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A new species of *Sarcofahrtiopsis* (Insecta, Diptera, Sarcophagidae) from mangrove forests in the Brazilian Amazon, with a key to species identification

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ABSTRACT

A new species of *Sarcofahrtiopsis* Hall, 1933, *S. terezinhae* **sp. nov.**, is described based on male specimens collected in traps baited with rotting crabs in a mangrove forest in the state of Pará, eastern Brazilian Amazon. This species differs from congeneric species in having vesica with a row of toe-like projections. We provide a key to the species of the genus.

KEYWORDS: flesh fly, Calyptratae, Oestroidea, Brazil, Pará

Uma nova espécie de *Sarcofahrtiopsis* (Insecta, Diptera, Sarcophagidae) de florestas de mangue na Amazônia brasileira, com uma chave de identificação

RESUMO

Uma nova espécie de *Sarcofahrtiopsis* Hall, 1933, *S. terezinhae* **sp. nov.**, é descrita com base em espécimes machos coletados com armadilhas contendo caranguejo em decomposição como isca em áreas de mangue no Pará, na Amazônia brasileira. Esta espécie difere das demais espécies do gênero por apresentar vesica com uma fileira de projeções parecidas com dedos. Uma chave para as espécies do gênero é apresentada.

PALAVRAS-CHAVE: mosca, Calyptratae, Oestroidea, Brasil, Pará

INTRODUCTION

The family Sarcophagidae (flesh flies) is the second largest family in the superfamily Oestroidea, with some 173 genera and 3,094 species (Pape *et al*. 2011). The family is present in all biogeographical regions except Antarctica. While these flies occur in many types of environments, some occur in very specific habitats, such as grasslands, mangroves, oceanic beaches and inundated forests (Pape and Dahlem 2010).

The Brazilian Amazon has one of the country's largest areas of mangroves (Herz 1991), and some species of animals and plants are endemic to this environment. Few entomological studies have been made in mangroves, and most surveys of flesh flies in the Amazon have been restricted to non-inundated forests (Esposito and Linhares 2002; Sousa *et al.* 2011), which are the most accessible and frequently sampled environments.

Sarcofahrtiopsis Hall, 1933 comprises 13 species of small to medium-sized flies (3-6 mm in length) distributed from the southern United States (Florida and Texas) to northern South America. Most species are from Central America, including the Antillean Islands, and only two have been recorded from Brazil: *S. cuneata* (Townsend, 1935) (Amazonas, Ceará, Maranhão, Pará, Pernambuco, Rio de Janeiro) and *S. cupendipe* Carvalho-Filho & Esposito, 2014 (Pará) (Pape 1996; Carvalho-Filho *et al*. 2014). The biology of most of these species is unknown, but some have been reared from dead crabs (Pape and Méndez 2002; 2004), and from feces accumulated in the roosts of disk-winged bats, *Thyroptera* spp. Spix, 1823, in young coiled leaves of *Heliconia* L. and related banana-like plants (Pape *et al.* 2002, Carvalho-Filho *et al.* 2014).

In this paper we describe a new species of *Sarcofahrtiopsis* collected in a mangrove forest in the Brazilian Amazon and provide a key to congeneric species based on males.

MATERIALS AND METHODS

Specimens were collected in two mangrove forests in the state of Pará, in the eastern Brazilian Amazon: (1) on the margin of the Marapanim River (0°51'40.57"S, 47°40'6.36"W), in the village of Calafate, municipality of Magalhães Barata; and (2) in the village of Itapuá (0°49'46.23"S, 48°8'19.11"W), municipality of Vigia de Nazaré. These localities are located in the same region, that is tropical, warm and humid. The annual average temperature is 26°C and precipitation varies between 2500-3000mm (Bêrredo *et al*. 2008), with a dry season with mean monthly precipitation less than 50 mm, lasting from July to December (Fisch *et al*. 1998). The mangrove forests are composed mainly by *Avicennia germinans* (L.) Stearn., *Avicennia schaueriana* Stapf and Leechm ex Moldenke., *Laguncularia racemosa* (L.) Gaertn. f. and *Rhizophora mangle* L. (Menezes *et al*. 2008) and they are subject to a macrotidal regime (Schaeffer-Novelli *et al.* 2000), with tidal amplitude varying between 4 m and 7.5 m (Souza-Filho 2005).

