

Morphology, Systematics, Evolution

Helicobia neuzalmeidae sp. nov., A New Species of Sarcophagidae (Diptera) Reared From a Pig Carcass in the Brazilian Savanna

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Abstract

A new species of Sarcophagidae (Diptera) in the genus *Helicobia* Coquillett, *Helicobia neuzalmeidae* sp. nov., is described based on two male specimens obtained from pig carcasses in savanna-like vegetation in northeastern Brazil (state of Maranhão) during a forensic study. The holotype was obtained from a larva that abandoned the pig carcass to pupate, whereas the paratype was collected with a trap placed above the cage containing the carcass. This is the first record of a *Helicobia* species reared from a vertebrate carcass.

Key words: Calyptratae, cerrado, pig carcass, Oestroidea, true fly

True flies of the family Sarcophagidae are known as flesh flies, because many species from different genera of the three subfamilies (Miltogramminae, Paramacronychiinae, and Sarcophaginae) are sarcosaprophagous (Yan et al. 2020). In other words, their larvae feed on rotting tissues of animals, including carrion, which may be the ancestral larval feeding habit of Sarcophagidae and each one of its subfamilies (Piwczynski et al. 2017, Yan et al. 2020, but see Buenaventura 2021). In addition, adult flesh flies are among the first flies to arrive on dead human bodies (Catts and Goff 1992, Vairo et al. 2017), and they are also very common around and on carcasses, which they use as a food source, breeding, and larviposition site (Shewell 1987, Pape and Dahlem 2010). For these reasons, flesh flies are considered one of the most important families of Diptera in forensic studies (Catts and Goff 1992, Oliveira and Vasconcelos 2010, Cherix et al. 2012).

Most of the potentially forensically relevant sarcophagid species in the Neotropical Region belong to the following genera: *Helicobia* Coquillett, *Microcerella* Townsend, *Oxysarcodexia* Townsend, *Peckia* Robineau-Desvoidy, *Sarcophaga* Meigen, and *Tricharaea*

Thomson, since their abundance and/or species-richness is usually high in forensic studies (Barros et al. 2008, Rosa et al. 2011, Bitar et al. 2013, Alves et al. 2014, Mello-Patiu et al. 2014, Faria et al. 2017, Lopes et al. 2018, Ramos-Pastrana et al. 2018, Paseto et al. 2019). *Helicobia* is a large genus of Sarcophaginae, which is now composed of 37 valid, small to medium-sized (4–9 mm) species that are properly characterized by the following combination of features: vein R₁ setulose dorsally on proximal half; ocellar and vertical setae thick; parafacial plate with well-developed setae; postalar wall setulose; male mid femur without a ctenidium; phallus with a distinct hinge between basiphallus and distiphallus; distiphallus with large and mostly membranous harpes; juxta well-developed, with juxtal lateral plate (Pape 1996, Buenaventura and Pape 2017).

Helicobia is predominately Neotropical, with six species occurring in the northern part of Mexico and one in the United States (Pape 1996). Many species (11 spp.) have been recorded from Brazil, five of which are only known from this country (Pape 1996, Mello-Patiu and Santos 2022). They occur in many kinds of environments, from different types of pristine forests to open environments, such as the

cerrado (savanna-like vegetation) (Flores and Dale 1995; Barros et al. 2008; Sousa et al. 2011, 2015; Vairo et al. 2011; Yepes-Gaurisas et al. 2013; Mello-Patiu et al. 2014; Faria et al. 2017; Toma et al. 2020; Nascimento et al. 2021).

