



Forensic Entomology

New records of Sarcophagidae (Insecta: Diptera) collected in Cerrado fragments in the municipality of Campo Grande, Mato Grosso do Sul state, Brazil

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Abstract. Collections carried out for a period of 10 weeks from October to December 2013 in two fragments of Cerrado (experimental farm of Embrapa Gado de Corte and Private Reserve of Natural Heritage belong to the Universidade Federal de Mato Grosso do Sul (RPPN-UFMS)) located in the municipality of Campo Grande, state of Mato Grosso do Sul, Midwestern Brazil, with traps baited with decomposing beef liver, and collections conducted for a period of 15 days in January 2014 in the RPPN-UFMS, using Shannon traps baited with dog corpses, resulted in 32 flesh fly species of eight genera, with the first record of the genus *Blaesoxipha* and 15 new species records to Mato Grosso do Sul.

Keywords: Brazilian Savanna; Dogs' Corpses; Flesh flies; Muscomorpha; Oestroidea.

Sarcophagidae or flesh flies (Diptera) have worldwide distribution and about 3,100 described species (PAPE *et al.* 2011). At least 800 species are known from Neotropical Region (PAPE 1996; MELLO-PATIU *et al.* 2014). Flesh flies are mainly attracted to decaying organic material, feces, carrion and corpses, and their larvae breed on these substrates (DIAS *et al.* 1984a; D'ALMEIDA & LIMA 1994; MELLO-PATIU *et al.* 2009). Many species are adapted to environments modified by human (D'ALMEIDA 1983; DIAS *et al.* 1984b) and are ecologically and forensically important as decomposers of decaying organic matter and as potential indicators of post-mortem interval (OLIVEIRA-COSTA *et al.* 2001). Some species are of medical and sanitary importance, either as vectors of human and animal diseases, or as producers of myiasis (GUIMARÃES *et al.* 1983).

The Sarcophagidae are divided into three subfamilies: Miltogramminae, Paramacronychiinae and Sarcophaginae. Miltogramminae are uncommon in South America, and most species are known as kleptoparasites of Hymenoptera. Most Paramacronychiinae are distributed in the non-tropical part of the Northern Hemisphere, while few species occur in the Southern Hemisphere, and only one species is endemic to the Neotropical Region. Some members of this subfamily are parasitoids or predators of other insects, and there are records of species bred from pulmonate snails and rotting tortoise eggs. Sarcophaginae is the largest subfamily in

number of genera and species in the Neotropical Region. This subfamily is biologically diverse and exhibits a wide variety of life habits, including species that are saprophagous, necrophagous, coprophagous, parasitoids of insects, and predators of invertebrates. Some species can cause myiasis (PAPE 1996).

Sarcophagidae can usually be distinguish from all other Oestroidea by the following combination of characters: thorax with three longitudinal black stripes on the mesonotum, notopleuron with two or four bristles (two large and two small), meron with bristles, subscutellum weakly developed, abdomen checkered, abdominal sternites 1 and 2 exposed and overlapping the sides of the respective tergites in males (SHEWELL 1987; MELLO-PATIU *et al.* 2009). The external morphology of the Sarcophagidae is quite uniform or vary too much and few characters can be used safely for species identification. Identification is based mainly on the structures of the male terminalia (CARVALHO & MELLO-PATIU 2008; MELLO-PATIU *et al.* 2009; PAPE & DAHLEM 2010; VAIRO *et al.* 2011).

Despite the Sarcophagidae being the second family in number of species among the Oestroidea and presenting species of ecological, forensic, and medical-sanitary importance, the family is little studied worldwide, not excluding the Neotropical Region, where there are gaps in knowledge about aspects of its biology, taxonomy and

systematics (MELLO-PATIU *et al.* 2017). In the same way, works on checklist and inventory of flesh fly species, which could potentially contribute to forensic, biodiversity, biogeography, and conservation policies studies, are little performed in the Neotropical Region (LOPES & TIBANA 1982; MELLO-PATIU *et al.* 2017). Knowledge of the Sarcophagidae from the state of Mato Grosso do Sul is still scarce and only 35 species are recorded from this state (PAPE & MELLO-PATIU 2006; MELLO-PATIU & SALAZAR-SOUZA 2016; MULIERI *et al.* 2017; MELLO-PATIU *et al.* 2017; TOMA *et al.* 2017; SANTOS & MELLO-PATIU 2018), which demands more collections in this region.

Considering the absences of studies in Mato Grosso do Sul and the importance of checklists and inventories as support for several research areas, the aim of this study is to present an updated checklist of the Sarcophagidae species from Mato Grosso do Sul, in order to broaden the knowledge of the regional fauna.

MATERIAL AND METHODS

The municipality of Campo Grande has a total area of 8,118.4 km² and is located geographically in the central region of the state of Mato Grosso do Sul, Brazil (Figure 1). According to the Köppen classification, the climate varies between Cfa (humid mesothermal subtype with no dry season) and the Aw (tropical wet and dry subtype with rainy summer and dry winter); most of the precipitation falls between October and April and low frequency of precipitation occur between June and August.

