

## Description of Two New Species of *Dexosarcophaga* (Diptera: Sarcophagidae) From the Coastal Environments of the Brazilian Amazon

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### Abstract

Two new species of *Dexosarcophaga* Townsend (Diptera: Sarcophagidae) are described, both from the coastal zone of the Brazilian Amazon: *Dexosarcophaga salgada* sp. nov. and *Dexosarcophaga klycyae* sp. nov.

**Key words:** flesh fly, mangrove forest, Oestroidea, Sarcophaginae, tropical forest

Sarcophagidae, also known as flesh flies, comprises >3,094 described species in 173 genera (Pape et al. 2011), with about 340 species in Brazil (Mello-Patiu 2020). A considerable number of species of this family are saprophagous and some of them have medical-legal importance (Carvalho et al. 2000, Martinez et al. 2007, Barros et al. 2008, Barbosa et al. 2009, Battan Horenstein et al. 2010, Vairo et al. 2011, Mello-Patiu et al. 2014, Vairo et al. 2015, Ren et al. 2018).

The taxonomic knowledge of several genera of the subfamily Sarcophaginae has increased considerably in the last few years, mainly due to advances in phylogenetic studies (Giroux et al. 2010, Kutty et al. 2010, Stamper et al. 2013, Buenaventura and Pape 2018). Nevertheless, the definitions and circumscriptions of many genera are still the focus of contentious debate among taxonomists, and such is the case of the genus *Dexosarcophaga* Townsend.

In one of the first suprageneric classifications proposed for some genera of Sarcophaginae, Lopes (1975) classified *Dexosarcophaga*, *Farrimyia* Dodge, and *Bezzisca* Lopes in the tribe Dexosarcophagina. This arrangement was maintained in the most detailed suprageneric classifications proposed by Lopes (1983). In the ‘Catalogue of the Sarcophagidae of the World’ Pape (1996) considers the nominal genera *Sarcomyia* Roback, *Farrimyia* Dodge, *Varcophaga* Dodge plus *Ectomyia* Dodge synonymous with *Dexosarcophaga*. Mello-Patiu and Pape (2000) treated *Dexosarcophaga*, *Farrimyia*, and *Bezzisca* as subgenera of *Dexosarcophaga*, but they did not mention *Ectomyia*.

In a recent phylogenetic study of Sarcophaginae, Buenaventura and Pape (2018) followed the taxonomic arrangement of Pape

(1996) and considered the monotypic *Cistudinomyia* as a subgenus of *Dexosarcophaga* (sensu lato). Therefore, they accepted only two subgenera: *Dexosarcophaga* and *Cistudinomyia*. This decision was taken since *Cistudinomyia* was recovered as the sister-group of the clade composed of the species of *Dexosarcophaga*, but this clade received low support. Buenaventura and Pape (2018) included in their phylogenetic analysis only three species of *Dexosarcophaga* (sensu stricto), a genus that in their broad sense comprises about 47 species (Pape 1996, Mello-Patiu and Pape 2000, Silva and Mello-Patiu 2010, Carvalho-Filho and Esposito 2011, Carvalho-Filho et al. 2014, Carvalho-Filho et al. 2018). Since there are no phylogenetic analyses with good coverage for each of the genera of the genus-group taxon *Dexosarcophaga*, we preferred to follow the classification proposed by Pape (1996).

The species of *Dexosarcophaga* (sensu Pape 1996) are distributed mainly in the Neotropics, with one species, *D. transita* Townsend, reaching into the southern part of the Nearctic region (Pape 1996). The biology of this genus is poorly known. Larvae of some species have been found in the nest of social insects (ants and termites; Lopes 1939, 1968) and holes bored by weevil (Curculionidae; Lopes 1973).

Adults of some species can be found in vertebrate carrion, being relevant in forensic investigations (Buenaventura et al. 2009, Alves et al. 2014, Barbosa et al. 2015, Meira and Barros 2015, Sousa et al. 2015). Forensic studies using pig carrion *Sus scrofa* have the occurrence of *Dexosarcophaga ampullula* (Engel, 1931), *Dexosarcophaga carvalhoi* (Lopes, 1980), *Dexosarcophagalenkoi* Lopes, 1968, *Dexosarcophaga paulistana* (Lopes, 1982) and *Dexosarcophaga*

*transita* (Townsend, 1917) (Barros et al. 2008, Rosa et al. 2011, Mello-Patiu et al. 2014). The genus *Dexosarcophaga* was also recorded in a snake, frog, and lizard carrion (Ledo et al. 2012). Until that moment, there are no species recorded on human corpses.