Adults of some species have been captured in traps baited with rotting bovine lung (Sousa et al. 2011, 2015; Nascimento et al. 2021) or while visiting carcasses of small (fish and rat) (Linhares 1981, Beuter et al. 2012, Yepes-Gaurisas et al. 2013) and large (pig and dog) vertebrates (Barros et al. 2008, Vairo et al. 2011, Mello-Patiu et al. 2014, Faria et al. 2017, Toma et al. 2020, Madeira-Ott et al. 2022). The larval feeding habitat of most species remains unknown, but some have been reared from dead and dying insects and snails (Plank 1929, Stegmaier 1972, Lopes 1973, Reeves et al. 2000, Pape and Dahlem 2010, Bragança et al. 2020, Yan et al. 2020). Although adult specimens of *Helicobia* are usually found on vertebrate carcasses, their larvae have not been bred from this substrate before the present work.

In the present paper, we describe a new species of *Helicobia*, obtained as larva and adult, from pig carcasses in forensic research carried out in savanna-like vegetation in northeastern Brazil. We provide figures and photographs of the male genitalia of the new species.

Material and Methods

The collections were made in a savanna-like habitat (known as *cerrado*) in Área de Proteção Ambiental Municipal do Inhamum

(APA do Inhamum) (04°53'56"S; 43°26'10"W), in the municipality of Caxias, state of Maranhão, located on the right side of the BR-316 highway (white circle in Fig. 1A). This site has an area of 3.564 ha, mainly composed of *cerrado* and some small patches of gallery forest along the streams (Barros 2012). The climate in the city of Caxias is of the sub-humid dry type C1 (Thorntwaite 1948), characterized by two well-defined seasons: rainy, from December to May; and dry, from June to November. Annual rainfall varies from 1600 to 2000 mm. The annual relative humidity varies from 70 to 73%. The average annual temperature is around 27°C (Barros 2012).

Specimens of the new species were collected in July 2010 during a forensic study on two whole pig carcasses placed in separate metal cages. We obtained two male specimens of the new species. One of them was collected with a suspended trap (Rafael and Gorayeb 1982) placed above the cage and lacking the lower septum, about 30 cm from the ground (Fig. 1B). The trap was of pyramidal shape with a quadrate base (1.60 m high and 1.50 × 1.50 m base) and a collecting bowl at the top, where the flies were retained. The other adult was obtained from a larva that abandoned the pig carcass to pupate. For this, a metal tray with a sawdust layer was placed under the cage to collect the larvae. The sawdust was collected every day during the decomposition process and placed in 5-liter plastic containers, whose aperture was closed with a piece of netting, and maintained at room temperature in the laboratory (Fig. 1C).

Adult specimens were initially preserved in 92.8% alcohol and then mounted dry on pins. They are deposited in the Coleção

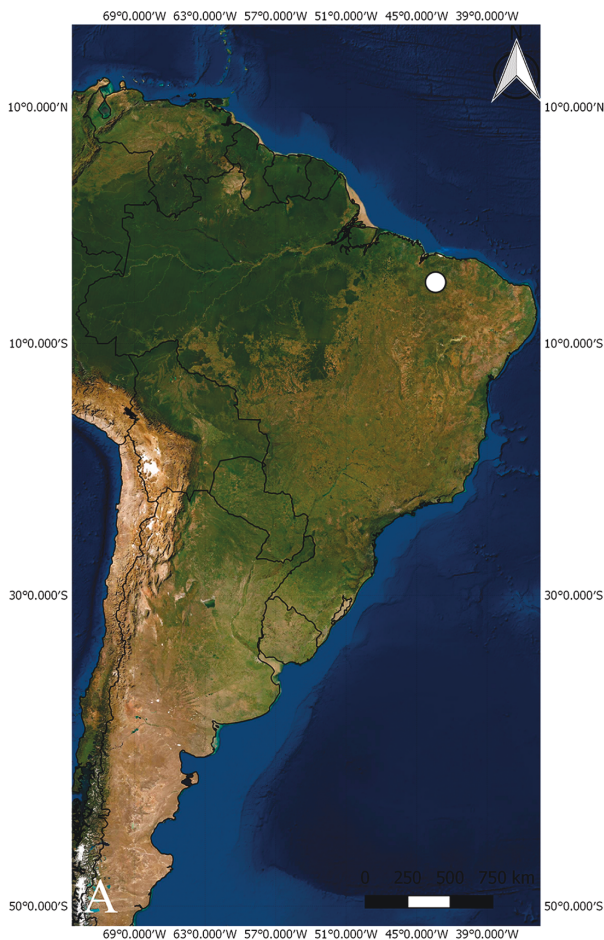


Fig. 1. (A) Map with the point of occurrence of *Helicobia neuzalmeidae* sp. nov. (B) Suspended trap above cage with pig carcass. (C) Plastic rearing containers.