The present study was conducted in two fragments of Cerrado in the municipality of Campo Grande: a riparian forest remnant near the headquarters of the experimental farm of Embrapa Gado de Corte (20°27'S, 54°37' W - 530 m) (Figure 2) and a Private Reserve of Natural Heritage belong to the Universidade Federal de Mato Grosso do Sul (RPPN-UFMS) (20°30'S, 54°36'W - 600 m) (Figure 3). Samples were taken weekly for a period of 10 weeks from October

to December 2013 in the two above-mentioned areas. Simultaneously in each area, three traps similar to those of LUIZ *et al.* (2012) were used, baited with about 150 g of bovine liver decomposed outdoors for 48 hours (the baits were replaced weekly). The traps were installed in trees about 1.40 m above the ground and 100 m away from each other. Another part of the samples was carried out using Shannon traps baited with dog carcasses at two collection points in the RPPN-UFMS in 2014 (January 12th - 26th), collected by RODRIGUES *et al.* (2019).

Flies were killed using ethyl acetate and then placed in 70% alcohol. Only males were identified. Male terminalia was exposed to facilitate identification up to the species level. Preliminary identification of the genera and of some species was carried out using keys provided by CARVALHO & MELLO-PATIU (2008), BUENAVENTURA & PAPE (2013), VAIRO *et al.* (2011) e VAIRO *et al.* (2014). Subsequently, samples of the material were sent to Dr. C Mello-Patiu (Museu Nacional/UFRJ), for confirmation and identification up to the species level.

Voucher specimens were deposited at the Zoological Collection of the Universidade Federal de Mato Grosso do Sul (ZUFMS) and at the Diptera Collection of the Museu Nacional/UFRJ (part of the deposited vouchers was lost in the fire of the Museu Nacional).

This checklist update follows classifications proposed by PAPE (1996) and BUENAVENTURA & PAPE (2013). Species are listed according to MELLO-PATIU *et al.* (2017), including information on type-locality and previous distribution. Additional information on substrate preference and synanthropy were mentioned, when available in the literature.

RESULTS AND DISCUSSION

A total of 8,580 individuals (3,626 males and 4,952 females) were collected using traps baited with bovine liver, and 319 individuals (157 males and 162 females) were collected

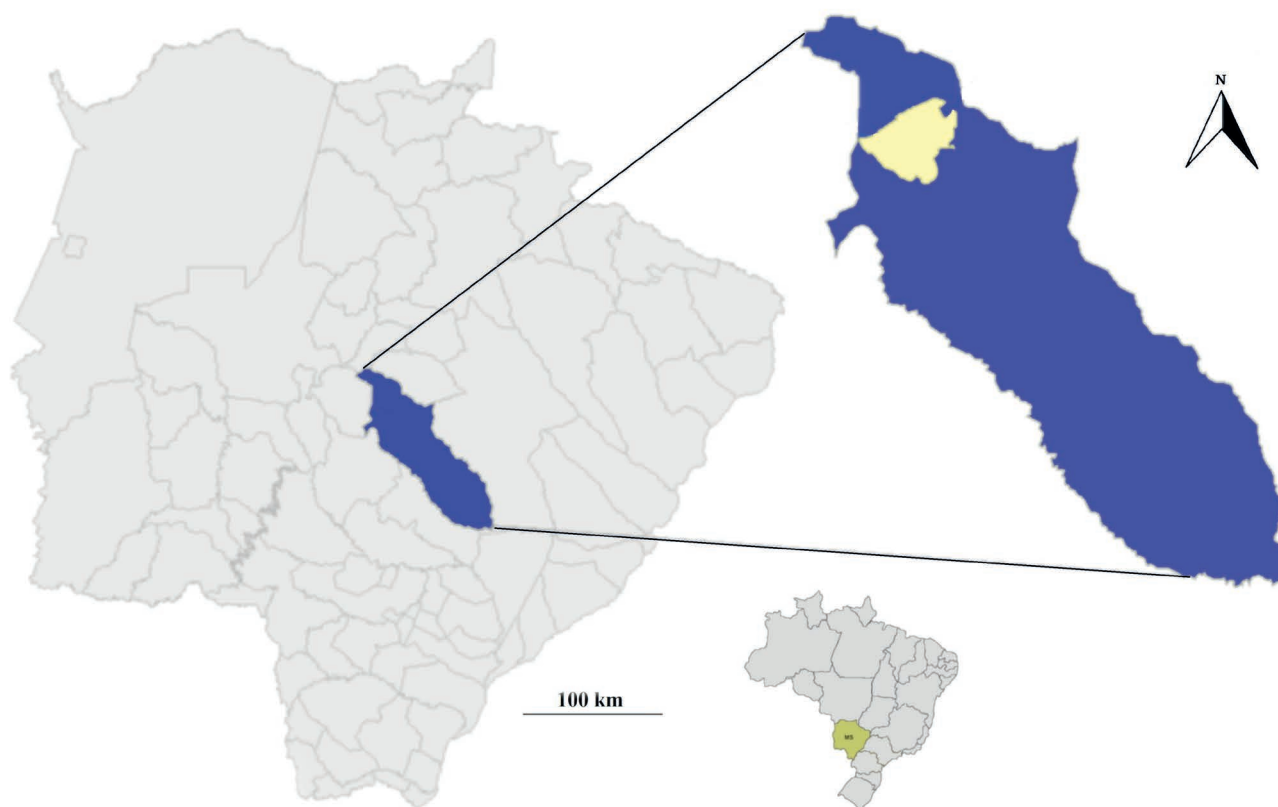


Figure 1. Map of Mato Grosso do Sul state; Campo Grande city (blue) and urban perimeter (yellow).

