

## Only the beginning: the high species diversity of soldier flies (Diptera: Stratiomyidae) in a Cerrado protected area of semideciduous seasonal forests in Goiás, Brazil

Gabriela Luiza Carvalho Mendes Machado<sup>1</sup> , Diego Aguilar Fachin<sup>1\*</sup> 

<sup>1</sup>Universidade Federal de Goiás, Instituto de Ciências Biológicas, Departamento de Ecologia, Goiânia, GO, Brasil.

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### ABSTRACT

The Stratiomyidae (Diptera) are small to large flies in size, characterized by a small discal cell and radial veins crowded toward the anterior margin of the wing. With over 2,800 described species worldwide, this family has high morphological variation and occurs in various habitats, including the Cerrado, the second-largest biome in Brazil. Despite the potential of Diptera for conservational studies, the lack of species lists and faunistic studies limits our understanding of stratiomyids, especially in the Cerrado and in the state of Goiás, for which only 10 stratiomyid species have been reported. This study presents the Stratiomyidae fauna from the Parque Estadual Altamiro de Moura Pacheco and the Parque Estadual do João Leite, remnant areas of the semideciduous seasonal forest from the Cerrado. Collections were carried out using Malaise traps, between June and December 2022 and January and March 2023. A total of 855 specimens were collected and identified into 63 stratiomyid species/morphospecies, 35 genera, and eight subfamilies. Of these species, 59 are new records for the state of Goiás and, in addition, two species—*Merosargus tangens* James, 1971 in James & McFadden, 1971 and *Sargus cirrhosus* McFadden, 1982 in James & McFadden, 1982—are new records for Brazil. The knowledge of the Stratiomyidae in the state has expanded to nine subfamilies, 36 genera, and 69 species, indicating that insect fauna in the Cerrado is still far beyond our comprehension.

### Introduction

The Cerrado is the second largest biome in Brazil, covering about 23% of the country, with over 2 million km<sup>2</sup> (IBGE, 2012; Borghetti et al., 2019). It is considered the most flora-rich savanna in the world and a biodiversity hotspot with very characteristic endemic fauna (Myers et al., 2000; Klink and Machado, 2005; Borghetti et al., 2019). The biome is, currently, one of the most threatened in the world, losing areas to agriculture, pastures, and urban centers (Strassburg et al., 2017; Rausch et al., 2019). In recent decades, the accelerated pace of habitat loss due to human action, as has been happening with the Cerrado, has heightened the concern of the scientific community regarding the extinction of species in a very short time scale, a situation referred to as the “biodiversity crisis” (Laurance and Wright, 2009).

Although Diptera has been gradually studied in Brazil, with the production of regional catalogs (Rafael et al., 2024), lists of species for regions, states, and specific localities in the country (e.g., Riccardi et al., 2022; Lamas et al., 2023; Rocha et al., 2024), and analytical studies based on available records (see Amorim and Santos, 2018), the fauna of Diptera in the Cerrado has received less attention. While the fauna of flies has been studied in the Cerrado areas in the states of Maranhão

(Nascimento et al., 2021; Sousa et al., 2021; Rocha et al., 2024), Mato Grosso and Mato Grosso do Sul (Lamas et al., 2023), Piauí (Silva et al., 2024), São Paulo (Dutra and Carmo, 2024) and Tocantins (Lima et al., 2015; Costa et al., 2024), the knowledge on the local fauna of flies in Goiás is scarce and only more recently started to be addressed (Costa et al., 2021, 2022; Silva et al., 2022; Afiune and Oliveira, 2024).

For soldier flies, in particular, faunistic treatments in general, with lists of species of a specific area, are quite limited (Fachin et al., 2023). As a result, most species are known from the type series and other sporadic studies (as some more recent taxonomic revisions); thus, the distribution records are restricted and incomplete (see Woodley, 2001). The Stratiomyidae have over 2,800 species described worldwide included in 12 subfamilies (Woodley, 2001, 2011), and are easily recognizable by having a small discal cell and radial veins concentrated in the anterior portion of the wing. Besides the high species diversity of Stratiomyidae globally and in the neotropics, with approximately 1,000 described species (Woodley, 2001, 2011), there is much to be known about the real diversity and distribution of the family worldwide and in Brazil. According to the Taxonomic Catalog of the Brazilian Fauna, approximately 345 species, 109 genera, and 11 subfamilies of Stratiomyidae are known from Brazil, of which only 10 species, four genera, and four subfamilies occur in the state of Goiás (Fachin, 2025).

\*Corresponding author.

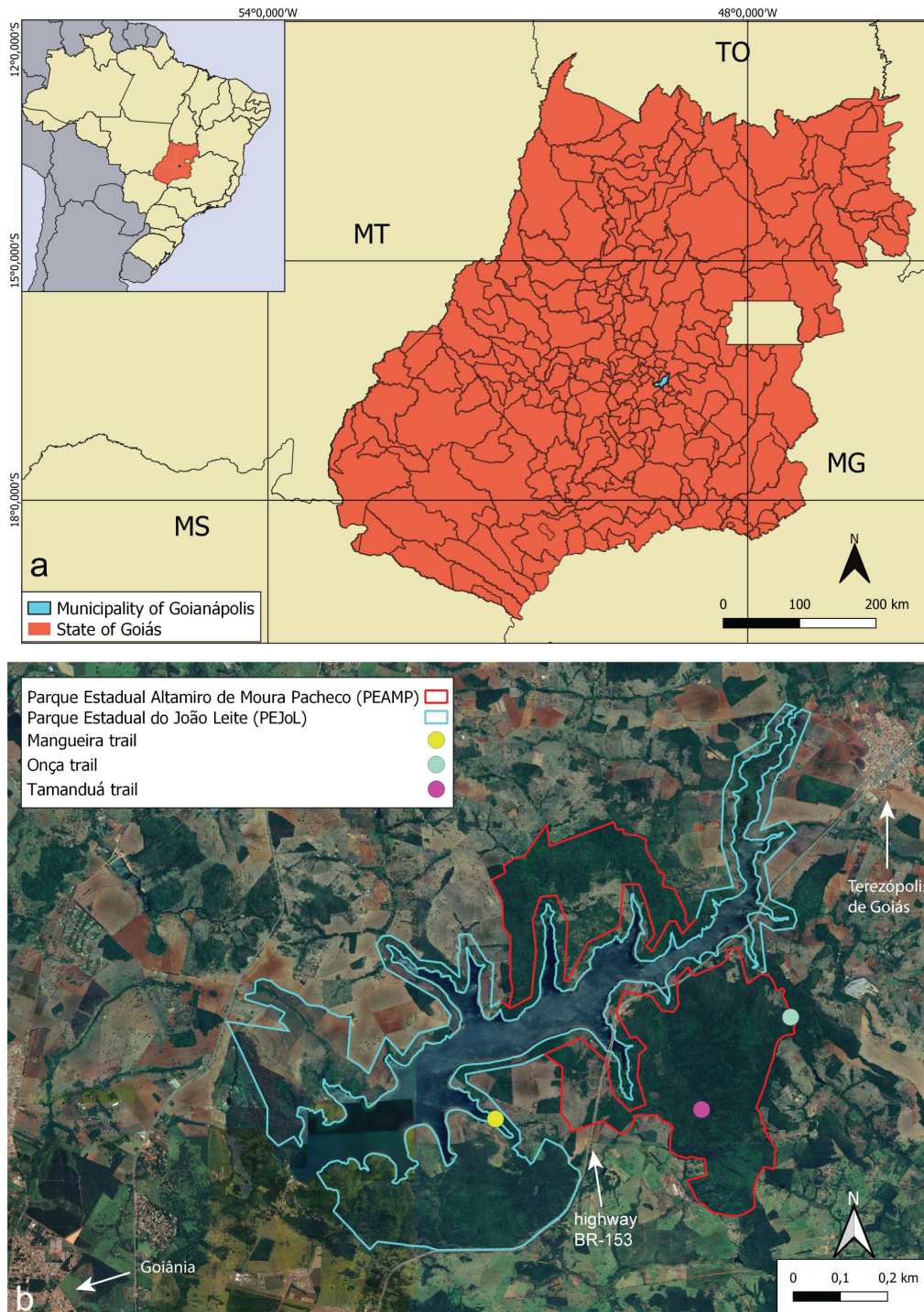
E-mail: [diegoafachin@gmail.com](mailto:diegoafachin@gmail.com) (D.A. Fachin).

Therefore, this deficit in knowledge about the family in Cerrado is an opportunity to provide taxonomic data for still poorly studied regions (and groups), before the additional loss of species. The present study provides an illustrated species list of the Stratiomyidae (Diptera, Brachycera), including data on the seasonality and abundance, of the Parque Estadual Altamiro de Moura Pacheco and Parque Estadual do João Leite, state of Goiás, one of the few protected areas in the state, composed of remnants of semideciduous seasonal forests in the core region of the Brazilian Cerrado.

## Material and methods

### Study area

The collecting occurred in a conservation unit that joins the Parque Estadual Altamiro de Moura Pacheco (PEAMP) and Parque Estadual do João Leite (PEJoL), 16°30' to 16°34'S and 49°07' to 49°11'W (Fig. 1), which has an area combined of 4.964 ha (SEMAD, 2021). It is a full protection conservation unit, located in the southeastern region



**Figure 1** Study area map, with the limits of all municipalities of the state of Goiás. (a) Limits of the municipality of Goianópolis; (b) Satellite image of the Parque Estadual Altamiro de Moura Pacheco (PEAMP) and Parque Estadual do João Leite (PEJoL). Yellow, pink, and green circles represent the locations where Malaise traps were installed to capture insects.

of the state of Goiás, between the municipalities of Goianópolis, Goiânia, Nerópolis, and Terezópolis de Goiás, about 24 km from the center of Goiânia. The PEAMP was created in December 1992, Law nº 11.878 (see <https://uc.socioambiental.org/en/arp/2576#pesquisa>), with a total area of 3.183 ha, but, in 1993, the protected area was reduced to 2.132 ha to construct the João Leite water reservoir to supply the surrounding cities. The PEJoL was created in 2014, Law nº 18.462, with an area of 2.832 (see <https://uc.socioambiental.org/en/arp/6051>), to protect the water reservoir surroundings. Currently, both areas protect one of the last remnants of semideciduous seasonal forests in Goiás (Ramalho et al., 2018) and 28 river sources linked to the Ribeirão Leite River (SEMAD, 2021).