Analysis of material deposited in Brazilian entomological collections and specimens obtained during fieldwork undertaken in many regions of Brazil has revealed that *Dexosarcophaga* is a highly speciose genus occurring in a diversity of environments, from forests to savannas (Barros et al. 2008, Barbosa et al. 2015, Sousa et al. 2015). Some species seem to be restricted to coastal environments (Carvalho-Filho et al. 2014), but the fauna of this zone remains poorly studied, especially that of the Brazilian Amazon, which harbors one of the largest mangrove forests of Brazil (Herz 1991). This paper aimed to describe two new species of *Dexosarcophaga* collected in the coastal zone (mangrove and a noninundated forest) of the Brazilian Amazon.

## Materials and Methods

The specimens analyzed in this study were collected in three localities in the state of Pará in the Brazilian Amazon (Fig. 1). One of the new species was collected in a noninundated coastal forest in the municipality of Bragança on the banks of the Caeté River (01°02'04" S; 46°45'48" W). The another new species was collected in two localities of the Brazilian Amazonian Atlantic coast: 1) an mangrove forest (locally known as 'mangal') in the municipality of Vigia de Nazaré, Pará, on the shore of Marajó Bay (00°49'46.23" S; 48°8'19.11" W); 2) an mangrove forest in the municipality of Magalhães Barata, Pará, on the banks of the Marapanim River (00°51'40.57" S; 47°40'6.36" W).

Sampling were made with a Van Someren-Rydon trap baited with rotting banana mixed with wine (in Bragança), and with two-liter plastic bottles, similar to those used by Amat (2010) but without alcohol, using rotting shrimp, crab, beef lung, and fish as bait (in Vigia de Nazaré and Magalhães Barata). The sampling in Bragança was sporadic with the aim of capture specimens for a course from the university. In Magalhães Barata and Vigia de Nazaré, the specimens

collected are part of a standardized study, where were utilized 15 traps for each kind of bait, totalizing 60 traps, that were exposed for 48 h in the field. We obtained 805 sarcophagid flies, 42 specimens were identified as *Dexosarcophaga* spp., and nine individuals were utilized in the description of the two new species. The flies were collected under ICMBio/SISBIO license 8874-1. All specimens, including the holotype and paratype, were deposited in the entomological collection of the Museu Paraense Emílio Goeldi (MPEG), Belém, Pará, Brazil.

The *Dexosarcophaga* specimens were identified to genus level using appropriate key (Pape and Dahlem 2010) and the morphology fit well into the diagnosis of the *Dexosarcophaga* genus proposed by Buenaventura and Pape (2018). They were stored in 70% alcohol and posteriorly mounted on entomological pins with extended terminalia following the method proposed by Lopes (1968). Dried specimens were relaxed in high humidity and its terminalia was detached from abdomen using iridectomy scissors. Terminalia were either glued on card triangles and pinned beneath the source specimens or macerated in 10% cold potassium hydroxide (KOH) for 24 h, transferred to 10% acetic acid for 2 min, and washed with distilled water before being placed in glycerin. They were examined under a Zeiss Standard 25 ICS transmitted light microscope and illustrated with the aid of a drawing tube.

Photographs were obtained with a Leica DFC450 camera coupled to a Leica M205A stereomicroscope and edited with the stacking program Leica Application Suite Version 4.2.0. Drawings and photographs were processed using Adobe Photoshop and Inkscape. After examination and illustration, the cleared terminalia were stored in glycerin in plastic microvials pinned under their respective source specimen. Distribution maps of species were generated using Quantum Gis version 2.18.10.

Terminology follows Cumming and Wood (2009) for external morphology and Buenaventura and Pape (2018) for male terminalia. Label data of types specimens are presented verbatim, with individual lines separated by a forward slash (/) and individual labels separated by a double forward slash (//). Information on specimen labels (shape and color) and condition of specimens is given in square brackets.