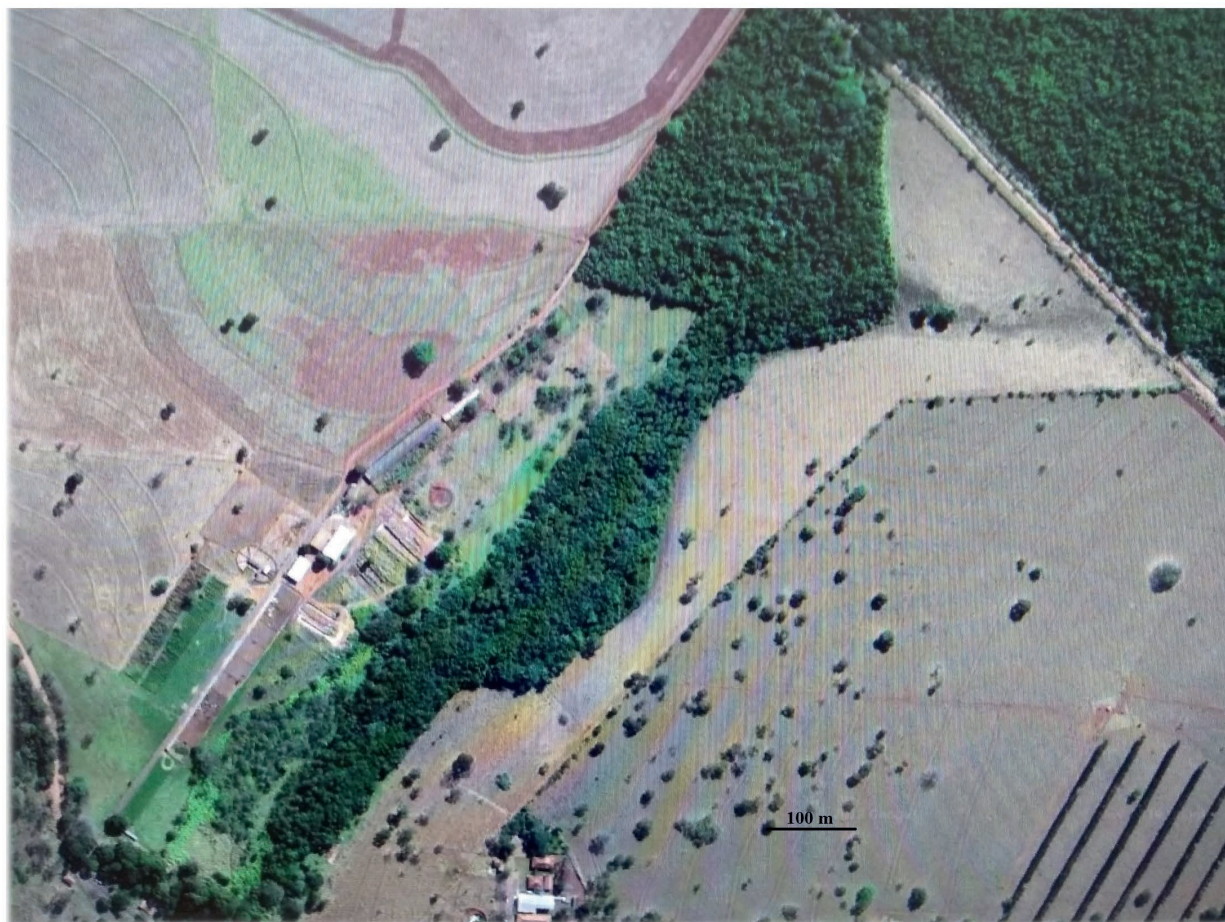


Figure 1. Photo (satellite - Google Earth) Riparian forest remnant near the headquarters of the experimental farm of Embrapa Gado de Corte.



Figure 1. Photo (satellite - Google Earth) Private Reserve of Natural Heritage of the Universidade Federal de Mato Grosso do Sul (RPPN-UFMS).

with Shannon traps containing dog carcasses. Prior to the present study, 35 species were recorded from Mato Grosso do Sul. Except for *Metopia pausiceta* Dodge belonging to the subfamily Miltogramminae, all other recorded species belong to the subfamily Sarcophaginae: *Dexosarcophaga ampullula* (Engel), *Dexosarcophaga globulosa* Lopes, *Engelomyia inops* (Walker), *Helicobia morionella* (Aldrich), *Helicobia pilifera* (Lopes), *Lepidodexia (Asilidodexia) elegans* (Lopes), *Lepidodexia (Asilidodexia) matogrossensis* (Lopes), *Lipoptilocnema crispula* (Lopes), *Lipoptilocnema salobrensis* Lopes, *Oxysarcodexia amorosa* (Schiner), *Oxysarcodexia angrensis* (Lopes), *Oxysarcodexia avuncula* (Lopes), *Oxysarcodexia confusa* Lopes, *Oxysarcodexia fringidea* (Curran & Walley), *Oxysarcodexia parva* Lopes, *Oxysarcodexia thornax* (Walker), *Oxyvinia excisa* (Lopes), *Peckia (Euboettcheria) collusor* (Curran & Walley), *Peckia (Pattonella) intermutans* (Walker), *Peckia (Peckia)*