Concerning the vegetation, there is a predominance of semideciduous seasonal forests in the area, with the occurrence of other phytophysiognomies of Cerrado as well, such as Cerrado *sensu stricto*, Vereda, Cerradão, along with areas still undergoing a regeneration process which corresponds to farms incorporated to the conservation unit area (Ramalho et al., 2018; SEMAD, 2021). In the PEJoL, over 40% of the total area is altered by agriculture and pastures (SEMAD, 2021). According to the Köppen classification, the climate type in the region is tropical with a dry winter (Aw) (Alvares et al., 2013), characterized by two well-defined seasons, one rainy and one dry.

#### Data collection, specimen processing, and identification

The specimens were collected using Malaise traps, Townes lightweight model (Townes, 1972), a passive flight interception trap, installed in three collecting sites within the limits of the reserves, one trap at each point: i) Mangueira trail (16°33'18.4"S 49°10'20.9"W), characterized by a semideciduous forestry area in regeneration at the edge of the João Leite water reservoir, ii) Onça trail (16°32'05.6"S 49°06'49.7"W), represented by a semideciduous forestry area with a water stream, and iii) Tamanduá trail (16°33'11.7"S 49°07'53.4"W), characterized by a drier forestry area (Figs. 1–2). Once installed, the collecting bottle of each trap was changed monthly, between June to October 2022 (representing the dry season) and November 2022 to March 2023 (representing the rainy season), summing up eight collecting events for the points (Table S1).

After collection, the specimens were previously stored in vials with 80% alcohol and then mounted on entomological pins. Medium to large soldier flies were pinned directly on pins; smaller specimens were glued to card points. A small fraction of specimens, most *Barbiellinia* sp. 1, remain in vials filled with 80% alcohol. All the specimens were labeled and deposited in the Coleção Zoológica da Universidade Federal de Goiás (ZUFG).

Stratiomyids were determined to genus using the identification keys for the Neotropical fauna (James and McFadden, 1979, 1982; James et al., 1980; Woodley, 2009). The identification of species was conducted using the few keys available for species (e.g., James, 1940; Iide, 1966; James and McFadden, 1971, 1982), and type specimen photographs and reliable images of the species when available in the literature (e.g., Fachin and Hauser, 2022 for distinguishing species of *Hermetia* Latreille, 1804), online collections databases and the personal database of the senior author. Yet, due to the lack of taxonomic revisions, images, and keys to species, some specimens could not be assigned to any described species, so they were identified to genus level, and putative distinct species were kept as distinct morphospecies.

A Zeiss Stemi 2000-C stereomicroscope coupled to an AxioCam ERc 5s camera was used to take dorsal and lateral habitus images of each species. The photos of each species, at several levels of focus, were stacked in the Helicon Focus. The final image and the plates were edited and prepared using Adobe Photoshop.

Maps were created using the software QGIS, version 3.22, with layers for the political delimitation of South America and Brazil obtained from the Instituto Brasileiro de Geografia e Estatística (<https://www.ibge.gov.br/geociencias/downloads-geociencias.html>). The boundaries of the state of Goiás and its municipalities were obtained from the Sistema de Informação do Estado de Goiás (<http://www.sieg.go.gov.br/siegddownloads/>) and the delimitation of the reserve from the Sistema de Informações Geográficas Ambientais do Estado de Goiás (<https://siga.meioambiente.go.gov.br>).

#### Data treatment and analysis

The Stratiomyidae data yielded from the reserves were compiled in an Excel datasheet, in alphabetical order of subfamily, genera, and species (Table S1), including collecting data. This dataset was used to calculate richness, abundance, and the number of specimens and species per trail. A graph with the number of genera and species in the reserves was made using Excel. The Mao Tao's method for the species accumulation curve used all the species captured. The richness estimators Chao 1, Chao 2, Jackknife 1, and Jackknife 2 were calculated with 100 randomizations to estimate the community's sampling sufficiency. These analyses were performed with EstimateS 9.1.0, then a graph was generated in Excel.

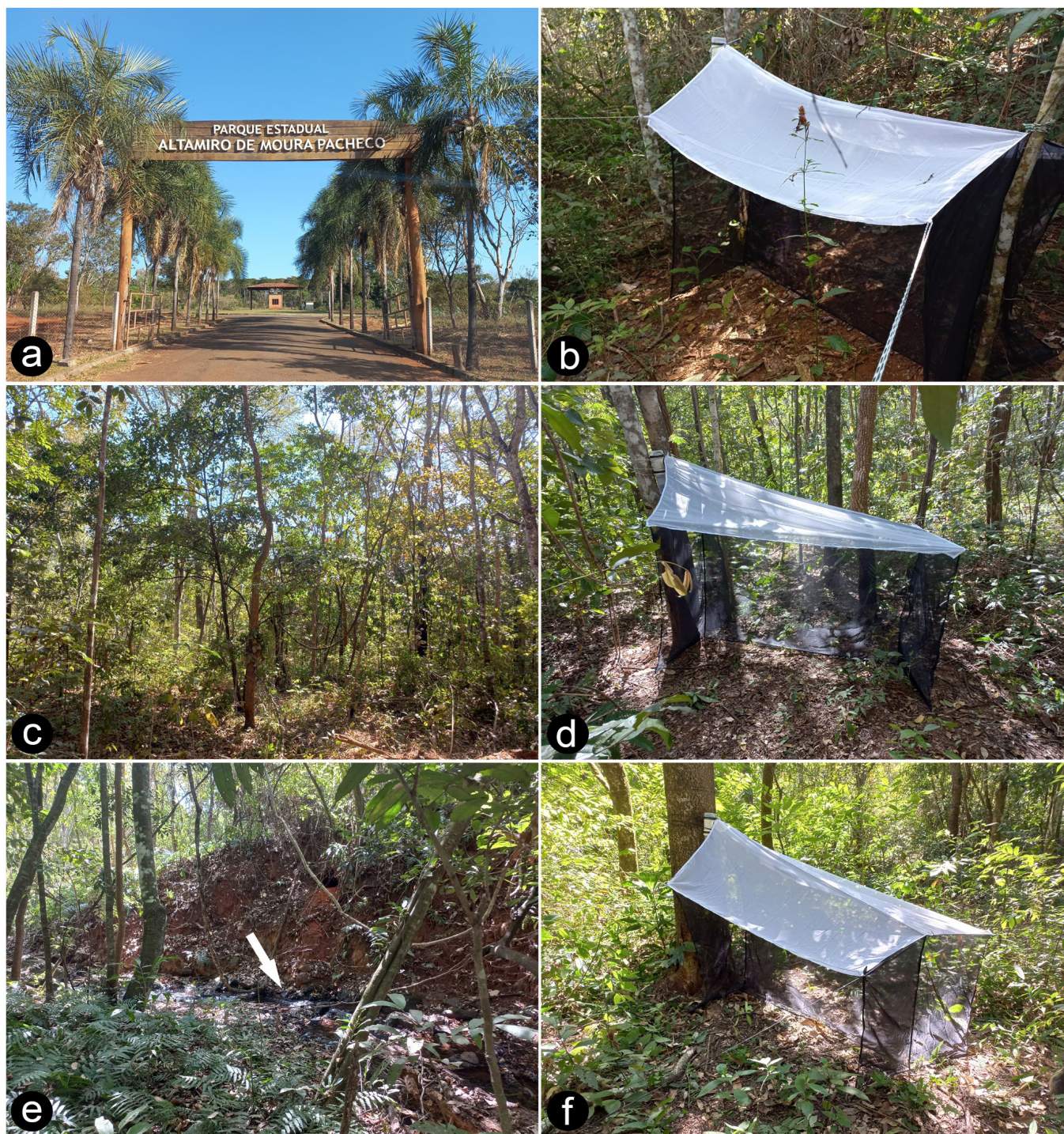
#### Results

Sixty-three species from 35 genera and eight subfamilies were identified from a total of 855 specimens of Stratiomyidae (Table 1, Figs. 3–10). Of these, 34 species with 311 specimens were assigned to described species. The remaining 29 species were left as morphospecies (with genus names followed by a code "sp. 1, sp. 2, etc" as in Table 1) as they may correspond to new taxa, such as *Chrysochlorina* sp. 1, which does match to none of the known species of the genus (Iide 1966, 1967) and two genera, left as "undescribed" since both do not match, respectively, none Neotropical genera of Clitellariinae and Pachygastrinae. In addition, "*Euparyphus*" sp. 2 may correspond to a new generic taxon. This species was found in Fachin et al. (2023) and was assigned to the genus *Glariopsis* Lindner, 1935. None of the specimens, however, match *Glariopsis*, and although they resemble *Euparyphus* (i.e., they are similar to our *Euparyphus* sp. 1), they do not fit entirely into the genus definition. Since the species might be a new taxon, we used "*Euparyphus*" and counted it as a separate genus. The full dataset with the number of species and specimens per month is found in Table S1.

Two known soldier flies, *Merosargus tangens* James, 1971 in James and McFadden, 1971 (Fig. 7f) from Ecuador and Peru and *Sargus cirrhusus* McFadden, 1982 in James & McFadden, 1982 (Fig. 7k), previously known only from Mexico, are reported for the first time to Brazil. It is worth mentioning that our *Sargus* sp. 1 is similar to *S. cirrhusus*, distinct, however, by the black color of the upper frons. Exclusively for the state of Goiás, 59 species are reported for the first time, of which 29 remain as morphospecies (Table 1). Four of the 10 previously known species for the state of Goiás (Fachin, 2025) were captured in our study: *Cyphomyia auriflamma* Wiedemann, 1829, *C. aurifrons* Wiedemann, 1830, *C. wiedemanni* Gerstaecker, 1857, and *Hermetia brachygastropsis* Fachin and Hauser, 2022.