Zoológica do Maranhão (CZMA), in the Caxias Campus, Universidade Estadual do Maranhão (UEMA), state of Maranhão, Brazil, and in the entomological collection of the Museu Paraense Emílio Goeldi, Belém, state of Pará, Brazil.

Identification of the genus was based on the key of Pape and Dahlem (2010) and on the diagnosis proposed by Buenaventura and Pape (2017). The terminology follows Cumming and Wood (2009) for external morphology and Buenaventura and Pape (2017) for male terminalia.

The male terminalia of the holotype and sternite 5 of the paratype of the new species were macerated in heated 85% lactic acid, washed in water, and subsequently mounted on temporary slides in glycerin. After examination and illustration, the terminalia and sternite 5 were placed in microvials with glycerin and pinned with their respective specimens. Line drawings were made using a drawing tube attached to a Leica DM-1000 compound microscope.

Photographs were taken with a Zeiss Discovery V12 stereomicroscope equipped with a AxionCan Cc1 digital camera and processed with the Zen@2012 software. Image stacks were processed using the software Combine ZP.

The label data are cited in full and complementary data, not included on the labels, are presented within square brackets. Each line of the label is separated by a slash (/) and individual labels are separated by a double forward slash (//).

Distribution map was plotted using specimens and recorded coordinates, verified using Google Earth Pro (©2017 Google). The distribution map was produced using Quantum Gis version 2.18.10.

This paper and the nomenclatural act(s) it contains have been registered in Zoobank (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:7E993716-86B9-4D86-ACD7-5945E691BEAB.

Results

Helicobia neuzalmeidae sp. nov.

(Figs. 1A, 2, and 3)

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Type material. HOLOTYPE: male, deposited in CZMA, labeled as follows: Brasil (MA) [= Brazil, state of Maranhão], Caxias/ APA do Inhamum/ Bandeja com Serragem [= tray with sawdust]// Data de emergência [= emergence day]/ 20.vii.2010. J. O. A./ Silva, cols.// CB-P1. PARATYPE: male deposited in MPEG labeled as follows: Brasil (MA) [= Brazil, state of Maranhão], Caxias/ APA do Inhamum/ Armadilha Suspensa [= suspended trap]// Carcaça Suína [= pig carcass] C/ 10.vii.2010. J. O. A./ Silva, cols.

Diagnosis. Juxta composed by a pair of well-developed pompom-like median structures. Juxta lateral plate with a broadened, triangular, plate-like structure distally.

Description. Male. Body total length: 6.23–6.47 mm ($n = 2$).

Head. Fronto-orbital and parafacial plates with silvery microtrichosity and postocular strip with grey microtrichosity; parafacial plate with a row of setulae (Fig. 2A). Frontal vitta dark brown or reddish. Frons with a row of six frontal setae. Outer vertical seta differentiated from postocular setae and shorter than inner vertical seta. Gena and postgena yellowish-brown, with silver microtrichosity; gena with blackish setae; postgena with black setae

anteriorly and yellowish hair-like setae posteriorly. Antenna brown with whitish microtrichosity; pedicel more than twice as long as wide; arista long and plumose on three basal fourths. Proboscis dark brown. Palpus blackish.