enderleini (Engel), *Peckia (Sarcodexia) lambens* (Wiedemann), *Peckia (Squamotodes) ingens* (Walker), *Ravinia advena* (Walker), *Ravinia almeidai* (Lopes), *Retrocitomyia fluminensis* Lopes, *Retrocitomyia retrocita* (Hall), *Retrocitomyia mizuguchiana* Tibana & Xerez, *Retrocitomyia sisbiota* Mello-Patiu & Salazar-Souza, *Titanogrypa cryptopyga* (Lopes), *Tricharaea canuta* (Wulp), *Tricharaea indonata* (Lopes), *Tricharaea occidua* (Fabricius), *Udamopyga percita* (Lopes), and *Udamopyga setigena* (Enderlein) (PAPE & MELLO-PATIU 2006; MELLO-PATIU & SALAZAR-SOUZA 2016; MULIERI et al. 2017; MELLO-PATIU et al. 2017; TOMA et al. 2017; SANTOS & MELLO-PATIU 2018).

Thirty-two species belonging to eight genera of Sarcophaginae were identified based only on the male (Table 1). Fifteen species are recorded for the first time from Mato Grosso do Sul: *Blaesoxipha (Acanthodotheca) brazil*, *Blaesoxipha*

Table 1. Absolute and relative frequencies of each species of Sarcophagidae collected with traps baited with bovine liver in the experimental farm of Embrapa Gado de Corte and Private Reserve of Natural Heritage of the Universidade Federal de Mato Grosso do Sul (RPPN-UFMS), Campo Grande, Brazil, and with dog carcass in the RPPN-UFMS, and new records from Mato Grosso do Sul state, Brazil.

Espécies	Absolute Freq. Bovine liver	Relative Freq. Bovine liver	Absolute Freq. Dog carcass	Relative Freq. Dog carcass	New records from Mato Grosso do Sul
<i>Blaesoxipha (Tephromyia) convena</i>	0	0	1	0.64	X
<i>Blaesoxipha (Acanthodotheca) brazil</i>	1	0.03	0	0	X
<i>Engelomyia inops</i>	1	0.03	0	0	
<i>Helicobia aurescens</i>	2	0.06	1	0.64	X
<i>Helicobia pilifera</i>	1	0.03	0	0	
<i>Lipoptilocnema crispula</i>	3	0.08	0	0	
<i>Lipoptilocnema salobrensis</i>	3	0.08	0	0	
<i>Oxysarcodexia admixta</i>	43	1.18	14	8.91	X
<i>Oxysarcodexia angrensis</i>	79	2.18	0	0	
<i>Oxysarcodexia amorosa</i>	13	0.36	3	1.91	
<i>Oxysarcodexia avuncula</i>	15	0.41	1	0.64	
<i>Oxysarcodexia carvalhoi</i>	24	0.66	2	1.27	X
<i>Oxysarcodexia diana</i>	34	0.93	3	1.91	X
<i>Oxysarcodexia meridionalis</i>	26	0.72	0	0	X
<i>Oxysarcodexia mineirensis</i>	5	0.14	0	0	X
<i>Oxysarcodexia occulta</i>	1	0.03	0	0	X
<i>Oxysarcodexia parva</i>	0	0	2	1.27	
<i>Oxysarcodexia thornax</i>	2,575	70.98	73	46.50	
<i>Oxysarcodexia xanthosoma</i>	9	0.25	0	0	X
<i>Peckia (Euboettcheria) anguilla</i>	12	0.33	0	0	X
<i>Peckia (Euboettcheria) collusor</i>	89	2.45	2	1.27	
<i>Peckia (Pattonella) intermutans</i>	29	0.80	0	0	
<i>Peckia (Peckia) chrysostoma</i>	348	9.59	0	0	X
<i>Peckia (Peckia) enderleini</i>	73	2.01	0	0	
<i>Peckia (Peckia) pexata</i>	67	1.85	0	0	X
<i>Peckia (Sarcodexia) florencioi</i>	2	0.06	0	0	X
<i>Peckia (Sarcodexia) lambens</i>	114	3.14	30	19.11	
<i>Peckia (Squamotodes) ingens</i>	25	0.69	1	0.64	
<i>Ravinia advena</i>	1	0.03	1	0.64	
<i>Ravinia belforti</i>	28	0.77	23	14.65	X
<i>Udamopyga percita</i>	1	0.03	0	0	
<i>Udamopyga setigena</i>	1	0.03	0	0	
Sarcophagidae total (machos)	3,628	100.00	157	100.00	

(*Tephromyia*) *convena*, *Helicobia aurescens* (Townsend), *Oxysarcodexia admixta* (Lopes), *Oxysarcodexia carvalhoi* Lopes, *Oxysarcodexia diana* (Lopes), *Oxysarcodexia mineirensis* Souza & Paseto, *Oxysarcodexia meridionalis* (Engel), *Oxysarcodexia occulta* Lopes, *Oxysarcodexia xanthosoma* (Aldrich), *Peckia (Euboettcheria) anguilla* (Curran & Walley), *Peckia (Peckia) chrysostoma* (Wiedemann), *Peckia (Peckia) pexata* (Wulp), *Peckia (Sarcodexia) florencioi* (Prado & Fonseca), and *Ravinia belforti* (Prado & Fonseca). The new records increased the number of known species to 50 in Mato Grosso do Sul.