#### Overall species richness and abundance

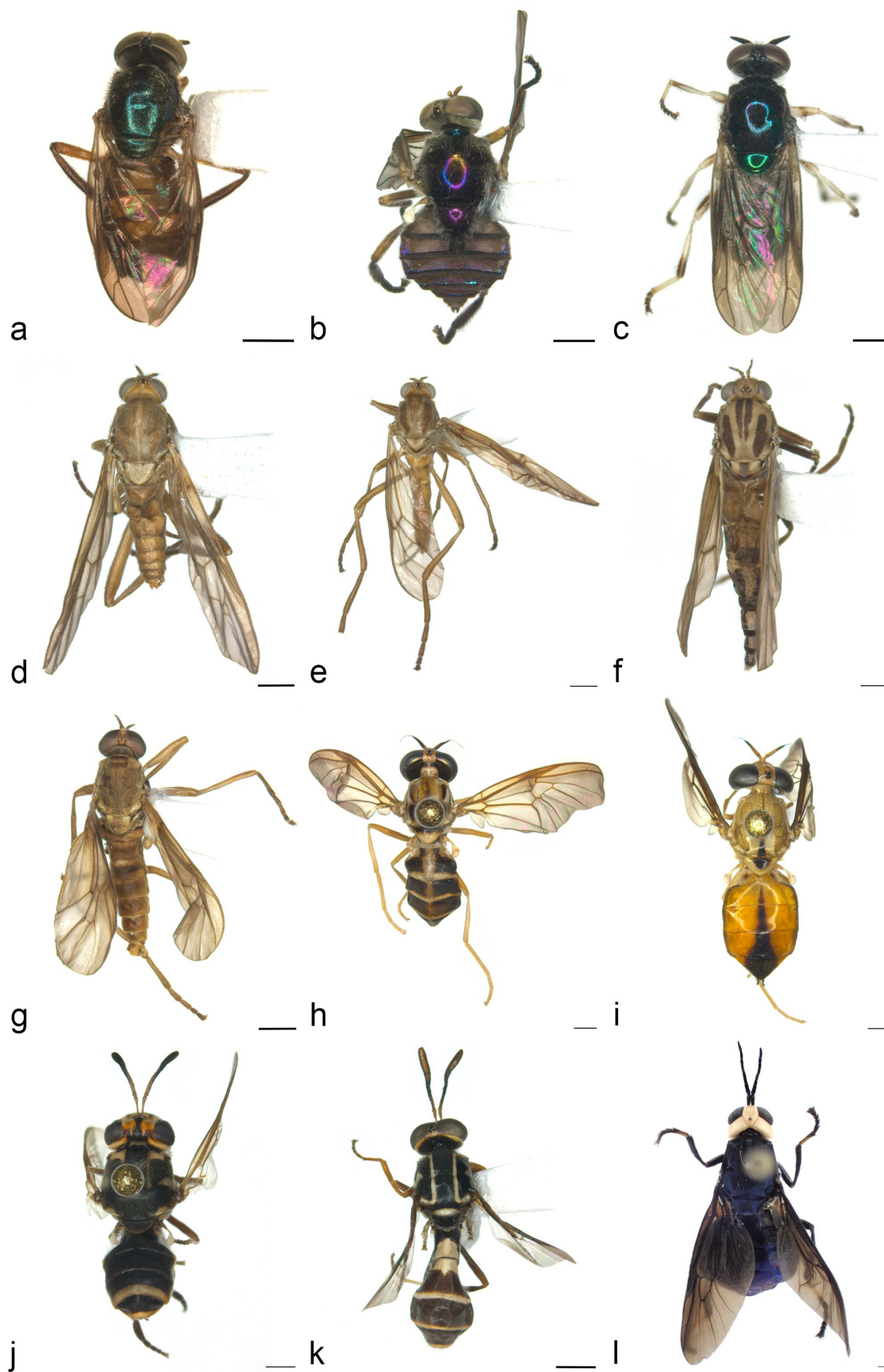
The richest subfamily in the number of species was Pachygastrinae, with 22 species, followed by Sarginae, with 15, and Clitellariinae, with 10. The other five subfamilies presented five or fewer species (Fig. 11).



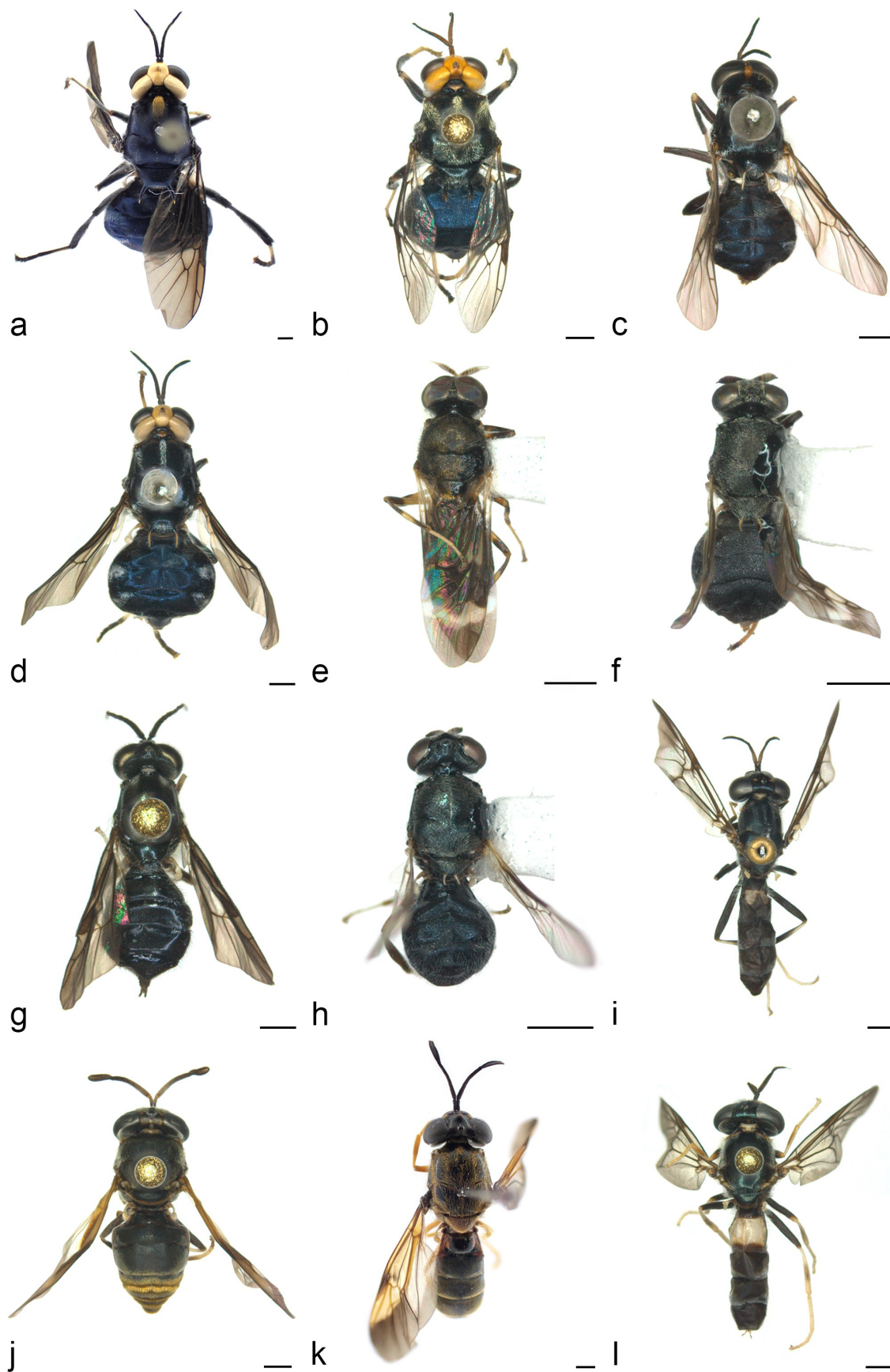
**Figure 2** (a) Entrance of the Parque Altamiro de Moura Pacheco, Goiás; (b) White roof Malaise trap in the Mangueira trail; (c) general landscape of the Tamanduá trail; (d) White roof Malaise trap in the Tamanduá trail; (e) general landscape of the Onça trail; (f) White roof Malaise trap in the Onça trail. White arrow indicates a water stream.

The genera *Merosargus* Loew, 1855, with seven, and *Sargus* Fabricius, 1805 (Sarginae), with six species, *Hermetia* Latreille, 1804 (Hermetiinae), with five, *Cyphomyia* Wiedemann, 1819 (Clitellariinae), with four, and *Chrysochlorina* James, 1939 (Chrysochlorininae), *Eidalimus* Kertész, 1914, and *Manotes* Kertész, 1916 (Pachygastrinae), all with only three species each, are the most speciose genera at the reserve (seven in total), with three or more species. Together, these seven genera accounted for 49.2% of the observed species richness. Twenty-four genera, however, were represented by one single species: one genus in Chiromyzinae, two each in