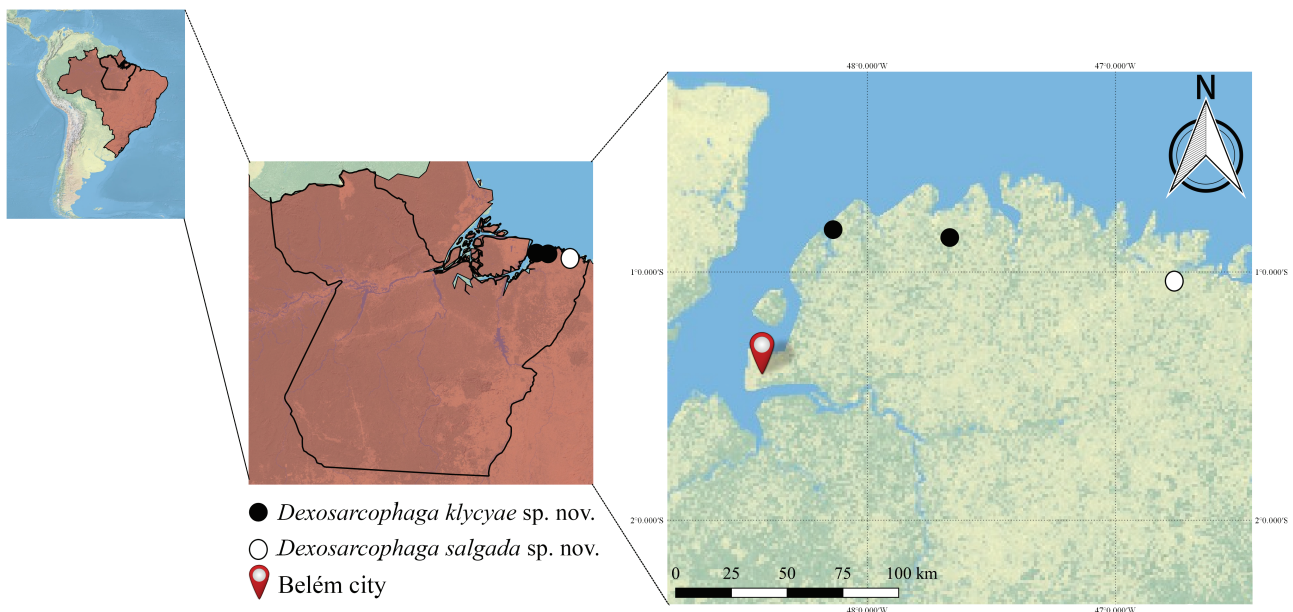


Fig. 1. Distribution map of *Dexosarcophaga* new species.

## Nomenclature

This paper and the nomenclatural act(s) it contains have been registered in Zoobank ([www.zoobank.org](http://www.zoobank.org)), the official register of the International Commission on Zoological Nomenclature. The LSID (Life Science Identifier) number of the publication is: urn:lsid:zoobank.org:pub:EC0D9685-E4DC-40A3-B67F-4ABCF0082358.

## Results

### *Dexosarcophaga klycyae* sp. nov.

(urn:lsid:zoobank.org:act:72D0F69A-022A-4AAF-AEC7-7F2F3A483EA8)

**Diagnosis.** Vesical arm-shaped lever very long and narrow, with rounded membranous tip; distal section of vesica elongate and narrow with bifid lateral process (Figs. 1 and 2A–G).

**Description.** Male. Body length: 4.9–6.5 mm ( $n = 9$ ).

**Head.** Fronto-orbital and parafacial plate covered with silver-yellowish pruinosity. Parafacial plate with setulae sparsely distributed along inner eye margin. Frontal vitta black, with row of 6–7 parallel frontal setae. One reclinate orbital seta. Proclinate orbital seta absent. Outer vertical seta not differentiated from the postocular setae. Gena and postgena with silver-yellowish pruinosity and black setae. Antenna dark brown, arista long plumose on basal 2/3. Palpus black.