Specimens of flesh flies were collected in traps made of 2-liter plastic bottles similar to those used by Amat (2010), but without alcohol, that were tied to the tree trunks about 1.50m from the ground. They were baited with rotting crab (*Ucides cordatus* L.), shrimp, fish and beef lung. Were utilized 15 traps for each kind of bait, totalizing 60 traps, that were exposed for 48h in the field. We obtained 805 flesh flies, four of which were utilized in the description of the new species. Specimens were collected under ICMBio/SISBIO license 8874-1. They were deposited in the entomological collection of Museu Paraense Emílio Goeldi (MPEG), Belém, Brazil.

Preparations of genitalia were made by removing the abdomen of a mounted specimen (dried specimens were first relaxed in high humidity) and clearing it in 10% KOH for 24h., after which it was washed in distilled water, and neutralized with acetic acid and 70% ethanol. The cleared abdomen was transferred to glycerin for further dissection, examination and drawing with the aid of a drawing tube attached to a compound microscope. Abdomen and genitalia were stored in plastic microvials pinned beneath the source specimen.

Terminology followed Cumming and Wood (2009) for external morphology and Giroux *et al*. (2010) for male terminalia. Label data are presented in verbatim quotation with individual lines separated by a forward slash (/) and individual labels separated by a double forward slash (//). Information on specimen labels (shape and color) is given in square brackets. The key was adapted from earlier keys by Pape and Méndez (2004) and Carvalho-Filho *et al.* (2014).

The map with the geographic records of species was generated using the software QGIS version 2.18.10. Collecting sites indicated on the map are based on data from literature (Dodge 1965; Pape 1996; Mello and Pape 2000; Pape and Méndez 2002; 2004; Pape *et al*. 2002; Carvalho-Filho *et al*. 2014).

RESULTS

Sarcofahrtiopsis terezinhae sp. nov.

Diagnosis

Vein R_1 setose only on proximal half. Sternite 5 shield-like with a small median convexity on the posterior margin. Surstylus with distal portion curved posteriorly (Figure 1A). Pregonite with dorsal margin bearing a row of long and stout setae which are sligthly swollen apically (Figure 1C). Postgonal apodeme elongate (Figure 1C). Vesical extension elongate and without bifurcation apically (Figure 1D). Vesica with a row of toe-like projections on the apical margin (Figure 1D).

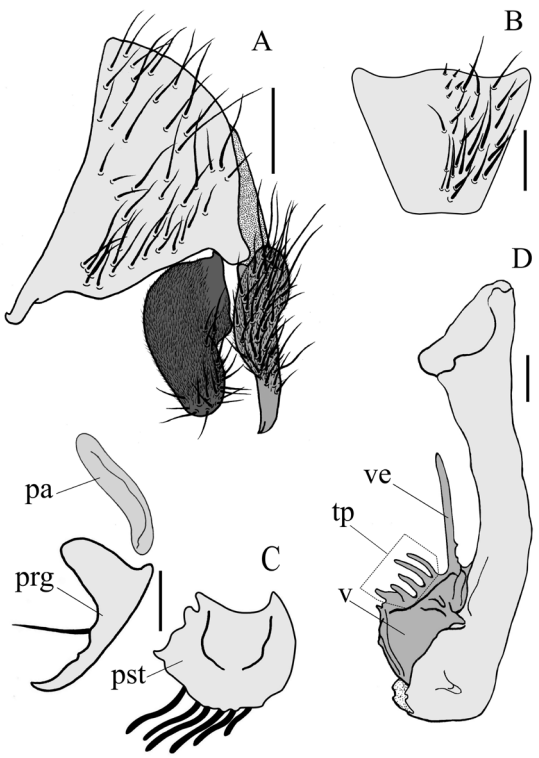

Figure 1. *Sarcofahrtiopsis terezinhae* **n. sp.**, male paratype. A. Epandrium, surstylus and cercus, left lateral view; B. Sternite 5, ventral view; C. Right gonite, lateral view; D. Phallus, lateral view. Scale bars = 0.1 mm, except in Fig. 1A where it represents 0.2 mm. Abbreviations: pa = postgonal apodeme, prg = pregonite; ptg = postgonite; tp = toe-like projections; v = vesica; ve = vesical extension.