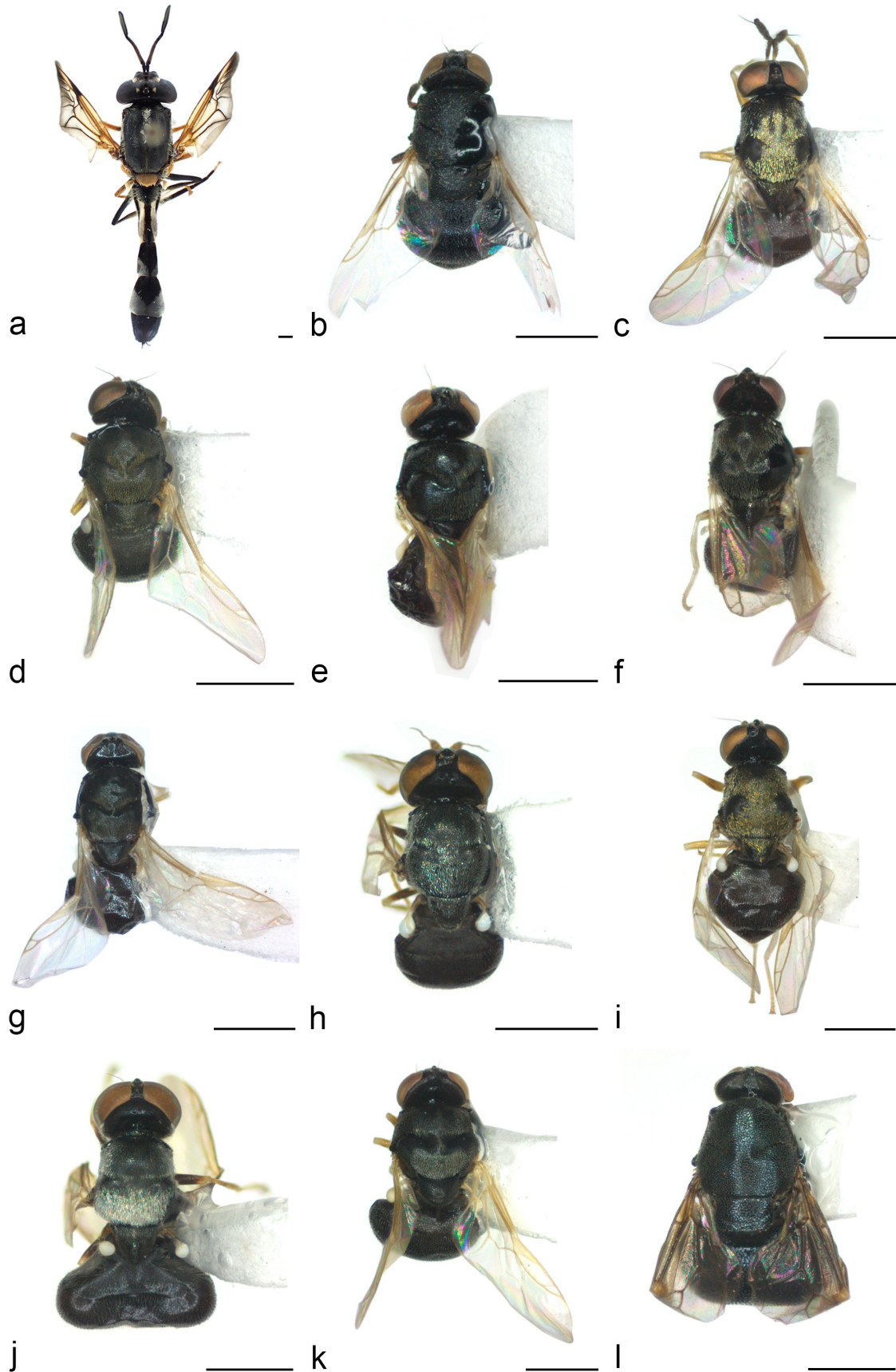
Sarginae and Stratiomyinae, three in Beridinae, four in Clitellariinae, and 12 in Pachygastrinae. The three subfamilies with the highest number of genera collected, with four or more, were Pachygastrinae, with 16 genera, Clitellariinae, with six, and Sarginae, with four. Together, Pachygastrinae, Clitellariinae, and Sarginae represented 76.4% of the total number of genera found (Fig. 11). Pachygastrinae was the richest in both species and genera, representing a little over one-third of the total number of species found (22 out of 63 species, 34.9% of the total) and nearly half of the total number of genera found (16 out of 34 genera, 47% of the total).



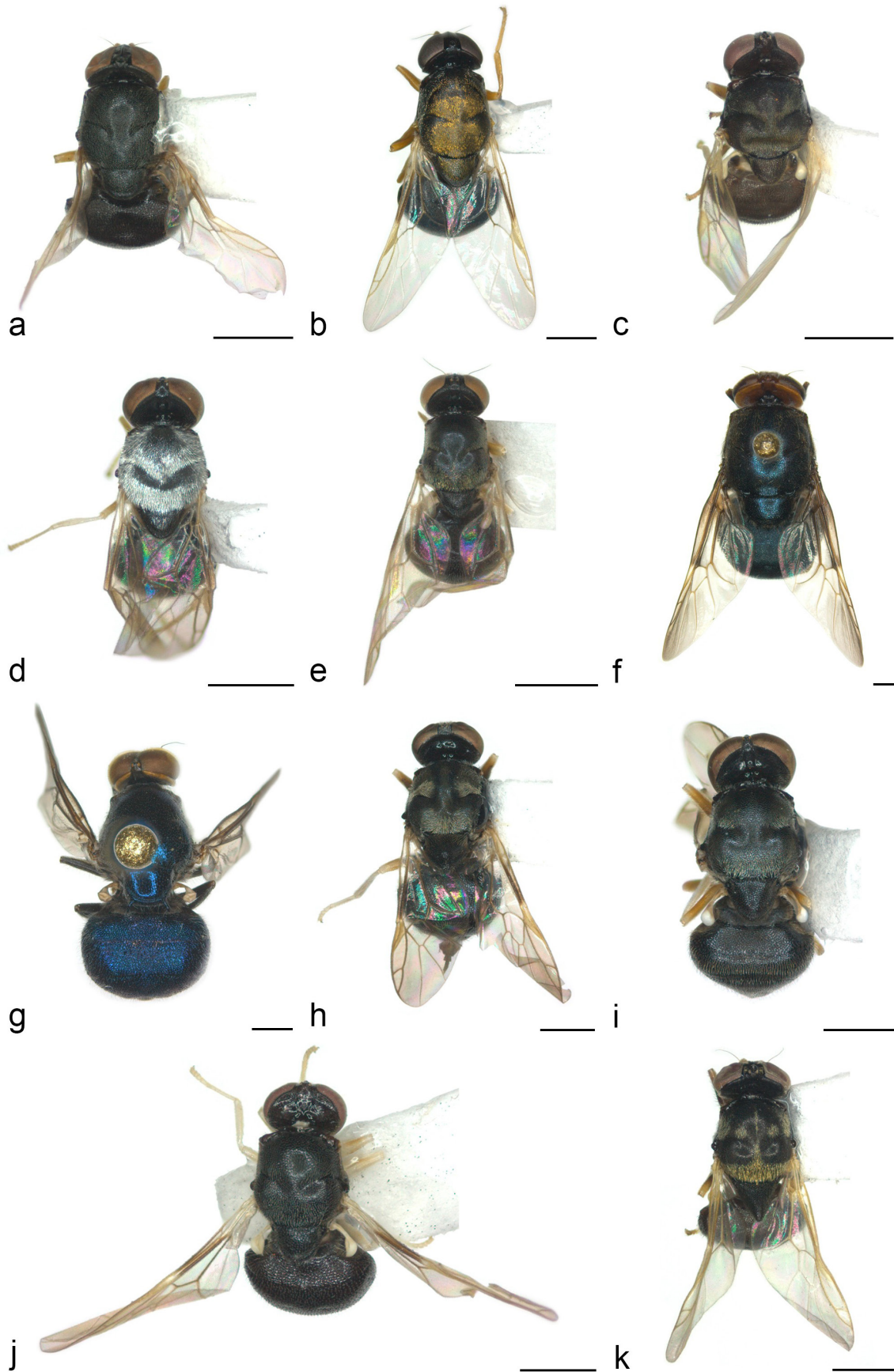
**Figure 3** Stratiomyidae of the PEAMP and PEJoL, Goiás, Brazil. (a) *Arcuavena* sp. 1, male; (b) *Heteracanthia ruficornis* Macquart, 1850, female; (c) *Oplachantha* sp. 1, female; (d) *Barbiellinia* sp. 1, male; (e) *Barbiellinia* sp. 2, male; (f) *Barbiellinia* sp. 2, female; (g) *Chiromyza* sp. 1, male; (h) *Chrysochlorina pluricolor* (Bigot, 1879), female; (i) *Chrysochlorina* sp. 1, female; (j) *Auloceromyia pachypoda* Fachin, 2015, female; (k) *A. pedunculata* Pimentel and Pujol-Luz, 2000, male; (l) *Cyphomyia auriflamma* Wiedemann, 1819, female. Scale bar = 1 mm.



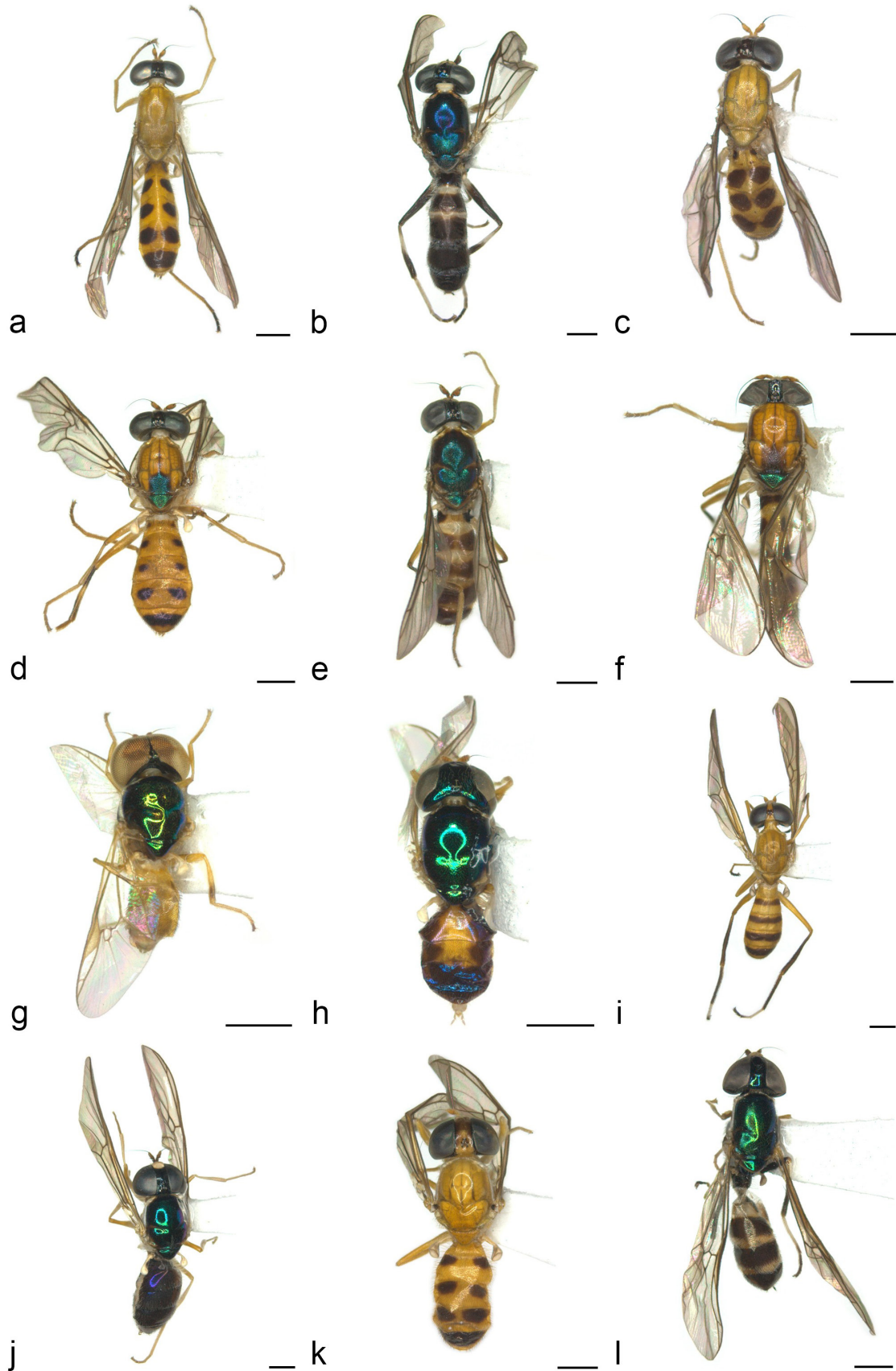
**Figure 4** Stratiomyidae of the PEAMP and PEJoL, Goiás, Brazil. (a) *Cyphomyia aurifrons* Wiedemann, 1830, female; (b) *C. picta* Schiner, 1868, female; (c) *C. wiedemanni* Gerstaecker, 1857, male; (d) *C. wiedemanni* Gerstaecker, 1857, female; (e) *Diaphorostylus* sp. 1, male; (f) *Euryneura* sp. 1, female; (g) *Leucoptilum plaumanni* James, 1943; (h) Undescribed genus 1, female; (i) *Hermetia albitarsis* Fabricius, 1805, female; (j) *H. brachygastropsis* Fachin and Hauser, 2022, female; (k) *H. currani* Lindner, 1949, female; (l) *H. flavipes* Wiedemann, 1830, female. Scale bar = 1 mm.