**Thorax.** Scutum with three black stripes, otherwise with silver pruinosity. Scutellum and postpronotal lobe black/gray with silver pruinosity. Chaetotaxy: acrostichals 0 + 1, dorsocentrals 1 + 3, intra-alars 2 + 2 (anterior one shorter), supra-alars 1 + 3, postpronotals 2, postalaris 2, notopleurals 4 (2 strong primary and 2 short subprimary setae), anepisternals 5, katepisternals 3, scutellum with 1 pair of basal setae, 1 pair of lateral setae, no apical setae and 1 pair of discal setae. *Legs.* Black. Mid femur with a ctenidium on posteroventral surface. Mid tibia with 2 median setae on ventral face and 2 median ones on posterodorsal margin, hind tibia with 1 median anteroventral seta. *Wing.* Hyaline. Costal spine absent. Vein  $R_1$  bare. Third costal section ventrally bare.

**Abdomen.** Tergites dark brown in ground color (Fig. 2A). Tergites 3–5 with a band of silvery gray pruinosity on anterior 4/5 on dorsal and lateral surfaces. Syntergite 1 + 2 without median marginal setae; tergite 3 and 4 with a pair of median marginal setae; tergite 5 with a complete row of marginal setae. Sternite 5 V-shaped, posterior arms slender, with setae in posterior region. *Terminalia.* Syntergosternite 7 + 8 and cercus dark brown (Fig. 2B). Epandrium black on the anterior half and brownish on the posterior half (Fig. 2B). Cercus shorter than epandrium, with enlarged cercal base and narrow and almost straight cercal prong (Fig. 2B); cercal base covered with long setae. Cercal base, in posterior view, widened and rounded, expanded laterally (Fig. 2C). Cercal prongs short, narrow, and divergent. Surstylus triangular covered with setae, except on posterobasal corner (Fig. 2D). Pregonite elongate with rounded tip and distal narrowed distal portion perpendicular to enlarged base (Fig. 2F). Postgonite claw-shaped, with pointed tip curved ventrally and with a long seta on

ventral margin and a row of three smaller setae just distal to this (Fig. 2F). Phallus dark brown (Fig. 1E), with membranous area between basi- and distiphallus (Fig. 2E–G). Basiphallus narrow and elongate (as long as distiphallus). Juxta sclerotized, elongate and slight curved ventrally, tapering distally (Fig. 2G). Paraphallic distal expansion elongate and glossiform, with membranous rounded tip (Fig. 2E–G). Vesical arm-shaped lever very long and narrow, with rounded tip (Fig. 2E–G); distal section of vesica elongate and narrow, with bifid lateral process (Fig. 2E–G). Lateral styli elongate with spinose distal portion; median stylus small and tubular (Fig. 2E–G).

**Female.** Unknown.

**Biology.** Unknown.

**Distribution.** NEOTROPICAL– Brazil (Pará) (Fig. 1).

**Etymology.** This species is named in honor of the biologist Klycy Mayara Tavares de Jesus, for her help during the difficult fieldwork in the mangrove forest and for her friendship.

**Type material.** HOLOTYPE: 1 male (MPEG) labeled as follows: Magalhães Barata, Pará, Brasil [= municipality of Magalhães Barata, state of Pará, Brazil] / Vila de [= Village of] Calafate / 16–18.XII.2015 / Cols. [= collectors]: SOUZA, C.C.; SOARES, J.M. M.; / TAVARES DE JESUS, K.M. [printed on white paper] // Armadilha de garrafa PET [= traps made of two-liter plastic bottles] / Isca de peixe [= fish bait] [printed on white paper; with abdomen detached from the body, clarified and conditioned in glycerin in a microvial pinned beneath the specimen].

