (Fig. 10A–B); ST2–5 with one pair of long setae (Fig. 10A); ST5 almost square (Fig. 10A); ST6–8 fused (Fig. 10A–B); ST7 about  $2 \times$  as long as ST6 (Fig. 10A–B); ST8 rounded (Fig. 10A–B); epiproct membranous, without setae (Fig. 10A–B); vaginal plate sclerotized (Fig. 10A–B).

#### **Distribution**

Brazil (Distrito Federal, Minas Gerais, Pernambuco, Roraima).

#### **Remarks**

*Dexosarcophaga sphaera* sp. nov. is similar to *D. globulosa* Lopes, 1946. Males of both species have paraphallus with a pointed projection on distal half and juxta like a narrow band (Fig. 9D–E; Mello 1996: figs 16, 18). These two species can be differentiated by the following features: postgonite with long seta inserted near a slightly dilated region in anterobasal corner (Fig. 9D), vesica short (Fig. 9D–E), and elongated lateral and median styli (Fig. 9D–E) in *D. sphaera* sp. nov., versus postgonite with long seta inserted near a slightly dilated region in anteroapical corner (Mello 1996: figs 13–14), vesica conspicuous (Mello 1996: figs 16–17), and short lateral and median styli (Mello 1996: figs 16, 18) in *D. globulosa*.

#### ***Dexosarcophaga napo* sp. nov.**

urn:lsid:zoobank.org:act:7D291A80-C95E-4B05-A495-2BFC055F6FA6

Figs 8E–F, 11

#### **Diagnosis**

Vein  $R_1$  setulose. Male: scutellum without apical setae; pregonite with distal part curved and with a spine-like projection (Fig. 11D); vesica stick-like in lateral view, extremities enlarged in ventral view (Fig. 11D–E); juxta mostly membranous and almost squared (Figs 8F, 11D). [Female unknown.]

#### **Etymology**

The species epithet ‘*napo*’ should be treated as a noun in apposition. The name refers to the province (named after the Río Napo) of the type locality of the new species.

#### **Material examined**

##### **Holotype**

ECUADOR • ♂; Napo Province, Yasuní National Park, Yasuní Research Station; 00°38' S, 76°36' W; Nov. 1998; T. Pape and B. Viklund leg.; NHRS [lost].