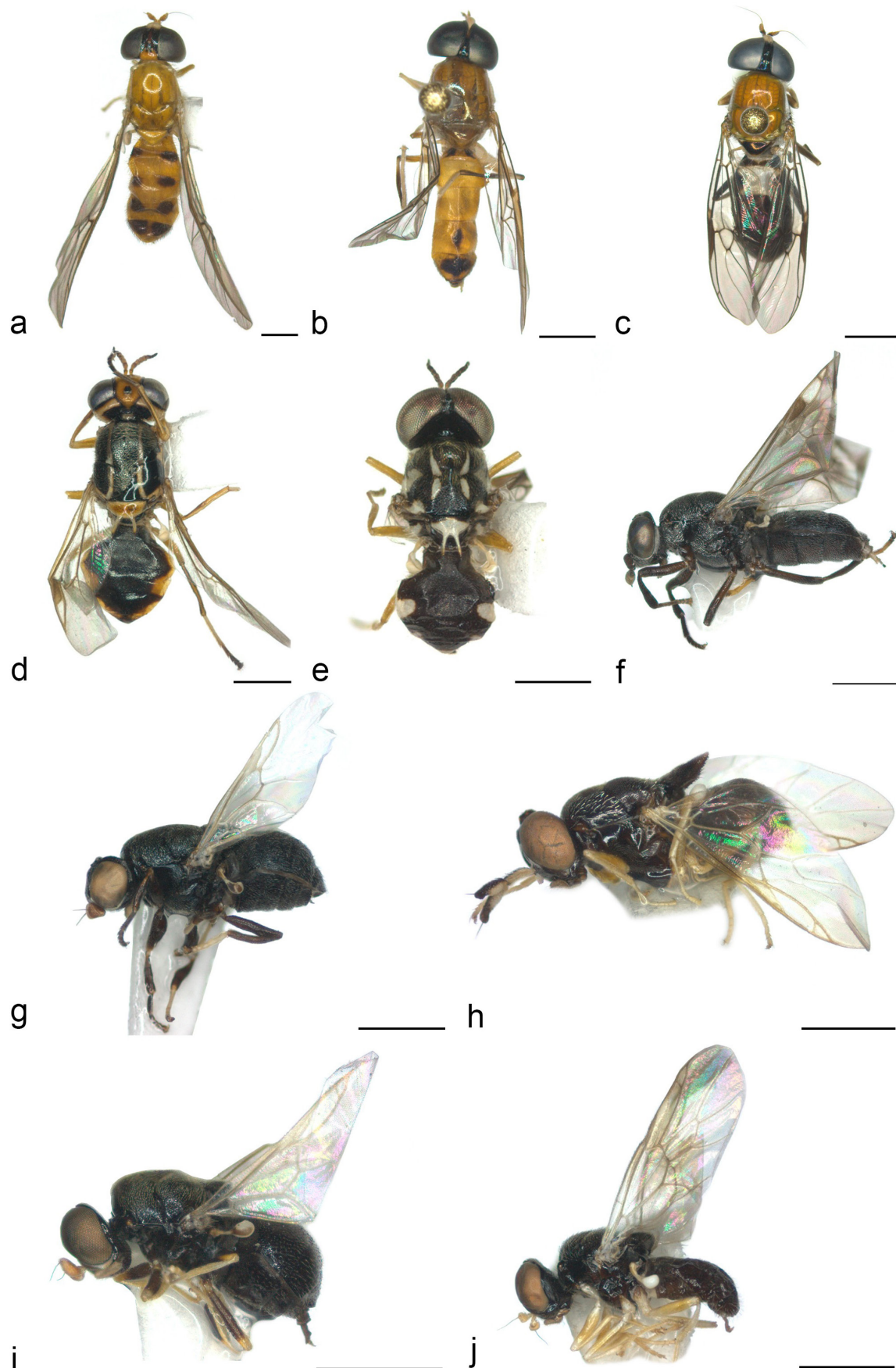
**Figure 5** Stratiomyidae of the PEAMP and PEJoL, Goiás, Brazil. (a) *Hermetia pulchra* Wiedemann, 1830, female; (b) *Borboridea* sp. 1, female; (c) *Chalcidomorpha aurata* Enderlein, 1914, female; (d) *Chlamydonotum nigreradiatum* Lindner, 1949, female; (e) *Cyclotaspis* sp. 1, female; (f) *Dactylodeictes* sp. 1, female; (g) *Diastophthalmus* sp. 1, female; (h) *Ecchaetomyia nigrovittata* Lindner, 1949, male; (i) *Eidalimus annulatus* Kertész, 1914, female; (j) *Eidalimus* sp. 1, male; (k) *Eidalimus* sp. 2, female; (l) *Manotes* sp. 1, female. Scale bar = 1 mm.



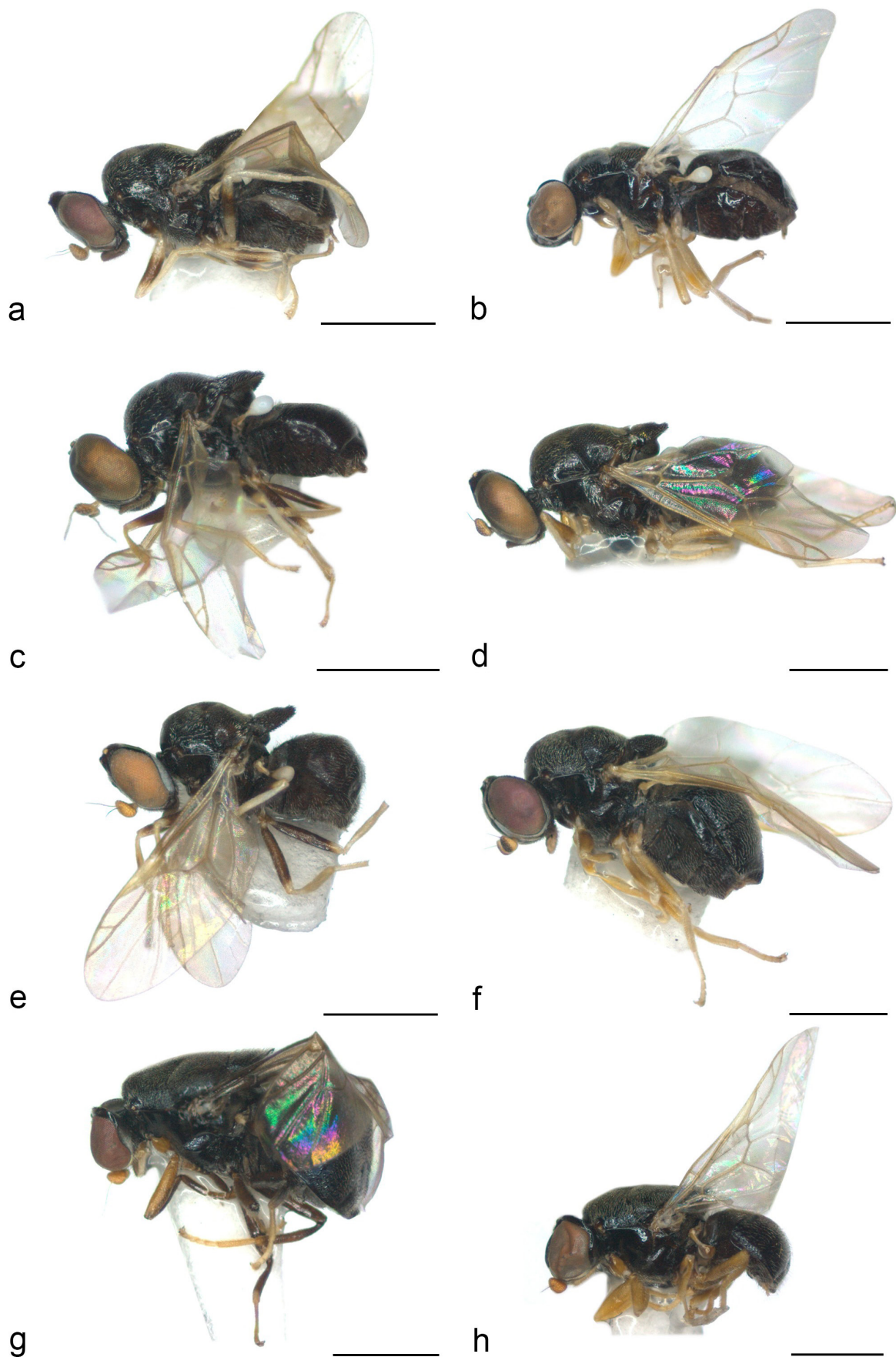
**Figure 6** Stratiomyidae of PEAMP and PEJOL, Goiás, Brazil. (a) *Manotes* sp. 2, female; (b) *Manotes* sp. 3, female; (c) *Meristocera aurea* Lindner, 1964, female; (d) *Myiocavia* sp. 1, male; (e) *Myiocavia* sp. 2, female; (f) Undescribed genus 2, female; (g) *Panacris lucida* Gerstaecker, 1857, male; (h) *Popanomyia femoralis* Kertész, 1909, female; (i) *Popanomyia* sp. 1, male; (j) *Psephiocera* sp. 1, female; (k) *Vittiger* sp. 1, female. Scale bar = 1 mm.