PARATYPES: 8 males (MPEG): 1 male, same data as holotype except: 15–18.X.2015 / isca de caranguejo [= crab bait] [printed on white paper; without head, with extended terminalia]; 3 male, same data as holotype, except: Manguezal [= mangrove forest] Açaitéua / (0°51'40.57" S 47°40'6.36" O) / Armadilha de garrafa PET [= traps made of two-liter plastic bottles] / Isca de caranguejo [= crab bait] [printed on white paper, one specimen with terminalia glued to cardboard; one specimen without abdomen; one specimen without head and abdomen]; 2 males, same data as holotype, except: Manguezal [= mangrove forest] Açaitéua / (0°51'40.57" S 47°40'6.36" O) / Armadilha de garrafa PET [= traps made of two-liter plastic bottles] / Isca de camarão [= shrimp bait] [printed on white paper; one specimen without fore legs and with terminalia glued to card; one specimen in good condition]; 2 males, Vigia de Nazaré, Pará, Brasil [municipality of Vigia de Nazaré, state of Pará, Brazil] / Vila de [= Village of] Itapuá / 18–20.II.2016 / Cols. [= collectors]: SOUZA, C.C.; SOARES, J.M. / TAVARES DE JESUS, K.M. [printed on white label] // Manguezal [= mangrove forest] Anauerá / (0°49'46.23"S 48°8'19.11"O) / Armadilha de garrafa PET [= traps made of 2-liter plastic bottles] / Isca de camarão [= shrimp bait] [printed on white paper, in good condition with extended terminalia].

### *Dexosarcophaga salgada* sp. nov.

(Figs. 1 and 3A–I)

(urn:lsid:zoobank.org:act:49758757-7BD5-4FA9-9FC7-4F0A1509E479)

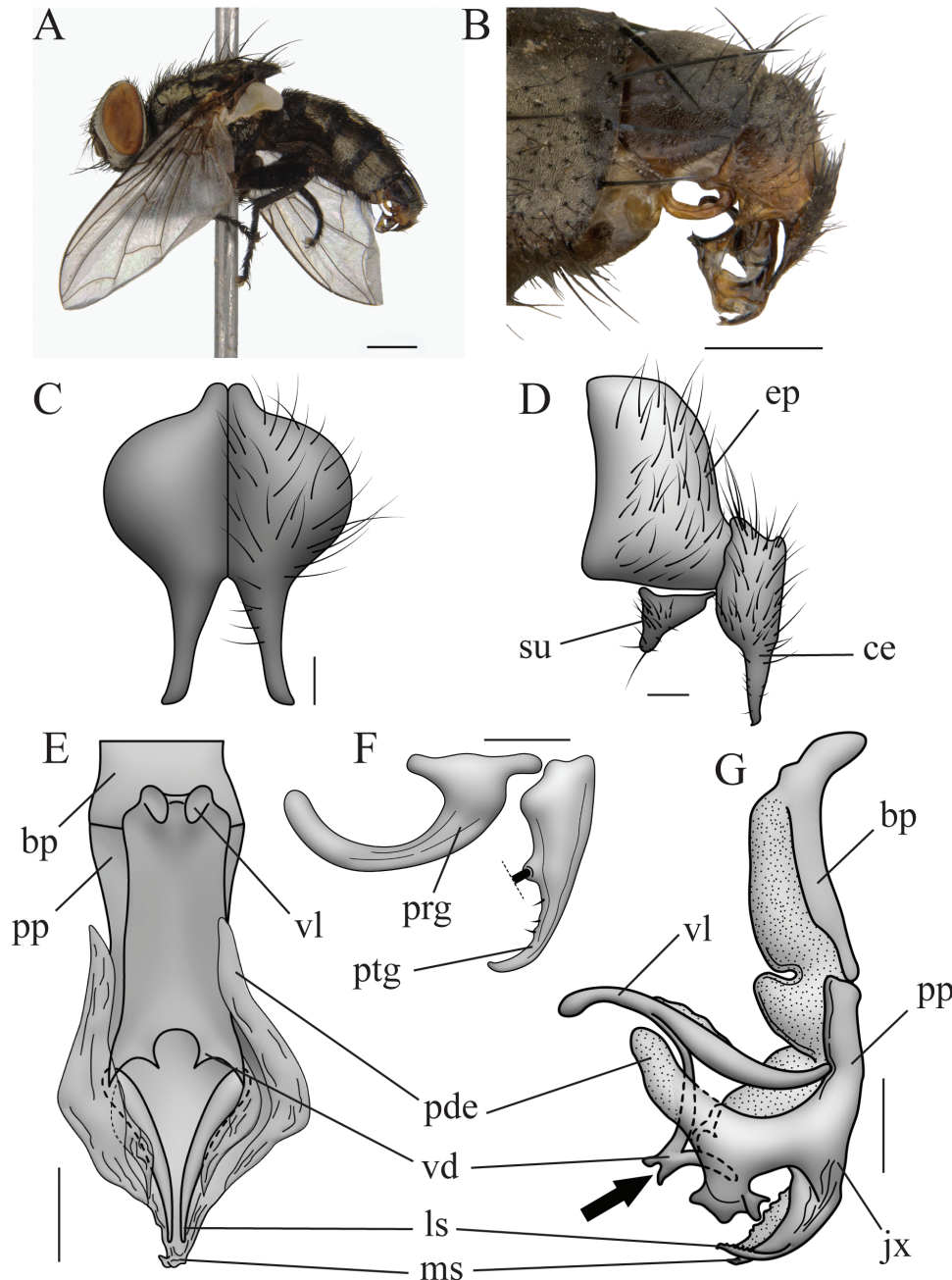
**Diagnosis.** Vesica dome-shaped in lateral view (Fig. 3H–I), with a pair of small rounded projections on ventral surface and a deep median fissure in the distal margin.