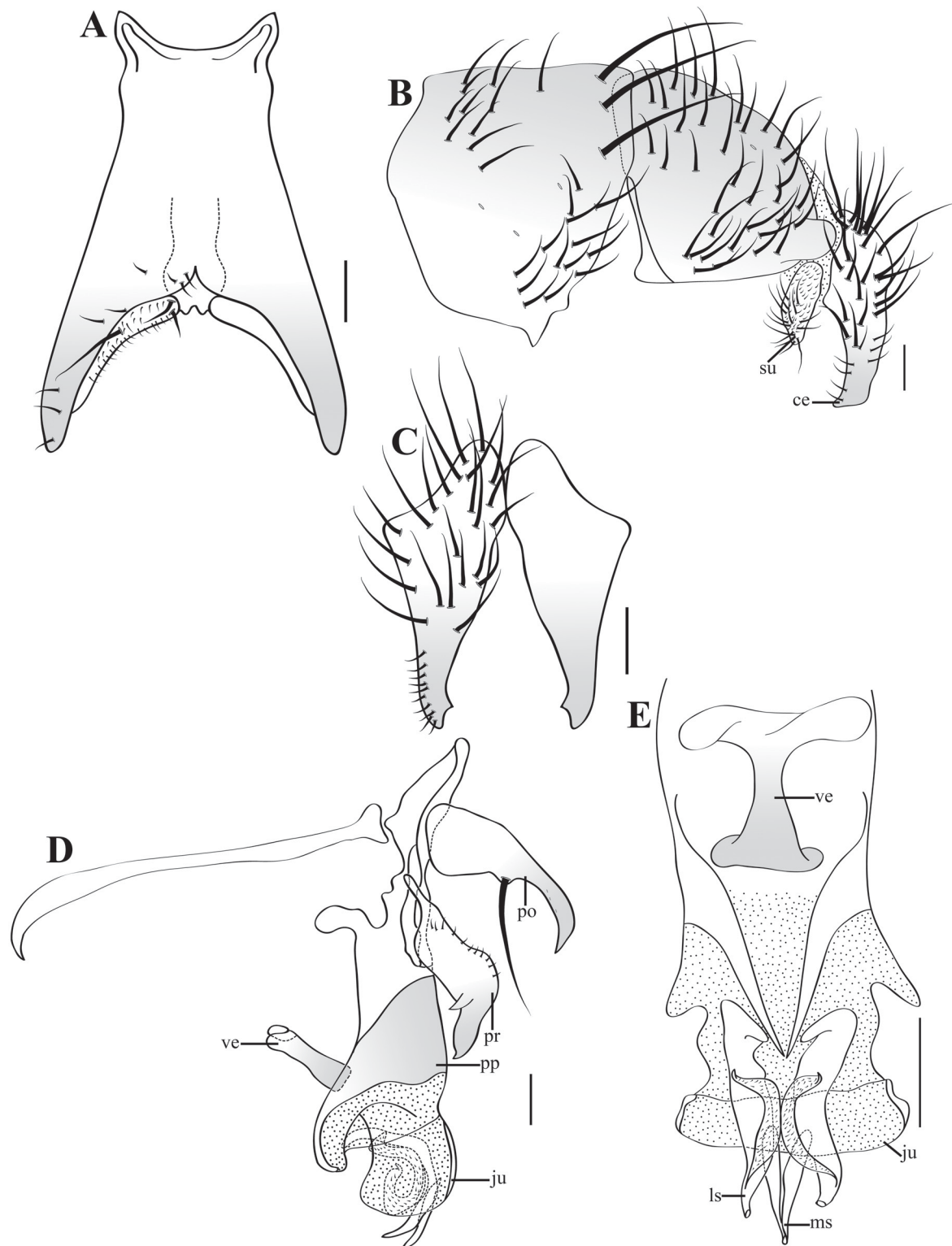
##### **Paratypes**

ECUADOR • 4 ♂♂: same collection data as for holotype; NHRS [lost].

#### **Description**

##### **Male (n=5)**

Length: 5–7 mm. Differs from *D. phoenix* sp. nov. as follows:



**Fig. 11.** *Dexosarcophaga napo* sp. nov., ♂, holotype (NHRS [lost]). **A.** Sternite 5, ventral view. **B.** Syntergosternite 7+8, epandrium, cercus and surstylus, lateral view. **C.** Cerci, posterior view. **D.** Phallus and associated structures, lateral view. **E.** Distiphallus, ventral view. Abbreviations: see Material and methods. Scale bars=0.1 mm.

Frons about  $0.28 \times$  head width at level of ocellar triangle; 5–8 well-developed frontal setae reaching level of apex of pedicel; gena and genal groove with slightly yellowish-silver pollinosity (Fig. 8E); first flagellomere approximately  $4 \times$  as long as pedicel; thorax with slightly yellowish-silver pollinosity (Fig. 8E); acrostichals 3 (weakly differentiated) + 1; dorsocentrals 3 (anteriormost shorter) + 3 (well differentiated); intra-alars 2 + 2; meral setae 5–7; vein  $R_1$  setulose; third costal sector setulose ventrally; abdomen dark brown, with slightly yellowish-silver pollinosity (Fig. 8E–F); T4 with 1–2 pairs of lateral marginal setae; row of about 10 marginal setae on T5; short incision along inner margin of ST5 and arms with pad-shaped protrusion (Fig. 11A); cercal prongs convergent in posterior view and truncated in lateral view (Fig. 11B–C); pregonite as long as postgonite, apical half curved and with spine-like projection (Fig. 11D); ventral margin of basiphallus with projection (Fig. 11D); vesica stick-like in lateral view and apically enlarged in ventral view (Fig. 11D–E); juxta mostly membranous and almost squared (Fig. 11D–E); median stylus tube-like with developed projection, shorter than lateral stylus, and with narrow apex (Fig. 11D–E); lateral stylus tube-like, with base twisted towards ventral margin of paraphallus (Fig. 11D–E).

### **Female**

Unknown.

### **Distribution**

Ecuador (Napo).