Thorax. Black in ground colour, entirely covered in silver microtrichosity, interrupted by three longitudinal equibroad black vittae (Fig. 2B). Chaetotaxy: Acrostichal setae 0 + 1 (hair-like), dorsocentrals 2 + 3, intra-alars 1 + 2, supra-alars 1 + 3, postpronotals 2, postalars 2, notopleurals 4 (2 long primaries and 2 shorter subprimaries), scutellum with 4 marginal setae (1 long proximal, 1 short subproximal, 1 long preapical, 1 apical), discals 1, katapisternals 3, postalar wall setulose. **Legs.** Blackish with silver microtrichosity. Mid femur with two median anterior setae, two preapical setae and without a ctenidium. Hind femur with two rows of anterodorsal and one row of anteroventral setae. Mid tibia with 3 anterodorsal, anteroventral, 1 posterodorsal and 1 anteroventral setae. Hind tibia with 3 anterodorsal, 2 anteroventral, 3 posterodorsal setae and without an apical posteroventral seta. **Wing.** Hyaline. Vein R_1 setulose dorsally on basal half. Vein R_{4+5} setulose dorsally, not reaching crossvein r-m. Third costal sector setulose ventrally.

Abdomen. Tergites and sternites dark brown. Tergites 3 to 4 with a band of silvery grey microtrichosity on anterior 4/5 on dorsal and lateral surfaces, tergite 5 with yellowish microtrichosity (Fig. 2A and B). **Terminalia.** Sternite 5 yellowish, widely V-shaped cleft; arms long and tapered distally; cleft margin modified into a swollen sheath and covered with many short setulae and some fine and long setulae distally; base narrow with a median membranous window (Fig. 3B). Syntergosternite 7 + 8 and epandrium yellowish, with golden

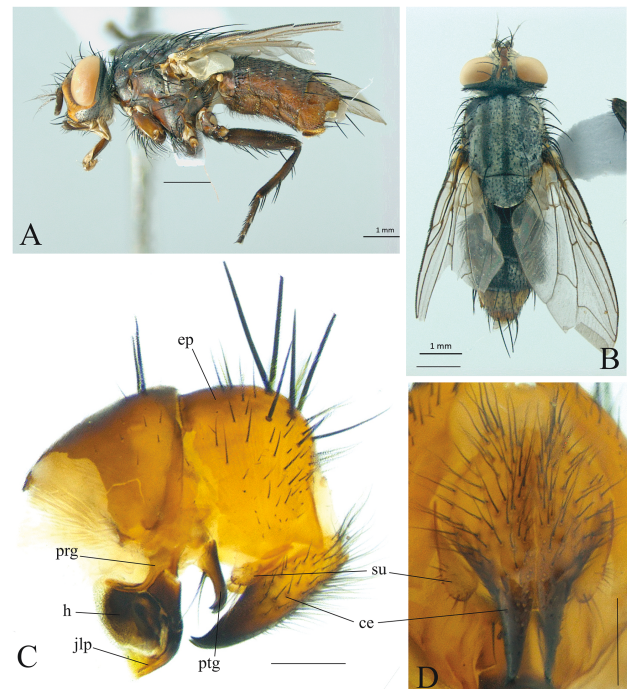


Fig. 2. *Helicobia neuzalmeidae* sp. nov., male holotype. (A) Habitus, left lateral view. (B) Habitus, dorsal view. (C) Terminalia, left lateral view. (D) Cerci, posterior view. Abbreviations: ce = cercus; ep = epandrium; h = harpes; jlp = juxtal lateral plate; prg = pregonite; ptg = postgonite; su = surstylus. Scale bars: A, B = 1 mm; C, D = 0,2 mm. Photos: A. A. T. Sousa.