**Description.** Male. Body length: 5.7–6.6 mm ( $n = 3$ ).

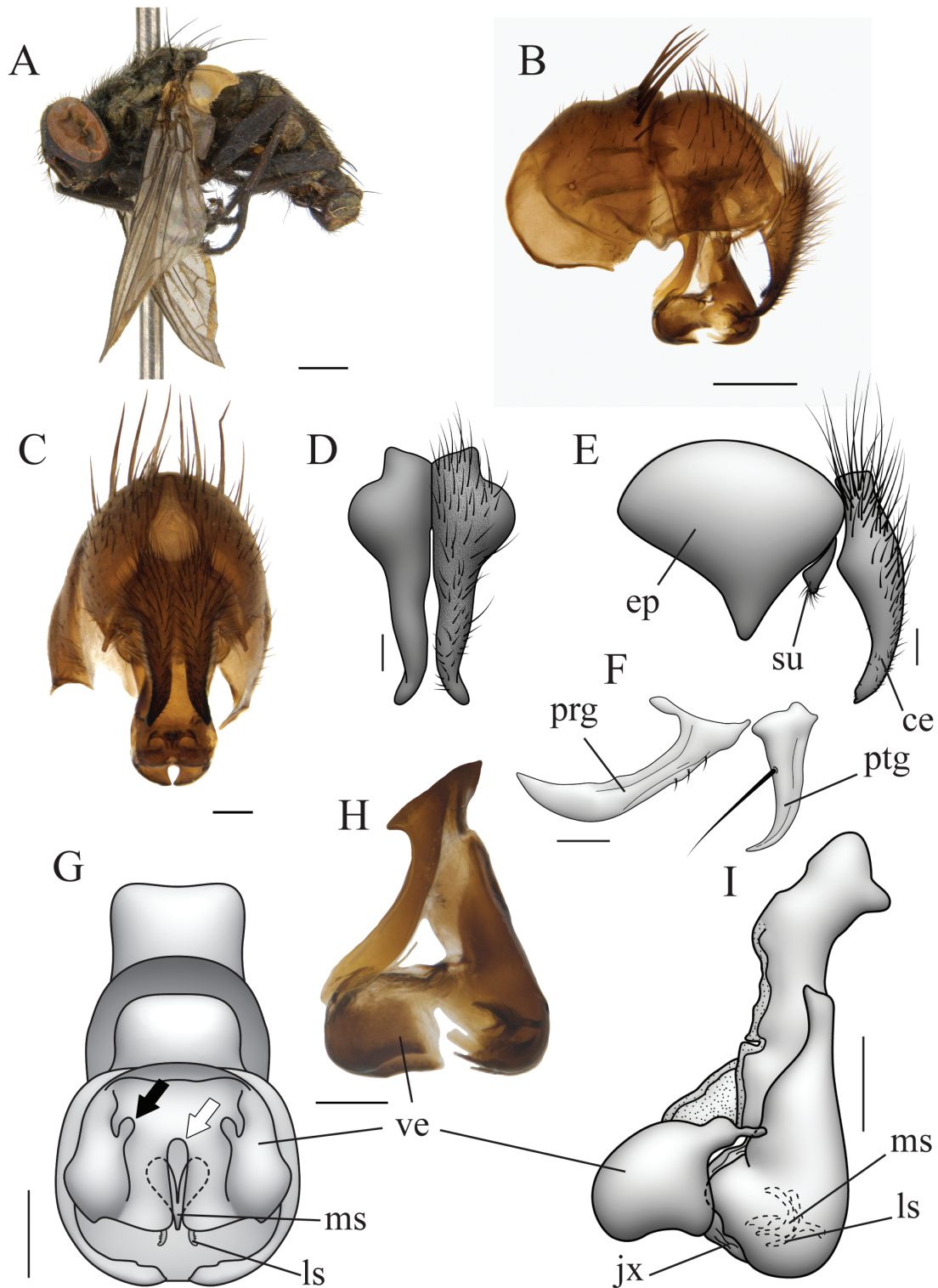
**Head.** Fronto-orbital and parafacial plates covered with golden pruinosity. Parafacial plate with setulae sparsely distributed along inner eye margin. Frontal vitta black, with row of 8–9 parallel frontal setae. One reclinate orbital seta. Proclinate orbital seta absent. Outer vertical seta not differentiated from the postocular