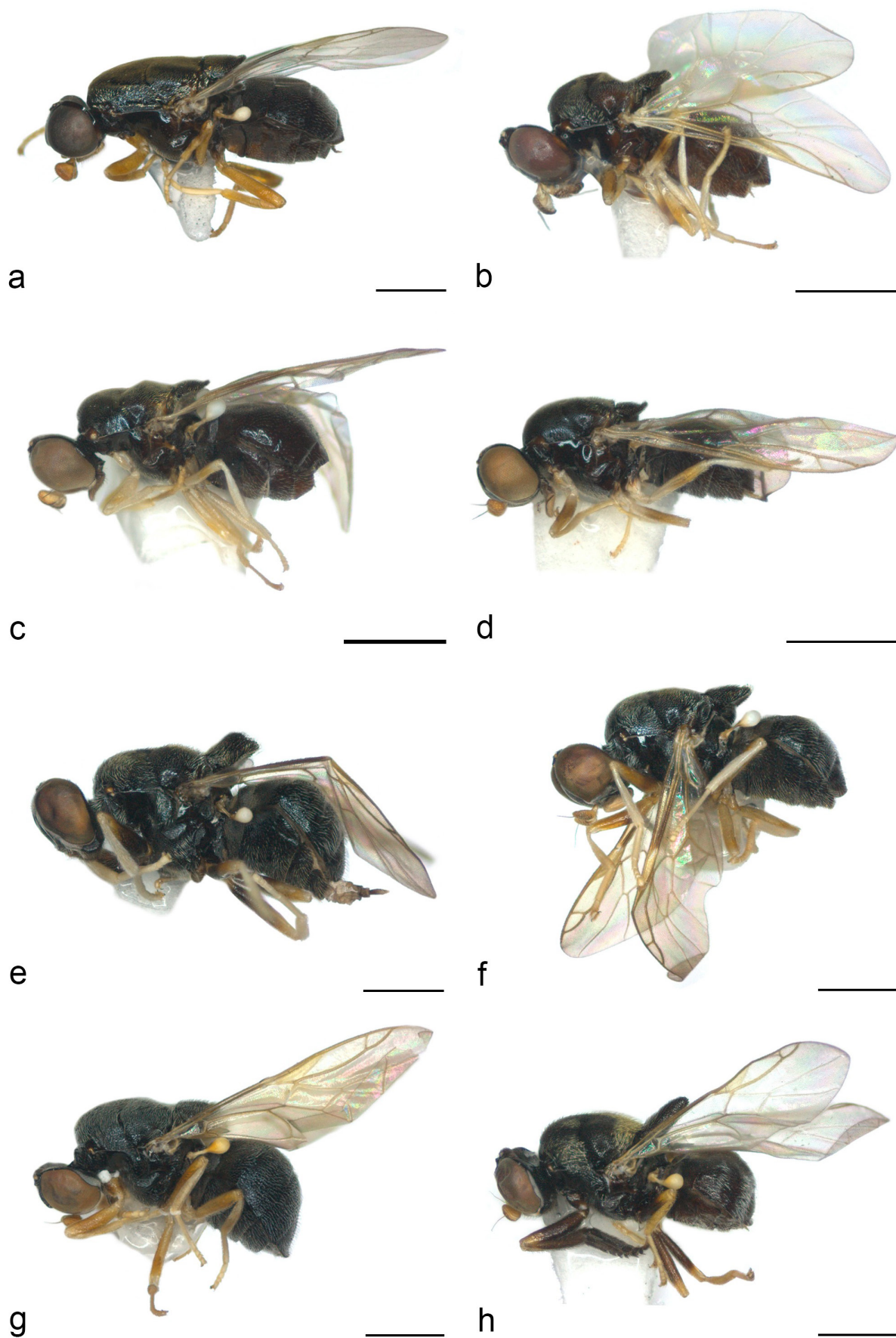
**Figure 7** Stratiomyidae of PEAMP and PEJoL, Goiás, Brazil. (a) *Merosargus golbachii* James, 1971 in James and McFadden, 1971, male; (b) *M. gracilis* Williston, 1888, female; (c) *M. nebulifer* James, 1971 in James and McFadden, 1971, female; (d) *M. opaliger* Lindner, 1931, male; (e) *M. tangens* James, 1971 in James and McFadden, 1971, female; (f) *M. tripartitus* James, 1971 in James and McFadden, 1971, male; (g) *Microchrysa bicolor* (Wiedemann, 1830), male; (h) *M. bicolor* (Wiedemann, 1830), female; (i) *Ptecticus testaceus* (Fabricius, 1794), female; (j) *Sargus brasiliensis* Wiedemann, 1830, female; (k) *S. cirrhosus* McFadden, 1982 in James and McFadden, 1982, female; (l) *S. fasciatus* Fabricius, 1805, female. Scale bar = 1 mm.



**Figure 8** Stratiomyidae of the PEAMP and PEJOL, Goiás, Brazil. (a) *Sargus* sp. 1, female; (b) *Sargus* sp. 2, male; (c) *Sargus thoracicus* Macquart, 1834, female; (d) *Euparyphus* sp. 1, female; (e) "*Euparyphus*" sp. 2, male; (f) *Euryneura* sp. 1, female; (g) *Borboridea* sp. 1, female; (h) *Chalcidomorphina aurata* Enderlein, 1914, female; (i) *Chlamydonotum nigreradiatum* Lindner, 1949, female; (j) *Cyclotaspis* sp. 1, female. Scale bar = 1 mm.



**Figure 9** Stratiomyidae of the PEAMP and PEJoL, Goiás, Brazil. (a) *Dactyloides* sp. 1, female; (b) *Diastopthalmus* sp. 1, female; (c) *Ecchaetomyia nigrovittata* Lindner, 1949, male; (d) *Eidalimus annulatus* Kertész, 1914, female; (e) *Eidalimus* sp. 1, female; (f) *Eidalimus* sp. 2, female; (g) *Manotes* sp. 1, female; (h) *Manotes* sp. 2, female. Scale bar = 1 mm.



**Figure 10** Stratiomyidae of the PEAMP and PEJOL, Goiás, Brazil. (a) *Manotes* sp. 3, female; (b) *Meristocera aurea* Lindner, 1964, female; (c) *Myiocavia* sp. 1, female; (d) *Myiocavia* sp. 2, female; (e) *Popanomyia femoralis* Kertész, 1909, female; (f) *Popanomyia* sp. 1, male; (g) *Psephiocera* sp. 1, female; (h) *Vittiger* sp. 1, female. Scale bar = 1 mm.

**Table 1**

Taxonomic composition and sampling months of soldier flies collected at the Parque Estadual Altamiro de Moura Pacheco and Parque Estadual do João Leite, Goiás, Brazil, from June to October 2022 and December 2022 to March 2023.

Subfamily	Species	Male	Female	Total	Month of occurrence	
					2022	2023
<b>Beridinae</b>						
	<i>Arcuavena</i> sp. 1*	16	4	20	Oct-Nov	-
	<i>Heteracanthia ruficornis</i> Macquart, 1850*	-	1	1	-	Feb-Mar
	<i>Oplachantha</i> sp. 1*	-	2	2	Oct-Nov-Dec	Jan
<b>Chiromyzinae</b>						
	<i>Barbiellinia</i> sp. 1*	235	5	240	Jun-Jul-Aug-Sep-Oct-Nov-Dec	Jan-Feb
	<i>Barbiellinia</i> sp. 2*	120	3	123	Jun-Jul-Aug	-
	<i>Chiromyza</i> sp. 1*	20	-	20	Jun-Jul-Aug	-
<b>Chrysochlorinae</b>						
	<i>Chrysochlorina pluricolor</i> (Bigot, 1879)*	1	16	17	Aug-Sep-Oct-Nov-Dec	Jan-Feb-Mar
	<i>Chrysochlorina</i> sp. 1*	-	2	2	Oct-Nov	-
	<i>Chrysochlorina</i> sp. 2*	-	1	1	-	Jan-Feb
<b>Clitellariinae</b>						
	<i>Auloceromyia pachypoda</i> Fachin, 2015*	-	14	14	Aug-Sep-Oct	-
	<i>Auloceromyia pedunculata</i> Pimentel and Pujol-Luz, 2000*	2	1	3	Aug-Sep-Oct	-
	<i>Cyphomyia auriflamma</i> Wiedemann, 1819	-	2	2	Dec	Jan
	<i>Cyphomyia aurifrons</i> Wiedemann, 1830	-	1	1	Sep-Oct	-
	<i>Cyphomyia picta</i> Schiner, 1868*	-	1	1	Dec	Jan
	<i>Cyphomyia wiedemanni</i> Gerstaecker, 1857	1	3	4	Aug-Sep-Oct	-
	<i>Diaphorostylus</i> sp. 1*	1	4	5	Oct-Nov	-
	<i>Euryneura</i> sp. 1*	-	1	1	Oct-Nov	-
	<i>Leucoptilum plaumanni</i> James, 1943*	-	3	3	Dec	Jan
	Undescribed genus 1**	-	4	4	Aug-Sep	-
<b>Hermetiinae</b>						
	<i>Hermetia albitarsis</i> Fabricius, 1805*	1	6	7	Aug-Sep-Oct-Dec	Jan
	<i>Hermetia brachygastropsis</i> Fachin and Hauser, 2022	-	11	11	Aug-Sep-Oct-Nov-Dec	-
	<i>Hermetia currani</i> Lindner, 1949*	-	1	1	Sep-Oct	-
	<i>Hermetia flavipes</i> Wiedemann, 1830*	-	10	10	Jun-Jul-Aug-Sep-Oct-Nov	Feb-Mar
	<i>Hermetia pulchra</i> Wiedemann, 1830*	-	3	3	Dec	Jan-Feb
<b>Pachygastrinae</b>						
	<i>Borboridea</i> sp. 1*	-	1	1	Aug-Sep	-
	<i>Chalcidomorphina aurata</i> Enderlein, 1914*	3	-	3	Oct-Nov	-
	<i>Chlamydonotum nigreradiatum</i> Lindner, 1949*	-	1	1	Sep-Oct	-
	<i>Cyclotaspis</i> sp. 1*	-	1	1	Oct-Nov	-
	<i>Dactylodeictes</i> sp. 1*	-	2	2	Oct-Nov	-
	<i>Diastopthalmus</i> sp. 1*	-	1	1	Sep-Oct	-
	<i>Ecchaetomyia nigrovittata</i> Lindner, 1949*	-	2	2	Oct-Nov	-
	<i>Eidalimus annulatus</i> Kertész, 1914*	-	1	1	Oct-Nov	-
	<i>Eidalimus</i> sp. 1*	5	66	71	Oct-Nov-Dec	-
	<i>Eidalimus</i> sp. 2*	-	6	6	Sep-Oct-Nov	-
	<i>Manotes</i> sp. 1*	1	7	8	Sep-Oct-Nov	-
	<i>Manotes</i> sp. 2*	-	1	1	Sep-Oct	-