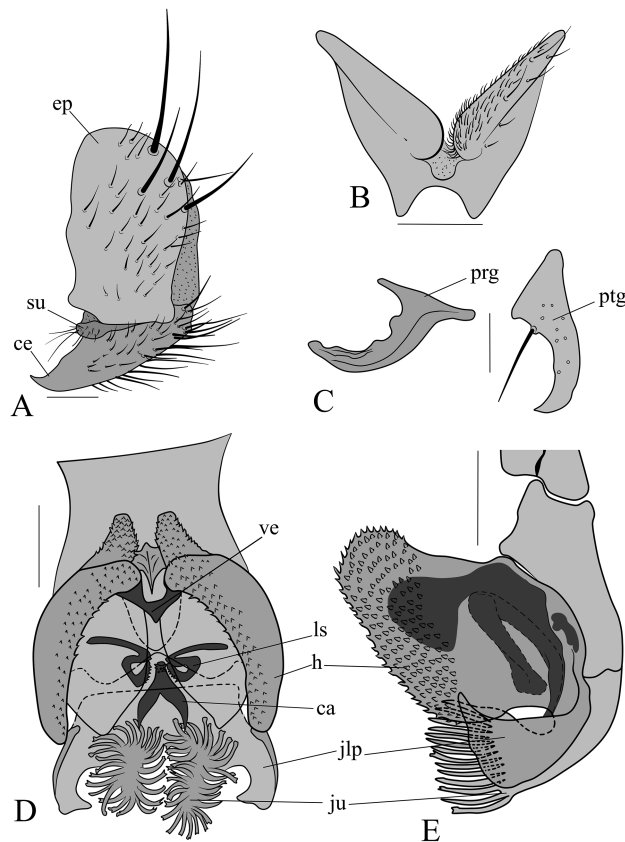


Fig. 3. *Helicobia neuzalmeidae* sp. nov., male. (A) Epandrium, surstylus, and cercus of holotype, left lateral view. (B) Sternite 5 of paratype, ventral view. (C) Gonites of holotype, left lateral view. (D) Phallus of holotype, ventral view. (E) Phallus of holotype, left lateral view. Abbreviations: ca = capitis; ce = cercus; ep = epandrium; h = harpes; ju = juxta; jlp = juxtal lateral plate; ls = lateral stylus; prg = pregonite; ptg = postgonite; su = surstylus; ve = vesica. Scale bars: A, B = 250 μ m; C, D, E = 100 μ m.

microtrichosity. Cercus yellowish, with cercal prong black, covered with some setae (Fig. 2C and D). Cercus almost straight, tapering towards and with pointed tip strongly curved anteriorly, in lateral view (Figs. 2C and 3A). Surstylus yellowish, small, clavate, with long and fine setae distally (Figs. 2C and 3A). Pregonite yellowish, elongate and thin, strongly curved anteriorly (Fig. 3C). Postgonite blackish with strongly curved apex and one long seta anteriorly (Fig. 3C). Phallus with a distinct hinge between basi- and distiphallus (Fig. 3E). Vesica short, triangular (Figs. 3D and E). Harpes well-developed and membranous, bearing many tiny spine-like processes on distal half (Figs. 3D and E). Lateral stylus elongated and convoluted, strongly pigmented (Fig. 3D). Capitis composed of two symmetrical elongate and thin parts (Fig. 3D). Juxta composed of a pair of well-developed pompom-like paired median structure, which has many elongate membranous filaments; juxtal lateral plate elongate with a plate-like broadened projection, which are almost triangular, in lateral view (Figs. 3D and E).

Female. Unknown.

Distribution. NEOTROPICAL—Brazil (Maranhão) (Fig. 1A).

Etymology. The specific epithet, which should be treated as a noun in the genitive case, is given in honor of teacher Neuza de Almeida Silva, mother of the first author. Even though she was a single mother, a migrant from the countryside to the city, she worked to support

and educate JOAS and her younger brother, Eduardo Almeida Silva. In addition, both Neuza and Eduardo contributed to the fieldwork.