setae. Gena and postgena with yellowish pruinosity and black setae. Antenna dark brown, arista long plumose on basal 2/3. Palpus black.

**Thorax.** Scutum with three black stripes, otherwise with silver-yellowish pruinosity. Scutellum and postpronotal lobe black/gray with silver-yellowish pruinosity. Chaetotaxy: acrostichals 0 + 1, dorsocentrals 1 + 3, intra-alars 2 + 2 (anterior one shorter), supra-alars 1 + 3, postpronotals 2, postalarars 2, notopleurals 4 (2 strong primary and 2 short subprimary setae), anepisternals 5, katepisternals 3, scutellum with 1 pair of basal setae, 1 pair of



**Fig. 2.** *Dexosarcophaga klycyae* sp. nov. (A and B) Male paratype from Magalhães Barata, Pará. (A) specimen, left lateral view; scale bar: 1.0 mm. (B) Terminalia, left lateral view; scale bar: 1.0 mm. (C–G) holotype. (C) Cerci, posterior view. (D) Epandrium, surstylus and cercus, left lateral view. (E) Phallus, anterior view. (F) Gonites, left lateral view. (G) Phallus, left lateral view, with black arrow pointing to the bifid region of distal section of the vesica. Abbreviations: bp = basiphallus; ce = cercus; ep = epandrium; jx = juxta; ls = lateral stylus; ms = median stylus; pp = paraphallus; pde = paraphallic distal expansion; prg = pregonite; ptg = postgonite; su = surstylus; vd = distal section of the vesica; vl = vesical arm-shaped lever. Scale bars: 0.1 mm.



**Fig. 3.** *Dexosarcophaga salgada* sp. nov. (A) male paratype, specimen in left lateral view; scale bar: 1.0 mm. B–I: holotype. (B) Epadrium, surstylus and cercus, left lateral view; scale bar: 0.5 mm. (C) Cerci, posterior view; scale bar: 0.2 mm. (D) Cerci, posterior view. (E) Epadrium, surstylus and cercus, left lateral view. (F) gonites, left lateral view. (G) Phallus, ventral view, with white arrow pointing to the median fissure in the distal margin of the vesica and black arrow pointing to the rounded projection on ventral surface of the vesica. (H) Phallus, left lateral view; scale bar: 0.2 mm. I. Phallus, left lateral view. Abbreviations: ce = cercus; ep = epadrium; jx = juxta; ls = lateral stylus; ms = median stylus; prg = pregonite; ptg = postgonite; su = surstylus; ve = vesica. Scale bars: 0.1 mm.

lateral setae, no apical setae and 1 pair of discal setae. *Legs.* Black. Mid femur with a ctenidium on posteroventral surface. Mid tibia with 1 median seta on ventral face and 2 median ones

on posterodorsal margin, hind tibia with 1 median anteroventral seta. *Wing.* Hyaline. Costal spine absent. Vein  $R_1$  bare. Third costal section ventrally bare.