### **Remarks**

*Dexosarcophaga napo* sp. nov. is morphologically similar to *Dexosarcophaga inaequalis* Lopes, 1975. Males of both species have a stick-like vesica in lateral view (Fig. 11D; Silva & Mello-Patiu 2010: figs 53–54) and paraphallus with a projected lobe ventrally (Fig. 11D; Silva & Mello-Patiu 2010: figs 53–54). These two species can be differentiated by the following features: basiphallus with a conspicuous projection at ventral margin (Fig. 11D), projected lobe of paraphallus pointing distally in lateral view (Fig. 11D), and median stylus with a developed projection (Fig. 11D–E) in *Dexosarcophaga napo* sp. nov., versus basiphallus without a conspicuous projection at ventral margin (Silva & Mello-Patiu 2010: fig. 53), projected lobe of paraphallus pointing ventrally in lateral view (Silva & Mello-Patiu 2010: figs 53–54), and median stylus without a developed projection (Silva & Mello-Patiu 2010: figs 54–55) in *Dexosarcophaga inaequalis*.

### ***Dexosarcophaga pallida* sp. nov.**

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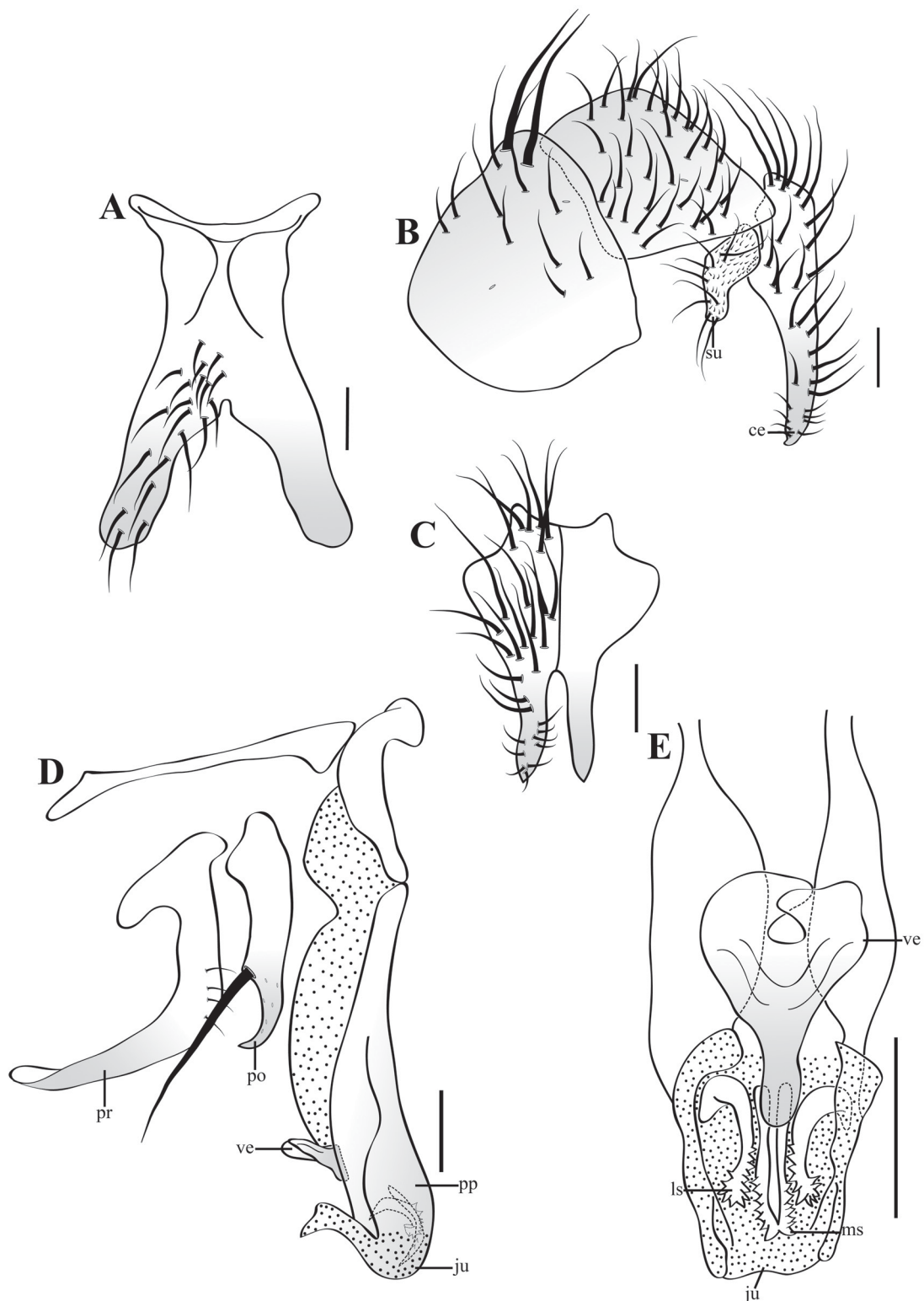
Figs 12–13