Etymology

This species is named in honour of the second author's grandmother**,** Terezinha de Jesus Ferreira Costa, for her hospitality during fieldwork carried out in the village of Calafate.

Description

Male. Body length: 4.63-5.10 mm (n = 4).

Head

Fronto-orbital and parafacial plates with golden pruinosity, postocular strip light golden. Parafacial plate with a row of three fine setae along the lower part of the eye. Frontal vitta black; frontal row of four setae; one reclinate and two proclinate orbital setae. Gena and postgena yellowish grey with black setae. Antenna black; first flagellomere about three times as long as pedicel; arista long plumose in basal two thirds. Palpus and proboscis black.

Thorax

Chaetotaxy: acrostichals 0+1, dorsocentrals 2+3, intra-alars 1+2, supra-alars 2+3, postpronotals 2, postalars 2, notopleurals 2, katepisternals 2, scutellum with marginal setae 2, apicals 0, discals 1. Wing hyaline, basicosta brown, vein R_1 setose on basal half, vein R_{4+5} setose dorsally to crossvein r-m. Legs black; forefemur with several bristles along anterodorsal and anteroventral margins; foretibia with one anteroventral and one posterior seta; midfemur with two anterior and two anteroventral setae; midtibia with one anteroventral and two posterior setae; hindtibia with two anterior, one anteroventral, and two posterodorsal setae.

Abdomen

Tergites dark brown, tergites 3 to 5 each with a band of silvery gray pruinosity anterolaterally. Sternites light brown with silvery gray pruinosity.

Terminalia. Sternite 5 shield-like, not cleft, with posterior margin sligthly sinuous and with a small median convexity, covered with long and stout setae and posteriorlly, above the convexity, with some short and spine-like setae (Figure 1B). Syntergosternite 7+8, epandrium and cercus dark brown. Cercus short (shorther than epandrium) and curved in profile, tapering distally, with pointed apex, covered with long setae, distal third without setae and setulae. Surstylus broad, sligthly narrowed at middle, with rounded apex curved anteriorly, covered with short setulae and with long setae mainly distally (Figure 1A). Pregonite broad, shorther than postgonite, with dorsal margin bearing a row of long and stout setae, which are slightly swollen apically (Figure 1C). Postgonite claw-shaped with a long and stout seta on the anterior margin (Figure 1C). Postgonal apodeme elongate. Phallic tube elongate, narrow and tubular, slighly curved posteriorly (Figure 1D). Vesica (highlighted in dark gray) enlarged and irregular (Figure 1D); vesical extension elongated and almost straight with rounded apex (Figure 1D). In addition to the vesical extension, there are about five toe-like projections as about one-third or less longer of the total of the vesical extension length (Figure 1D).

Female

Unknown.

Material examined

Holotype male (Figure 2) labelled as follows: "Magalhães Barata, Pará, Brasil/ Vila de Calafate/ Manguezal [= mangrove forest] Açaiteua/16-18.XII.2015 [printed on rectangular white label]// Armadilha de garrafa Pet [= traps made of 2-liter plastic bottles]/ Isca de caranguejo [= crab bait]/ Cols: Souza, C.C.; Soares, J.M./ Tavares-Jesus, K.M." [printed on rectangular white label]. Specimen [MPEG 02022668] in good condition with terminalia extended.

Paratypes: three males labelled as the holotype and one male labelled as follow: "Vigia de Nazaré, Pará, Brasil/ Vila de Itapuá/ Manguezal [= mangrove forest] Anauerá/ 15-18.X.2015 [printed on rectangular white label]// Armadilha de garrafa

Figure 2. *Sarcofahrtiopsis terezinhae* **n. sp.**, habitus of male holotype, lateral view. Scale bar = 1.0 cm. This figure is in color in the electronic version.

Pet [= traps made of 2-liter plastic bottles]/ Isca de caranguejo [= crab bait]/ Cols: Souza, C.C.; Soares, J.M./ Tavares-Jesus, K.M." [printed on rectangular white label]. One paratype [MPEG 02022667] laterally flattened, anterior legs missing and terminalia glued to cardboard triangle pinned below the specimen. One paratype [MPEG 02022669] without head, abdomen, right mid leg and left hind leg. The paratype [MPEG 02022670] from Vigia de Nazaré is in good condition.