\*New record for the state of Goiás; \*\*New record for Brazil.

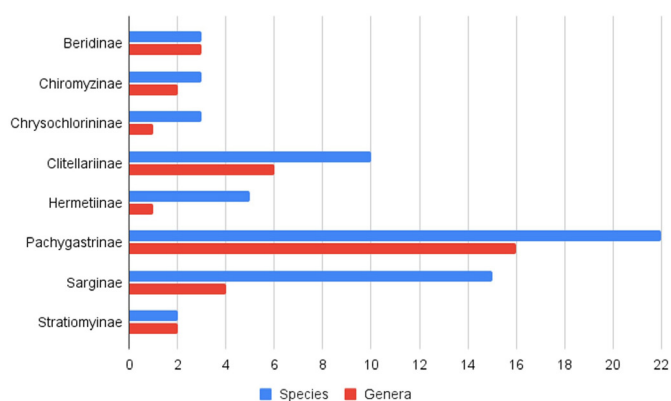
**Table 1**  
Continued...

Subfamily	Species	Male	Female	Total	Month of occurrence	
					2022	2023
<b>Pachygastrinae</b>						
	<i>Manotes</i> sp. 3*	-	1	1	Oct-Nov	-
	<i>Meristocera aurea</i> Lindner, 1964*	-	1	1	Dec	Jan
	<i>Myiocavia</i> sp. 1*	1	6	7	Jun-Jul-Aug- Sep-Oct-Nov	-
	<i>Myiocavia</i> sp. 2*	-	2	2	Oct-Nov	-
	<i>Panacris lucida</i> Gerstaecker, 1857*	1	-	1	Oct-Nov	-
	<i>Popanomyia femoralis</i> Kertész, 1909*	-	1	1	Sep-Oct	-
	<i>Popanomyia</i> sp. 1*	7	4	11	Oct-Nov-Dec	Jan
	<i>Psephiocera</i> sp. 1*	-	3	3	Sep-Oct-Nov	-
	<i>Vittiger</i> sp. 1*	-	1	1	Sep-Oct	-
	Undescribed genus 2**	-	1	1	Sep-Oct	--
<b>Sarginae</b>						
	<i>Merosargus c-nigrum</i> Lindner, 1951*	0	1	1	-	Jan-Feb
	<i>Merosargus golbachi</i> James, 1971 in James and McFadden, 1971*	4	2	6	Sep-Oct-Nov-Dec	Jan-Feb
	<i>Merosargus gracilis</i> Williston, 1888*	3	8	11	Jun-Jul-Aug- Sep-Oct	-
	<i>Merosargus nebulifer</i> James, 1971 in James and McFadden, 1971*	15	10	25	Sep-Oct- Nov-Dec	Jan
	<i>Merosargus opaliger</i> Lindner, 1931*	2	-	2	Oct-Nov	-
	<i>Merosargus tangens</i> James, 1971 in James and McFadden, 1971**	-	1	1	Oct-Nov	-
	<i>Merosargus tripartitus</i> James, 1971 in James and McFadden, 1971*	1	-	1	Oct-Nov	-
	<i>Microchrysa bicolor</i> (Wiedemann, 1830)*	57	54	111	Aug-Sep-Oct- Nov-Dec	Jan-Feb-Mar
	<i>Ptecticus testaceus</i> (Fabricius, 1794)*	3	6	9	Sep-Oct- Nov-Dec	Jan-Feb
	<i>Sargus brasiliensis</i> Wiedemann, 1830*	-	1	1	Dec	Jan
	<i>Sargus cirrhosus</i> McFadden, 1982 in James and McFadden, 1982**	-	5	5	Oct-Nov-Dec	Jan
	<i>Sargus fasciatus</i> Fabricius, 1805*	-	1	1	Oct-Nov	-
	<i>Sargus thoracicus</i> Macquart, 1834*	26	23	49	Jun-Jul-Aug- Sep-Oct-Nov-Dec	Jan-Feb-Mar
	<i>Sargus</i> sp. 1*	-	4	4	Oct-Nov-Dec	Jan
	<i>Sargus</i> sp. 2*	1	-	1	Oct-Nov	-
<b>Stratiomyinae</b>						
	<i>Euparyphus</i> sp. 1*	-	1	1	Oct-Nov	-
	" <i>Euparyphus</i> " sp. 2*	1	2	3	Oct-Nov	-
<b>Total</b>		528	327	855		

\*New record for the state of Goiás; \*\*New record for Brazil.

Chiromyzinae, with 383 specimens, was the most abundant, constituting 44.7% of all specimens, followed by Sarginae, with 228 (26.6% of the total), and Pachygastrinae, with 127 specimens (14.8% of the total) (Table 1). The remaining subfamilies, all with less than 50 specimens, are as follows, Clitellariinae, with 38, Hermetiinae, with 32, Beridinae, with 23, Chrysochlorininae, with 20, and Stratiomyinae, with only four specimens, the five representing altogether only 13.6% of all specimens.

Twenty-five and seven species were collected as singletons and doubletons, respectively, with most of these rare species found in Pachygastrinae (15) and Sarginae (seven). These species, which have only one or two specimens captured, accounted for 4.5% of all collected specimens, even so, representing 32 species, 50.7% of the total number of species. In contrast, 14 species (one each in Beridinae, Chrysochlorininae, and Clitellariinae, two each in Hermetiinae and Pachygastrinae, three in



**Figure 11** Diversity of genera and species in each subfamily at the PEAMP and PEJoL, Goianópolis, Goiás, Brazil.

Chiromyzinae, and four in Sarginae), only 22.5% of all species, have 10 specimens or more, representing, alone 85.7% (733 specimens) of all specimens. The five most abundant species, *Barbiellinia* sp. 1 (240 specimens) and *Barbiellinia* sp. 2 (123) (Chiromyzinae), *Eidalimus* sp. 1 (71) (Pachygastrinae), and *Microchrysa bicolor* (Wiedemann, 1830) (111) and *Sargus thoracicus* Macquart, 1834 (49) (Sarginae), represented 69.4% of all collected specimens (Table 1).

In the Tamanduá trail, 40 species and 340 specimens were collected. The most abundant species, with more than 10 specimens, were: *Barbiellinia* sp. 2 (123 specimens), followed by *Eidalimus* sp. 1 (49), *Sargus thoracicus* (33), *Microchrysa bicolor* (22), *Chrysochlorina pluricolor* (Bigot, 1879) (15), and *Auloceromyia pachypoda* Fachin, 2015 (14). On the other hand, 21 species were represented by singletons and four species by doubletons. Of the 40 species, 20 were exclusive to the Tamanduá trail, of which eight are from Pachygastrinae (Table 2). In the Onça trail, 33 species and 310 specimens were collected. The most abundant species, with more than 10 specimens, were: *Microchrysa bicolor* (79 specimens), *Barbiellinia* sp. 1 (77), *Merosargus nebulifer* James, 1971 in James & McFadden, 1971 (25), and *Chiromyza* sp. 1 and *Arcuavena* sp. 1, both with 20. In the trail, 14 species were represented by singletons and five by doubletons. Of the 34 species, 17 were exclusive to the Onça trail, and similar to the Tamanduá trail, most of the exclusive species were from Pachygastrinae (six) (Table 2). Finally, in the Mangueira trail, 17 species and 205 specimens were collected. The most abundant species, with more than 10 specimens, were: *Barbiellinia* sp. 1 (153 specimens) and *Sargus thoracicus* (12). Five species were exclusive to this collecting site and seven and three species were represented by singletons and doubletons, respectively (Table 2).

## Discussion

Faunistic studies with checklists of Stratiomyidae in the Neotropical Region are rare. For Brazil, in particular, except for the studies that compiled material from several localities (and from other South American countries), along with dates and collectors, and included descriptions of new taxa (e.g., Lindner, 1928, 1929, 1931, 1933, 1935, 1949, 1951, 1964, 1965, 1969), there are only six more recent faunistic studies that include soldier flies, either exclusively or combined with additional data for a specific area. These studies include: a species list from the Serra do Navio, Amapá (Couri et al., 2000)—with a single record of a soldier fly species—; the Ecological Station of Maracá, Ilha de Maracá, Roraima (Rafael, 1991; Riccardi et al., 2022); the Parque Estadual do Rio Doce, Minas Gerais (Fontenelle et al., 2012); the Tropical Silviculture Experimental Station, Manaus, Amazonas (Amorim et al., 2022); and

the Reserva Ecológica e Biológica Augusto Ruschi, Sertãozinho, São Paulo (Fachin et al., 2023). Therefore, for the Brazilian Cerrado and the state of Goiás, this is the first list of species of soldier flies from a single area, giving a glimpse into the fauna of the family in the state.