### **Diagnosis**

Vein  $R_1$  bare. Male: scutellum without apical setae; vesica narrow at base and expanded at apex in ventral view (Fig. 12E); juxta strongly membranous, smooth and not differentiated from paraphallus (Fig. 12D–E). [Female unknown.]

### **Etymology**

The species epithet '*pallida*' should be treated as a noun in apposition. The name is a Latin adjective '*pallida*' (= Latin), meaning 'pale', and alluding to the light apex of the distiphallus.



**Fig. 12.** *Dexosarcophaga pallida* sp. nov., ♂, holotype (NHRS [lost]). **A.** Sternite 5, ventral view. **B.** Syntergosternite 7+8, epandrium, cercus and surstylus, lateral view. **C.** Cerci, posterior view. **D.** Phallus and associated structures, lateral view. **E.** Distiphallus, ventral view. Abbreviations: see Material and methods. Scale bars=0.1 mm.



**Material examined****Holotype**

COLOMBIA • ♂; Caquetá, Chiribiquete National Park, W Campamento; alt. 840 m; 26 Nov. 1992; G. Andrade-C leg.; NHRS [lost].

**Paratype**

COLOMBIA • 1 ♂; same collection data as for holotype; NHRS [lost].

**Description****Male** (n=2)

Length: 5–6 mm. Differs from *D. phoenix* sp. nov. as follows:

Frons about  $0.30 \times$  head width at level of ocellar triangle; 7–9 well-developed frontal setae reaching level of apex of pedicel; gena and genal groove with slightly yellowish-silver pollinosity (Fig. 13A); acrostichals 3 (weakly differentiated) + 1; dorsocentrals 4 (anteriormost shorter) + 3 (two minor anterior); intra-alars 2+2; meral setae 5–7; abdomen dark brown, with slightly yellowish-silver pollinosity; T4 with 1–2 pairs of lateral marginal setae; row of about 10 marginal setae on T5; marginal setae of ST2–4 slightly differentiated from discal setae; short median incision at posterior margin of ST5 (Fig. 12A); surstylus slightly curved (Fig. 12B); vesica narrow at base and expanded at apex in ventral view (Fig. 12E); juxta arching over acrophallus, strongly membranous, smooth and not clearly differentiated from paraphallus (Fig. 12D–E); median stylus narrow and with apical spines (Fig. 12D–E); lateral stylus equipped with strong spines apically and base curved towards ventral margin of paraphallus (Fig. 12D–E).

**Female**

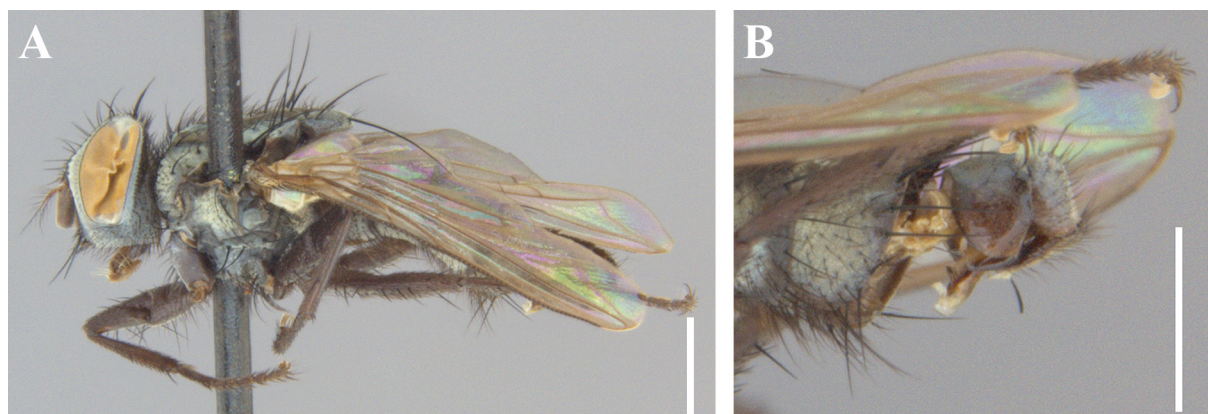
Unknown.