Oxysarcodexia showed the highest number of species collected with traps baited with bovine liver and dog carcass, with 11 and seven species respectively, followed by *Peckia*, with nine and three species, resulting in seven and four new records respectively for each genus from Mato Grosso do Sul. Prior to the present work, these genera were the most diverse in this state, with seven and five species respectively (MELLO-PATIU *et al.* 2017; TOMA *et al.* 2017). MELLO-PATIU *et al.* (2017) assumed that *Oxysarcodexia* and *Peckia* were undersampled in Mato Grosso do Sul, since 23 and 14 species were recorded, respectively, for each genus from other areas of the Brazilian Cerrado. *Oxysarcodexia thornax* was the most abundant species, with 2,575 and 73 specimens collected with traps baited with bovine liver and dog carcass, corresponding to 70.98% and 46.50%, respectively, of the collected males. These results agreed with those showed by BARROS *et al.* (2008) and ROSA *et al.* (2011), who studied the entomofauna associated with the domestic pig carcasses in Cerrado areas of the Distrito Federal and the state of Minas Gerais, respectively, in which *Oxysarcodexia* showed the highest number of species among the Sarcophagidae and *O. thornax* was the most abundant species. This may be related to the large size of this genus and the attraction of its species to different types of baits (MELLO-PATIU *et al.* 2017).

Among the new records from Mato Grosso do Sul, *H. aurescens*, *O. admixta*, *O. diana* e *P. (E.) anguilla*, *P. (P.) chrysostoma*, *P. florencioi*, *P. pexata*, and *R. belforti* have already been collected from domestic pig carcasses in the Cerrado areas of the Distrito Federal and the state of Minas Gerais (BARROS *et al.* 2008; ROSA *et al.* 2011; MELLO-PATIU *et al.* 2014; FARIA *et al.* 2017), and *O. carvalhoi*, *O. meridionalis*, *O. mineirensis*, *O. occulta*, *O. xanthosoma*, and *P. florencioi*, in Cerrado areas of Minas Gerais (ROSA *et al.* 2011; MELLO-PATIU *et al.* 2014; SOUZA & PASETO 2015; FARIA *et al.* 2017).

Two species herein collected [*Peckia chrysostoma* (Wiedemann) and *R. belforti*] have already been registered on human corpses in Brazil, and have potential importance as forensic indicators, like other species previously recorded from Mato Grosso do Sul, such as *O. angrensis*, *O. thornax*, *P. (P.) intermutans*, and *P. (S.) lambens* (CARVALHO *et al.* 2000; OLIVEIRA-COSTA *et al.* 2001; OLIVEIRA & VASCONCELOS 2010; VASCONCELOS *et al.* 2014).

MELLO-PATIU *et al.* (2017), in their checklist of the Sarcophagidae from Mato Grosso do Sul, could not confirm the records of seven species from this state [*H. morionella*; *O. confusa*; *P. (E.) collusor*; *P. (P.) intermutans*; *P. (P.) enderleini*; *P. (S.) ingens*; *R. advena*], due to the lack of collection and publication data prior to the separation of the states of Mato Grosso and Mato Grosso do Sul. Among the species mentioned above, the last five are confirmed here to Mato Grosso do Sul.

List of new records from Mato Grosso do Sul

SARCOPHAGINAE

Blaesoxipha Loew, 1861

The genus *Blaesoxipha* comprises about 245 species worldwide (PAPE & DAHLEM 2010), of which approximately 77 species are

known from Neotropical Region (PAPE 1996). Prior to this study, there was no record of species of this genus from Mato Grosso do Sul. *Blaesoxipha (A.) brazil* and *Blaesoxipha (T.) convena* are the first recorded from this state. This genus has numerous parasitoid species, especially of Acrididae grasshoppers, Tenebrionidae beetles, but also of Mantidae, cockroaches and other Coleoptera and Saltatoria (PAPE & DAHLEM 2010). Some species of the subgenus *Gigantotheca* seem to breed in vertebrate and invertebrate carrions (PAPE 1996; PAPE & DAHLEM 2010). *Blaesoxipha* species can be recognized by the following combination of characters (PAPE 1996): postalar wall setose, trochanter of hind leg with posteromedian row of spines present in both sexes; male mid femur with ctenidium with normal spines; male terminalia with cercus bent backwards with cercal prong with spines dorsally, lateral styli fused to each other through a median plate-like structure proximal to the stylus, lateral styli collapsed with no outlet from spermatiduct, and phallic vesica reduced or undeveloped.

Blaesoxipha (Acanthodotheca) Townsend, 1918

Blaesoxipha brazil Pape. Type locality: Brazil [state?], Chapada. Previous distribution (PAPE 1994, 1996): Neotropical: Argentina (Entre Ríos, Tucumán), Brazil (Santa Catarina). The biology of this species is little known.

Blaesoxipha (Tephromyia) Brauer & Bergenstamm, 1891

Blaesoxipha convena (Reinhard). Type locality: United States, Texas, Brazos Co., College Station. Previous distribution (PAPE 1994, 1996): Nearctic: United States (Florida, North Carolina, Oklahoma, Texas). Neotropical: Costa Rica, El Salvador. This is the first record of this species from Brazil. Its biology is little known.

Helicobia Coquillett, 1895

There are about 35 species of this genus worldwide, most of them recorded from Neotropical Region (PAPE 1996). *Helicobia aurescens* is the third species of this genus recorded from Mato Grosso do Sul, in addition to *H. morionella* and *H. pilifera* (MELLO-PATIU *et al.* 2017). Species of this genus are recognized by their small size, large bristles mainly on thorax, ocellar and vertical bristles very strong, reclinate orbital bristles in both sexes, parafacial bristled, wing with vein R₁ setose and third costal sector bare, and male mid femur without ctenidium (PAPE 1996). These three species can be identified using redescrptions provided by LOPES (1939) and TIBANA & MELLO-PATIU (1992).