Similar to the checklist conducted at the Reserva Ecológica e Biológica in Sertãozinho (Fachin et al., 2023), located in the northeastern region of the state of São Paulo, the present study was in an area most characterized by semideciduous seasonal forests, a phytophysiognomy that, originally, covered large areas of the state of São Paulo (Fundação SOS Mata Atlântica, 2021). Although apart by about 600 km and mostly embedded in two distinct biomes (Cerrado and Atlantic Forest), the two areas sampled share over 20 species, and besides expanding the species distribution towards central portions of Cerrado, this reinforces the existence of connections between the two biomes (Instituto Florestal, 2020). The present study, however, showed a higher species richness even within a much shorter collecting period. In Sertãozinho, 41 species and 25 genera were found in about 19 months (from May 2010 to December 2011), whereas in the present area, 63 species and 35 genera were collected in 10 months. Regarding abundance, Sertãozinho yielded more specimens (1,533) than the present study (818), which could be linked to its longer collecting period or simply to the fact that it collected nearly three times more Chiromyzinae than in our area. Disregarding the number of Chiromyzinae and its species found in both studies, they have a similar abundance, with 432 specimens for 39 species in Sertãozinho and 472 for 60 species at the PEAMP/PEJoL, indicating that our new collecting area rendered more singletons or doubletons than Sertãozinho.

Interestingly, the two most abundant subfamilies in both areas were Chiromyzinae and Sarginae, with 1,101 and 213 specimens in Sertãozinho, and 383 and 228 in our area. As Fachin et al. (2023) pointed out, a high abundance of chiromyzines is not seen in other faunistic studies in different regions of Cerrado (Lamas et al., 2023), with only 85 chiromyzines (data unpublished), or in other biomes, as in Riccardi et al. (2022), where not a single specimen was recorded. Humidity, temperature, and vegetation type may influence the abundance and emergence of adults of Chiromyzinae, as seen in studies conducted even in distinct phytophysiognomies of the Cerrado (Lamas et al., 2023; and in our study), however, it should be considered that biases of the collecting method (perhaps different colors of the Malaise trap could be tested), period of the year, and the duration of the collecting may also affect the abundance of Chiromyzinae (and likely of other subfamilies).

According to the Taxonomic Catalog of the Fauna of Brazil (Fachin, 2025), only 10 species of four genera and four subfamilies of Stratiomyidae (Chrysochlorinae, Clitellariinae, Hermetiinae, and Raphiocerinae) are known from the state of Goiás. Our results increase the number of subfamilies by 125%, adding Beridinae, Chiromyzinae, Pachygastrinae, Sarginae, and Stratiomyinae, and bring an increase of 590% in the number of species and 775% in the number of genera for the state, with the inclusion of 59 new species/morphospecies records. Besides that, our data shows that the number of soldier fly species in the area, according to the use of richness estimators, can reach ~120, which is nearly twice the number of species found (Fig. 12). While the observed richness in the area was 63 species (Mao Tao accumulation curve), two estimators, Jackknife 2 and Chao 2, indicated about 120 species, and the other two estimators, Jackknife 1 and Chao 1, point to nearly 90 species for the studied area (Fig. 12). This is not a surprise, considering that the collections in the area are still limited in time and space. Likely, the estimators would indicate a richness more similar to the observed richness if the area had been extensively sampled.

With this study, the current number of soldier flies in the state is raised to 69 species, 35 genera, and nine subfamilies, of which 59 species and 31 genera are solely reported from a single locality of Goiás. Besides the

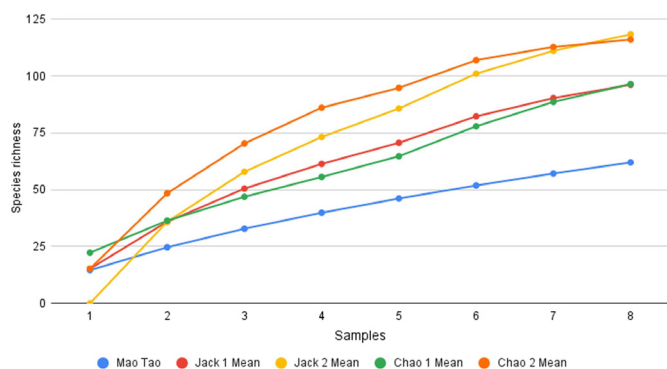
**Table 2**

Taxonomic composition by collecting sites at the Parque Estadual Altamiro de Moura Pacheco and Parque Estadual do João Leite, Goiás, Brazil.

Subfamily	Species	Collecting site		
		Tamanduá trail	Onça trail	Mangueira trail
<b>Beridinae</b>				
	<i>Arcuavena</i> sp. 1	-	20	-
	<i>Heteracantha ruficornis</i>	-	1	-
	<i>Oplachantha</i> sp. 1	2	-	-
<b>Chiromyzinae</b>				
	<i>Barbiellinia</i> sp. 1	10	77	153
	<i>Barbiellinia</i> sp. 2	123	-	-
	<i>Chiromyza</i> sp. 1	-	20	-
<b>Chrysochlorininae</b>				
	<i>Chrysochlorina pluricolor</i>	15	-	2
	<i>Chrysochlorina</i> sp. 1	2	-	-
	<i>Chrysochlorina</i> sp. 2	1	-	-
<b>Clitellariinae</b>				
	<i>Auloceromyia pachypoda</i>	14	-	-
	<i>Auloceromyia pedunculata</i>	-	-	3
	<i>Cyphomyia auriflamma</i>	-	2	-
	<i>Cyphomyia aurifrons</i>	1	-	-
	<i>Cyphomyia picta</i>	1	-	-
	<i>Cyphomyia wiedemanni</i>	4	-	-
	<i>Diaphorostylus</i> sp. 1	1	4	-
	<i>Euryneura</i> sp. 1	-	1	-
	<i>Leucoptilum plaumanni</i>	1	2	-
	Undescribed genus 1	4	-	-
<b>Hermetiinae</b>				
	<i>Hermetia albitarsis</i>	3	1	3
	<i>Hermetia brachygastropsis</i>	7	-	4
	<i>Hermetia currani</i>	-	-	1
	<i>Hermetia flavipes</i>	1	8	1
	<i>Hermetia pulchra</i>	3	-	-
<b>Pachygastrinae</b>				
	<i>Borboridea</i> sp. 1	1	-	-
	<i>Chalcidomorphina aurata</i>	-	3	-
	<i>Chlamydonotum nigreradiatum</i>	-	1	-
	<i>Cyclotaspis</i> sp. 1	-	1	-
	<i>Dactylodeictes</i> sp. 1	2	-	-
	<i>Diastopthalmus</i> sp. 1	-	1	-
	<i>Ecchaetomyia nigrovittata</i>	1	1	-
	<i>Eidalimus annulatus</i>	-	1	-
	<i>Eidalimus</i> sp. 1	49	15	7
	<i>Eidalimus</i> sp. 2	5	1	-
	<i>Manotes</i> sp. 1	5	1	2
	<i>Manotes</i> sp. 2	1	-	-
	<i>Manotes</i> sp. 3	1	-	-
	<i>Meristocera aurea</i>	1	-	-
	<i>Myiocavia</i> sp. 1	6	-	1
	<i>Myiocavia</i> sp. 2	-	2	-
	<i>Panacris lucida</i>	1	-	-
	<i>Popanomyia femoralis</i>	1	-	-
	<i>Popanomyia</i> sp. 1	6	5	-
	<i>Psephiocera</i> sp. 1	-	1	2
	<i>Vittiger</i> sp. 1	-	-	1
	Undescribed genus 2	1	-	-

**Table 2**  
Continued...

Subfamily	Species	Collecting site		
		Tamanduá trail	Onça trail	Mangueira trail
<b>Sarginae</b>				
	<i>Merosargus c-nigrum</i>	-	1	-
	<i>Merosargus golbachi</i>	2	4	-
	<i>Merosargus gracilis</i>	-	11	-
	<i>Merosargus nebulifer</i>	-	25	-
	<i>Merosargus opaliger</i>	-	2	-
	<i>Merosargus tangens</i>	-	1	-
	<i>Merosargus tripartitus</i>	-	1	-
	<i>Microchrysa bicolor</i>	22	79	10
	<i>Ptecticus testaceus</i>	1	7	1
	<i>Sargus brasiliensis</i>	1	-	-
	<i>Sargus cirrhosus</i>	4	1	-
	<i>Sargus fasciatus</i>	-	-	1
	<i>Sargus thoracicus</i>	33	4	12
	<i>Sargus</i> sp. 1	1	3	-
	<i>Sargus</i> sp. 2	1	-	-
<b>Stratiomyinae</b>				
	<i>Euparyphus</i> sp. 1	-	-	1
	" <i>Euparyphus</i> " sp. 2	1	2	-
<b>Total</b>		340	310	205



**Figure 12** Species accumulation curve (Mao Tao's method) and performance of the richness estimators (Jackknife 1, Jackknife 2, Chao 1, and Chao 2) of the Stratiomyidae collected at the PEAMP and PEJoL, Goiás, Brazil, from June 2022 to March 2023. Samples refer to each collecting event.

records of described species, genera, and subfamilies for the state, this study also reported new records of species for Brazil—*Merosargus tangens* and *Sargus cirrhosus*—, and undescribed taxa, such as the “undescribed genus 1 and 2”, belonging to Clitellariinae and Pachygastrinae, respectively, and a new species of Chrysochlorininae, which will be described elsewhere. These results illustrate the still unrevealed diversity of the family in Goiás and the Cerrado and, therefore, this is likely only the tip of the iceberg since the family (and other groups of insects) has been scarcely studied in the Cerrado.

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### Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

### Author contribution statement

GLCMM and DAF contributed to the study conception, design, material preparation, data collection, and analysis. GLCMM prepared the first draft of the text. The figures were prepared by both authors who read and approved the final manuscript.

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**Supplementary material**

The following online material is available for this article:

Table S1 - Species of Stratiomyidae at the Parque Estadual Altamiro de Moura Pacheco and Parque Estadual do João Leite, with all species and specimens sampled by each collecting date.