**Abdomen.** Tergites dark brown in ground color (Fig. 3A). Tergites 3–5 with a band of silvery-gray pruinosity on anterior 4/5 on dorsal and lateral surfaces. Syntergite 1 + 2 without median marginal setae. Tergites 3 and 4 with a pair of median marginal setae. Tergite 5 with a complete row of marginal setae. Sternite 5 V-shaped, posterior arms short, with setae in posterior region. **Terminalia.** Syntergosternite 7 + 8, epandrium, and cercus black. Cercus slightly curved ventrally, in lateral view, with pointed apex, bearing long setae on cercal base and short setae along dorsal surface of cercal prong (Fig. 3B). Cercal prongs parallel with divergent tips in posterior view (Fig. 3C and D). Surstylus small, subtriangular with fine apical setae (Fig. 3E). Pregonite elongate with pointed tip, slightly longer than postgonite, curved ventrally, with three setae on dorsal margin of proximal half (Fig. 3F). Postgonite claw-shaped, with pointed tip curved ventrally and with a long seta on ventral margin (Fig. 3I). Phallus dark brown, with membranous area between basi- and distiphallus. Basiphallus short and subrectangular. Juxta reduced, membranous and roughly differentiated from paraphallus (Fig. 3I). Paraphallus with rounded dorsal margin. Vesica sclerotized, dome-shaped in lateral view, with distal margin rounded (Fig. 3H and I). Vesica, in ventral view, widened, almost as wide as the distiphallus, with a deep median fissure in the distal margin and a pair of small rounded projections on ventral surface (Fig. 3G). Lateral styli short with spinose distal portion (Fig. 3I); median stylus small and tubular (Fig. 3I).

**Female.** Unknown.

**Biology.** Unknown.

**Distribution.** NEOTROPICAL—Brazil (Pará) (Fig. 1).

**Etymology.** The specific epithet ‘salgada’, which should be treated as a noun in apposition, refers to the name utilized locally to denominate the Atlantic coastal zone in the state of Pará, Brazil, where the specimens were collected.

**Type material.** HOLOTYPE: 1 male (MPEG) labeled as follows: Brasil-Pará- Bragança [= Brazil, state of Pará, municipality of Bragança] / Mata do Lobão / Armadilha borboleta, [= Van Someren-Rydon trap] / 14–15.VII.2008 / R.C.O. Santos [collector] [printed on white paper; with terminalia in glycerin in a microvial pinned beneath the specimen].

PARATYPES: 2 males (MPEG): 1 male, same data as holotype [printed on white paper; in good conditions]; 1 male, Bragança-PA-BR [= Brazil, state of Pará, municipality of Bragança] / Mata do Lobão / Arm. borboleta, [= Van Someren-Rydon trap] / 11.V.2007 / R. Santos [collector] [printed on white paper; with terminalia in glycerin in a microvial pinned beneath the source specimen].

## Discussion

*Dexosarcophaga klycyae* sp. nov. is similar to *Dexosarcophaga avispaensis* Mello 1986, in having the vesical arm-shaped lever very long and narrow and a glossiform paraphallic distal expansion. *Dexosarcophaga klycyae* sp. nov. differs from *D. avispaensis* mainly in having juxta sclerotized and curved ventrally, distal section of vesica with bifid distal margin, and vesical arm-shaped lever with rounded tip. In *D. avispaensis*, the juxta is membranous and poorly

differentiated, the distal section of vesica is pointed, and the vesical arm-shaped lever has a pointed tip (Mello 1986).

*Dexosarcophaga salgada* sp. nov. differs from congeners mainly in having a dome-shaped vesica bearing two paired rounded projections on the ventral surface and a median fissure in the distal margin. *Dexosarcophaga malaisei* Dodge 1968 has a rounded vesica that, in lateral view, is somewhat similar to *D. salgada* sp. nov. The vesica of *D. malaisei* differs from that of *D. salgada* sp. nov. mainly in having two paired conspicuous projections on the distal margin.

According with geographical records available to *D. klycyae* sp. nov. and *D. salgada* sp. nov., both species seem to be restricted to coastal zone.

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