Helicobia aurescens (Townsend). Type-locality: Brazil, São Paulo, Itaquaquetuba. Previous distribution (PAPE 1996; BARROS *et al.* 2008; ROSA *et al.* 2011; SOUZA *et al.* 2015): Neotropical: Argentina, Brazil (Distrito Federal, Maranhão, Minas Gerais, Paraná, Rio de Janeiro, São Paulo). *Helicobia aurescens* has already been caught in traps baited with animal tissues (decomposing bovine liver and lung), dog feces, and domestic pig and rodent carcasses (MOURA 2004; MULIERI *et al.* 2008; BARROS *et al.* 2008; MULIERI *et al.* 2010; MELLO-PATIU *et al.* 2014; SOUZA *et al.* 2015). In Curitiba, Paraná state, this species showed a preference for inhabited areas (FERREIRA 1979).

Oxysarcodexia Townsend, 1917

This is one of the largest genera of Sarcophaginae with 86 known species, broadly distributed in the Neotropical Region, and with a small number of species recorded from Nearctic, Australasia and Oceania Regions (PAPE 1996; SOARES & MELLO PATIU 2010; SOUZA & BUENAVENTURA 2016). Prior to this study, seven species were recorded from Mato Grosso do Sul (MELLO-PATIU *et al.* 2017), here the number of species was increased to 14. Species of *Oxysarcodexia* can be recognized by the following combination of characters (PAPE 1996): postalar wall

haired, male mid femur with ctenidium of flattened spines, tegula blackish, contrasting from orangish basicosta, male sternite 5 deeply cleft and usually with almost parallel sides, vesica elongated, phallus with lateral and medium styli. The identification of the *Oxysarcodexia* species is difficult, the species of this genus are mostly separate from each other by differences in the male terminalia, which in some cases have very similar morphology. Except for *O. mineirensis*, most of the species recorded from Mato Grosso do Sul can be identified using identification key to the species of *Oxysarcodexia* provided by LOPES & TIBANA (1987), and a taxonomic synopsis provided by SOUSA 2014.

Oxysarcodexia admixta (Lopes). Type-locality: Brazil, Rio de Janeiro, Angra dos Reis. Previous distribution (PAPE 1996; BARROS et al. 2008; VAIRO et al. 2011; SOUSA et al. 2015): Neotropical: Argentina, Brazil (Distrito Federal, Goiás, Mato Grosso, Maranhão, Minas Gerais, Paraná, Rio de Janeiro, Santa Catarina, São Paulo). *Oxysarcodexia admixta* has already been captured in traps baited with bovine lung and liver, human feces, fish, and domestic pig carcass (D'ALMEIDA & LIMA 1994; OLIVEIRA et al. 2002; BARROS et al. 2008; ROSA et al. 2011; VAIRO et al. 2011; SOUSA et al. 2015).

Oxysarcodexia carvalhoi Lopes. Type-locality: Brazil, Minas Gerais, Cordisburgo. Previous distribution (PAPE 1996; COURI et al. 2000; VAIRO et al. 2014): Neotropical: Brazil (Amapá, Amazonas, Ceará, Mato Grosso, Minas Gerais, Pará, Rio de Janeiro, São Paulo), Ecuador, Guyana. *Oxysarcodexia carvalhoi* has already been collected with traps baited with chicken viscera, human feces, mouse and domestic pig carcasses. This species was mostly attracted to chicken viscera (DIAS et al. 1984b). LOPES (1973) collected this species with a trap containing powdered milk and agar. *Oxysarcodexia carvalhoi* was regarded as one of the most asynanthropic species in Belo Horizonte, Minas Gerais state (DIAS et al. 1984a).

Oxysarcodexia diana (Lopes). Type-locality: Brazil, Rio de Janeiro. Previous distribution (LOPES & TIBANA 1991; PAPE 1996; MARCHIORI et al. 2001; BARROS et al. 2008; YEPES-GAURISAS et al. 2013; LOPES et al. 2018): Nearctic: Mexico (Morelos, San Luis de Potosí); Neotropical: Argentina, Brazil (Bahia, Distrito Federal, Ceará, Goiás, Mato Grosso, Minas Gerais, Paraná, Rio de Janeiro, Roraima, Santa Catarina, São Paulo), Colombia, Ecuador, El Salvador, Mexico (Chiapas), Paraguay, Trinidad and Tobago (Trinidad). *Oxysarcodexia diana* has already been collected with traps baited with fish, chicken viscera, human and bovine feces, domestic pig and rodent carcasses, and fruits. This species showed mostly coprophagous and scavenger habits (LOPES 1973; D'ALMEIDA 1983; DIAS et al. 1984b; D'ALMEIDA & LIMA 1994; MARCHIORI et al. 2001; BARROS et al. 2008), and was correlated to the rural area in Guajira, Colombia (VALVERDE-CASTRO et al. 2017).

Oxysarcodexia meridionalis (Engel). Type-locality: Argentina, Chaco, San José. Previous distribution (PAPE 1996; MELLO-PATIU et al. 2014): Neotropical: Argentina, Bolivia, Brazil (Goiás, Minas Gerais, São Paulo). The biology of this species remains unknown.