Discussion

The two analyzed specimens of *H. neuzalmeidae* sp. nov. were collected in the *cerrado* habitats of northeastern Brazil during a forensic study utilizing pig carcasses as bait. One of them was collected in a suspended trap placed over a cage containing a pig carcass (Fig. 1B), during the second day of decomposition (bloated decomposition phase). The other was obtained from a larva (Fig. 1C) present in the sawdust layer in a tray placed under the cage during the decay phase. The small number of obtained specimens of *H. neuzalmeidae* sp. nov. indicates that it is a rare species or that it does not regularly breed in vertebrate carcasses. However, the number of specimens of *H. neuzalmeidae* sp. nov. obtained may be low for one or more of the reasons given below.

Female flesh flies are ovoviviparous and, with exception of some parasite species, usually deposit more than one larva on the feeding substrate (Shewell 1987, Pape and Dahlem 2010). However, as expected, not all larvae reach the adult stage due to several factors, among them predation by larvae of other dipteran species [e.g., *Chrysomya albiceps* (Wiedemann) (Diptera: Calliphoridae), *Ravinia* Robineau-Desvoidy (Diptera: Sarcophagidae)], wasps (Hymenoptera), and ants (Hymenoptera: Formicidae) (Coffey 1966, Pickens 1981, Patel 1994, Faria et al. 1999, Andrade et al. 2002, Gomes et al. 2007, Amendt et al. 2010, Oliveira-Costa 2011, Sales et al. 2016). It must also be taken into account that some larvae may pupate outside of the trays placed under the cages with the pig carcasses. In addition, as only male specimens were identified, female specimens were not counted, including the female that deposited the larva from which the holotype was bred.

Helicobia is one of the largest genera of Neotropical Sarcophagidae, but the larval feeding substrate of most species remains unknown (Pape and Dahlem 2010). Larvae of some species, whose feeding biology is known, are sarcosaprophagous, feeding on dead or injured insects (beetles, Lepidoptera, and ants) and snails (Plank 1929, Stegmaier 1972, Lopes 1973, Reeves et al. 2000, Pape and Dahlem 2010, Yan et al. 2020, Bragança et al. 2020, Stireman III 2021). However, adults of different species are very common on carrion and in traps baited with rotting animal tissues (Barros et al. 2008, Mello-Patiu et al. 2014, Faria et al. 2017, Paseto et al. 2019, Madeira-Ott et al. 2022), indicating that at least some species may be obligate or facultative carrion breeders, as observed in the present study. Some genera of flesh flies (e.g., *Blaesoxipha* Loew, *Peckia*, *Peckiamyia* Dodge, *Sarcophaga*, *Sarcophabrtiopsis* Hall, *Tricharaea* Thomson, *Villegasia*, Dodge) include species that feed on both dead invertebrates and vertebrates (Pape and Dahlem 2010, Yan et al. 2020, personal observations), indicating that it is a widespread feeding behavior in the family.

Most forensic studies on sarcophagids in the Neotropical region utilizing pig carcasses identify only adult males taken in traps or by net. Thus, there are few data about the species that actually feed in the carcasses (Barros et al. 2008, Rosa et al. 2009, Mello-Patiu et al. 2014, Faria et al. 2017, Paseto et al. 2019, Madeira-Ott et al. 2022). As more studies on flesh fly larvae that breed in carrion are carried out, additional species of *Helicobia* that feed on vertebrate carcasses will likely be revealed.

Helicobia neuzalmeidae sp. nov. differs from all other known species in having juxta composed by a pair of paired well-developed pompom-like median structures and an elongated juxtal lateral plate with a well-developed triangular, plate-like structure distally (Fig. 3D and E). The general aspect of the male terminalia

of *H. neuzalmeidae* sp. nov. resembles that of *Helicobia cearensis* Tibana, 1976 (Diptera: Sarcophagidae), since they share elongate harpes directed toward the gonites. However, the shapes of the juxta and juxtal lateral plates of these species are very different. The juxta of *H. cearensis* is composed of a unique broadened plate, without filaments and the juxtal lateral plate is apically bifid (Tibana 1976).

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