Geographical record

NEOTROPICAL—Brazil (Pará).

Key to the identification of *Sarcofahrtiopsis* spp. (males only)

Modified from Pape and Méndez (2004) and Carvalho-Filho *et al.* (2014).

Females are not included in this key since they are unknown for most of the species. *Sarcofahrtiopsis diembroma* Dodge, 1965 was not included because only the female is known.

1. Vein R1 setose along full length. Postgonal apodeme not elongate [Figure 3 in Carvalho-Filho *et al.* (2014)] 2

- Vein R1 setose only proximal to the knob at level of subcostal break. Postgonal apodeme distinctly elongate [Figures 13 and 22 in Mello-Patiu and Pape (2000)] 3

2. Distiphallus laterally without cuticular spines [Figure 5 in Carvalho-Filho *et al.* (2014)]. Postgonite with tip strongly curved [Figure 3 in Carvalho-Filho *et al.* (2014)]. Surstylus without spines on basal half [Figure 1 in Carvalho-Filho *et al.* (2014)] ..... *S. cupendipe* Carvalho-Filho & Esposito

- Distiphallus laterally with minute cuticular spines [Figure 1 in Pape *et al.* (2002)]. Postgonite with tip gently curved [Figure 3 in Pape *et al.* (2002)]. Surstylus with spines on basal half [Figure 1 in Pape *et al.* (2002)] ..... *S. thyropteronthos* Pape, Dechmann & Vonhof

3. Abdominal tergite 5 reddish ..... *S. baumhoveri* Dodge

- Abdominal tergite 5 black 4

4. Vesica with apical margin bearing a spiny process in addition to the usual vesical extension [Figure 29 in Dodge (1965)] ..... *S. paterna* Dodge

- Vesica without separate spiny process on apical margin, only showing the vesical extension [Figure 24 in Mello-Patiu & Pape (2000)] 5

5. Vesical extension with a small or a large bifurcation [Figure 24 in Mello-Patiu and Pape (2000) and Figures 1, 2, 4 and 5 in Pape and Méndez (2004)] 6

- Vesical extension simple, entirely without bifurcation [Figure 4 and 13 in Mello-Patiu and Pape (2000)] 9

6. Vesical bifurcation small, mainly a subapical barb- or thorn-like process [Figure 24 in Mello-Patiu and Pape (2000)] ..... *S. cuneata* (Townsend)

- Vesical bifurcation large, both prongs about equally long [Figures 1, 2, 4 and 5 in Pape and Méndez (2004)] 7

7. Cercus distally slightly swollen and compressed, tip blunt [Figure 3 in Pape and Méndez (2002)] ..... *S. carcini* Pape & Méndez

- Cercus gradually tapering, tip pointed [Figures 3 and 6 in Pape and Méndez (2004)] 8

8. Vesical bifurcation with prongs of about equal length, the one perpendicular to the longitudinal axis of the vesical extension set close to base [Figures1 and 2 in Pape and Méndez (2004)] ..... *S. kuna* Pape & Méndez

- Vesical bifurcation with prongs of subequal length, the one perpendicular to the longitudinal axis of the vesical extension is shortest and set just proximal to the mid point [Figures 4 and 5 in Pape and Méndez (2004)] ..... *S. chiriqui* Pape & Méndez

9. Vesical extension much longer than remaining vesica and with a spade- or shovel-like flattened tip [Figure 15 in Mello-Patiu and Pape (2000)] ..... *S. spathor* Mello-Patiu & Pape

- Vesical extension at most as long as remaining vesica, tip not flattened [Figure 1D, this study] 10

10. Vesica rounded or broadly oval [Figure 24 in Dodge (1965)] ..... *S. capitata* (Curran)

- Vesica more irregular, almost triangular [Figure 1D, this study] 11

11. Vesica with long (about one-third or less longer than the total vesical extension length) toe-like projections on the apical margin [Figure 1D, this study]. Ventral margin of vesica without a quadrate projection [Figure 1D, this study]. Surstylus with distal portion curved posteriorly [Figure 1A, this study]. Basicosta brown ..... *S. terezinhae* **sp. nov.**