Oxysarcodexia mineirensis Souza & Paseto. Type-locality: Brazil, Minas Gerais, Uberlândia. Previous distribution (SOUSA & PASETO 2015): Neotropical: Brazil (Minas Gerais). This species was collected with traps containing domestic pig carcass in a semi-deciduous forest area in the Cerrado (SOUSA & PASETO 2015; FARIA et al. 2017).

Oxysarcodexia occulta Lopes. Type-locality: Brazil, Rio de Janeiro, Guanabara. Previous distribution (LOPES & TIBANA 1991; PAPE 1996; MELLO-PATIU et al. 2014): Neotropical: Brazil (Ceará, Minas Gerais, Rio de Janeiro, Roraima), Colombia, Ecuador, Panama. In previous works, *Oxysarcodexia occulta*

was collected with traps containing powdered milk and agar, fish, rotten banana with brown sugar, human feces, and domestic pig carcass (LOPES 1973; LOPES 1975; MELLO-PATIU et al. 2014; VALVERDE-CASTRO et al. 2017). This species was captured exclusively in a forest area in Colombia, being attracted to fish bait, however that study involved only two specimens (VALVERDE-CASTRO et al. 2017).

Oxysarcodexia xanthosoma (Aldrich). Type-locality: Guatemala, Los Amates. Previous distribution (LOPES & TIBANA 1991; PAPE 1996; VAIRO et al. 2011): Nearctic: Mexico (San Luis Potosí, Sonora); Neotropical: Argentina, Brazil (Amazonas, Ceará, Espírito Santo, Mato Grosso, Minas Gerais, Pará, Paraná, Rio de Janeiro, Roraima, São Paulo), Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Mexico (Jalisco, Veracruz), Panama, Peru. *Oxysarcodexia xanthosoma* has already been captured in traps baited with sardine, human feces, wild pig viscera, domestic pig carcass, and palm (CURRAN & WALLEY 1934; LOPES 1973; OLIVEIRA et al. 2002; LEANDRO & D'ALMEIDA 2005; BARBOSA et al. 2009). In previous studies, this species was collected in a urban environment (BARBOSA et al. 2009), Cerrado area in Minas Gerais (ROSA et al. 2011), remnant of Mixed Ombrophilous Forest in Paraná (VAIRO et al. 2011), Humid Tropical Forest in Amazonas (VAIRO et al. 2014), and Atlantic Forest fragment in Rio de Janeiro (LEANDRO & D'ALMEIDA 2005).

Peckia Robineau-Desvoidy, 1830

There are 67 New World species of this genus, mainly Neotropical (BUENAVENTURA & PAPE 2015). Nine species are known from Mato Grosso do Sul, including the four new records from this study. The monophyly and systematic position of this genus remain controversial issues. PAPE (1996) listed a combination of characters for recognition of *Peckia*: lower calypter with fringe of long hair along the outer margin extending to its posterior corner, lateral styli filiform, female tergite 6 divided into two lateral plates door-like closing the terminalia. Species recorded from Mato Grosso do Sul can be identified using the taxonomic revision work of the *Peckia* species by BUENAVENTURA & PAPE (2013), which provides good redescriptions and illustrations mostly of the male terminalia.

Peckia (Euboettcheria) Townsend, 1927

Peckia anguilla (Curran & Walley). Type locality: Guyana, Cartabo. Previous distribution (PAPE 1996; BARROS et al. 2008; BUENAVENTURA & PAPE 2013; SOUSA et al. 2015): Nearctic: Mexico (San Luis Potosí); Neotropical: Argentina, Bolivia, Brazil (Amazonas, Ceará, Distrito Federal, Maranhão, Mato Grosso, Rio de Janeiro, São Paulo), Costa Rica, Guyana, Nicaragua, Panama, Peru, Trinidad & Tobago. This species has already been collected with traps baited with fish, chicken viscera, bovine lung, human feces, and domestic pig carcass (YEPEZ-GAURISAS et al. 2013; MELLO-PATIU et al. 2014; SOUSA et al. 2015); *Peckia (E.) anguilla* was considered asynanthropic in a study carried out in Belo Horizonte (DIAS et al. 1984a), but in Colombia, this species was more abundant in rural area than in urban and forest areas. In the last two areas it showed the same proportion of collected specimens and showed attraction to fish (YEPEZ-GAURISAS et al. 2013).

Peckia (Peckia) Robineau-Desvoidy, 1830

Peckia chrysostoma (Wiedemann). Type locality: US Virgin Islands, St. Thomas. Previous distribution (PAPE 1996; BUENAVENTURA & PAPE 2013; YEPEZ-GAURISAS et al. 2013): Nearctic: Mexico (Baja California Sur, Morelos, Sonora), United States (Florida, Texas); Neotropical: American Virgin Islands, Argentina, Bahamas, Belize, Bolivia, Brazil (Ceará, Espírito Santo, Distrito Federal, Pernambuco, Rio de Janeiro, Santa Catarina, São Paulo), Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Islands Galapagos, Guatemala, Guyana, Jamaica, Mexico (Chiapas, Jalisco, Tabasco, Yucatán),

Nicaragua, Panama, Peru. Australasia-Oceania - Cook Islands, French Polynesia (Society Is.). *Peckia (P.) chrysostoma* has already been bred or collected with traps baited with fish, crab, squid, shrimp, gastropod, mouse, bovine liver, human feces, domestic pig carcass, and human corpse (LOPES 1973; D'ALMEIDA 1988, 1989; D'ALMEIDA & LIMA 1994; VASCONCELOS *et al.* 2014). This species was bred more frequently in fish in a study of Calyptratae trophic niche (D'ALMEIDA & D'ALMEIDA 1998). *Peckia (P.) chrysostoma* showed strong preference for inhabited areas in Rio de Janeiro (D'ALMEIDA 1983) and slight preference for the urban environment in Colombia (VALVERDE-CASTRO *et al.* 2017), however, in Belo Horizonte, it was more frequent in uninhabited areas (DIAS *et al.* 1984a).