**Distribution**

Colombia (Caquetá).

**Remarks**

*Dexosarcophaga pallida* sp. nov. is morphologically similar to *Dexosarcophaga currani* Dodge, 1968. Males of both species have a stick-like vesica in lateral view (Fig. 12D; Mello-Patiu 2002: figs 53, 56) and a membranous projection from the ventral part of the paraphallus at the level of the acrophallus (Fig. 12D; Mello-Patiu 2002: figs 53, 56). The latter projection may be formed by the paraphallus or be a



**Fig. 13.** *Dexosarcophaga pallida* sp. nov., ♂, paratype (NHRS [lost]), Colombia, Caquetá, Chiribiquete National Park. **A.** Habitus, lateral view. **B.** Terminalia, lateral view.

composite of both the paraphallus and the juxta. These two species can be differentiated by the following features: vesica strongly bifurcated at apex (Fig. 12E) and lateral and median styli approximately  $\frac{1}{3}$  the length of paraphallus (Fig. 12D–E) in *Dexosarcophaga pallida* sp. nov., versus vesica slightly bifurcated at apex (Mello-Patiu 2002: fig. 58) and lateral and median styli approximately  $\frac{1}{2}$  the length of paraphallus (Mello-Patiu 2002: figs 53, 56–57) in *Dexosarcophaga currani*.

## Discussion

Sarcophagidae species, as those of many other Diptera families, are mostly identified based on the male terminalia (Sinclair *et al.* 2013). The morphological definitions of *Dexosarcophaga* proposed by Lopes (1975b, 1982b) [as tribe Dexosarcophagina], Pape (1996), Mello-Patiu & Pape (2000), and Buenaventura & Pape (2018) show that there is not an exclusive male character state that can unambiguously identify species as belonging to this genus.

Buenaventura & Pape (2018) tested the monophyly of this taxon. However, their sampling included just three species, one species for each of the species-groups proposed by Mello-Patiu & Pape (2000) plus the monotypic *Cistudinomyia*. The autapomorphy shared by species of *Dexosarcophaga* in this phylogenetic study was the C-shaped male pregonite (e.g., Figs 1D, 4D), and this character state was used by the authors to propose *Cistudinomyia* as a junior synonym under a more broadly defined *Dexosarcophaga*. Our study indicates that there are species of *Dexosarcophaga* with a mostly straight pregonite, which would a priori appear as plesiomorphic (e.g., Fig. 5C). Thus, we have abstained from assigning the new species in this paper to any of the groupings proposed by Mello-Patiu & Pape (2000) or Buenaventura & Pape (2018), awaiting a comprehensive phylogenetic analysis of these morphological variables to test the monophyly of this genus as well as the character state changes involved.

Therefore, we agree that the better approach to recognize a species as belonging to *Dexosarcophaga* is to use a combination of characters, as proposed by Lopes (1975b, 1982b) and Mello-Patiu & Pape (2000). Females are difficult to identify, and the female sex is still unknown for many species of Sarcophagidae; however, Lopes (1975b, 1982b) and Mello-Patiu & Pape (2000) observed that female tergite 8 with broad and ventro-laterally truncated halves connected medially by a narrow strip as a possible autapomorphy for *Dexosarcophaga*. Thus, female terminalia may add important diagnostic and phylogenetic information for a better understanding of the evolution of these flies.

## Acknowledgments

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