- Vesica with very small (less than a fifth of the vesical total length) spine-like projections on the apical margin [Figures 22 and 25 in Dodge (1965)]. Ventral margin of vesica with a quadrate projection [Figures 22 and 25 in Dodge (1965)]. Surstylus with distal portion not curved posteriorly [Figures 22 and 25 in Dodge (1965)]. Basicosta brown or yellowish 12

12. Basicosta yellowish. Vesica with 4 to 5 spines on the apical margin [Figure 25 in Dodge (1965)] ..... *S. farri* Dodge

- Basicosta brown. Vesica with 8 to 10 spines on the apical margin [Figure 22 in Dodge (1965)] ..... *S. jamaicensis* Dodge

DISCUSSION

The new species described in here differs from congeneric species in having the vesica with about five toe-like projections (about one-third or less longer than the total vesical length) close to the vesical extensison (see Figure 1D). *Sarcofahrtiopsis farri*, *S. paterna* and *S. jamaincens* also show vesica with projections close to the vesical extension, however these are tiny and pointed apically.

One of the diagnostic features of *Sarcofahrtiopsis* is the presence of strong setae along the dorsal margin of the pregonite (Lopes 1990). However, the four species described after Lopes' work (*S. baumhoveri*, *S. cupendipe, S. spathor*, and *S. thyropteronthos*) did not have this feature. For this reason, Mello-Patiu and Pape (2000) did not include this feature in their diagnosis of the genus and considered it to be a diagnostic feature of a subset of species, which includes the new species described herein.

All the studied specimens were collected in mangrove forest, which suggests that *S. terezinhae* is associated with this environment. Other species of this genus also show a close association with marine coastal environments (Pape and Méndez 2002; 2004). This is the third species of *Sarcofahrtiopsis* described for South America (Figure 3). The other two species are associated with terra-firme forest environments.

The biology of most *Sarcofahrtiopsis* species remains unknown. Two species have been collected only in the feces of disk-winged bats, *Thyroptera* spp. (Pape *et al.* 2002; Carvalho-Filho *et al.* 2014), while *S. cuneata* has been collected in large numbers in traps baited with rotting beef lung (Sousa *et al.* 2011), and visiting human feces or rotting fish (Lopes 1973; Pape and Mendéz 2002). *Sarcofahrtiopsis terezinhae* was collected in traps baited only with *Ucides cordatus* crabs, a species common in mangroves. We hypothesize that *S terezinhae* possibly uses dead crabs as a breeding substrate, as do other three species in the genus (Pape and Méndez 2002; 2004).

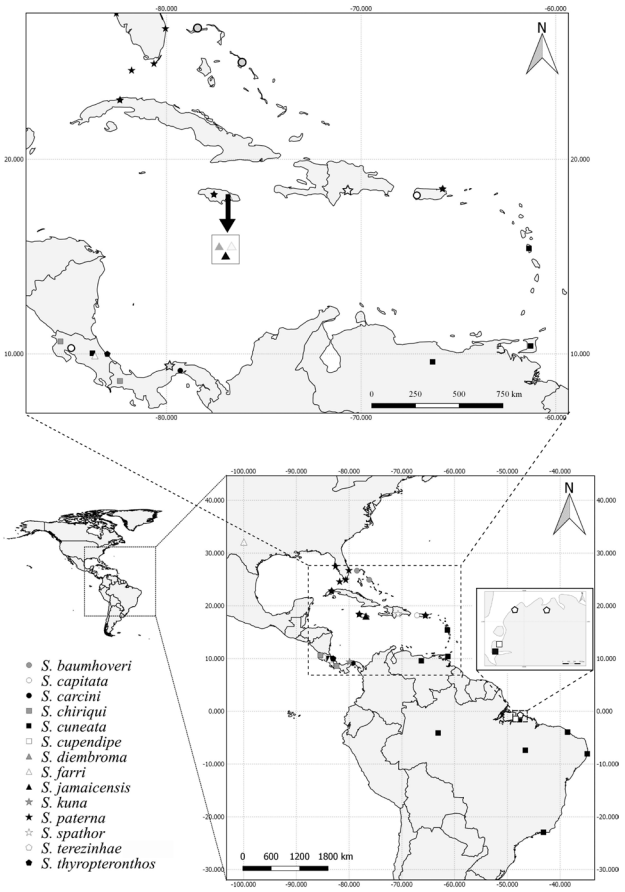

Figure 3. Geographic records of *Sarcofahrtiopsis*.

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