Peckia pexata (Wulp). Type-locality: Mexico, Yucatán. Previous distribution (PAPE 1996; BUENAVENTURA & PAPE 2013; YEPEZ-GAURISAS *et al.* 2013; MELLO-PATIU *et al.* 2014; SOUSA *et al.* 2015): Neártico: Mexico (Morelos), United States (Texas); Neotropical: Barbados, Bolivia, Brazil (Amapá, Amazonas, Bahia, Ceará, Distrito Federal, Espírito Santo, Maranhão, Minas Gerais, Piauí, Rio de Janeiro, Rondônia, Roraima), Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Mexico (Guerrero, Jalisco, Sinaloa, Tamaulipas, Veracruz, Yucatán), Nicaragua, Saint Lucia, Saint Vincent & the Grenadines, Trinidad & Tobago (Trinidad), Venezuela. *Peckia (P.) pexata* has already been collected with traps baited with fish, chicken viscera, feces, bananas, rodents and pig carcasses (DIAS *et al.* 1984b; BARROS *et al.* 2008; ROSA *et al.* 2011, VALVERDE-CASTRO *et al.* 2017). Its behavior has indicated necrophagous habits (DIAS *et al.* 1984b; VALVERDE-CASTRO *et al.* 2017). This species was found in urban, rural and forest areas in Colombia, but was highly associated with the last two areas (VALVERDE-CASTRO *et al.* 2017), agreeing with the studies carried out by DIAS *et al.* (1984a) in Belo Horizonte.

Peckia (Sarcodexia) Townsend, 1892

Peckia florencioi (Prado & Fonseca). Type-locality: Brazil, São Paulo. Previous distribution (FERREIRA 1979; PAPE 1996; BUENAVENTURA & PAPE 2013): Neotropical: Brazil (Mato Grosso, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo), Argentina, Paraguay. *Peckia (S.) florencioi* has already been collected with traps baited with fish, bovine liver, bovine ground beef, feces, and domestic pig carcass (LOPES 1973; D'ALMEIDA 1994; D'ALMEIDA & LIMA 1994; ROSA *et al.* 2011; SOUZA & ZUBEN 2016). The most attractive baits were fish and bovine liver in Rio de Janeiro (D'ALMEIDA 1983), and fish, in Belo Horizonte (DIAS *et al.* 1984b). This species was considered asynanthropic in studies carried out in Campinas and Rio Claro in São Paulo state (LINHARES 1981; SOUZA & ZUBEN 2016), Belo Horizonte (DIAS *et al.* 1984a), and Rio de Janeiro (D'ALMEIDA 1983).

Ravinia Robineau-Desvoidy, 1863

Ravinia has 34 described species and is a predominantly New World genus, except for one Palearctic species (PAPE 1996; PAPE & DAHLEM 2010). Prior to this study, two species were known from Mato Grosso do Sul, *R. advena* and *R. almeidai* (MELLO-PATIU *et al.* 2017). This genus can usually be recognized by the following combination of characters (PAPE 1996): postalar wall setose, tegula usually yellowish or orangish and the same color as basicosta, male mid femur with ctenidium with flattened spines, male sternite 5 deeply cleft and parallel-sided, and aedeagus with hilla. *Ravinia* species are difficult to identify (LOPES 1947), and no identification keys are currently available to New World species. However, species recorded from Mato Grosso do Sul can be recognized using the redescrptions based on male terminalia provided by LOPES & LEITE (1991) and GUIMARÃES (2004).

Ravinia belforti (Prado & Fonseca). Type-locality: Brazil, São

Paulo, São Paulo. Previous distribution (LOPES & TIBANA 1991; PAPE 1996; VAIRO *et al.* 2014; SOUZA *et al.* 2015): Neotropical: Argentina, Brazil (Amazonas, Ceará, Distrito Federal, Goiás, Mato Grosso, Maranhão, Minas Gerais, Paraná, Pernambuco, Rio de Janeiro, Roraima, São Paulo), Colombia, Paraguay, Trinidad & Tobago. *Ravinia belforti* has already been collected with traps baited with fish, bovine liver, human and bovine feces, bananas, mouse and pig carcasses, and on human corpse (LOPES 1973; D'ALMEIDA & MELLO 1996; D'ALMEIDA & D'ALMEIDA 1998; BARROS *et al.* 2008; OLIVEIRA & VASCONCELOS 2010; ROSA *et al.* 2011). *Ravinia belforti* showed preference for feces for larvipositing (D'ALMEIDA & MELLO 1996). This species showed synanthropic habits in Rio de Janeiro (LOPES 1973; D'ALMEIDA 1983), Campinas (LINHARES 1981), and Belo Horizonte (DIAS *et al.* 1984a).

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